August 20, 2019

Ex Parte
Ms. Marlene H. Dortch
Secretary
Federal Communications Commission
445 Twelfth Street, S.W.
Washington, D.C. 20554

Re: Establishing the Digital Opportunity Data Collection WC Docket No. 19-195
Modernizing the FCC Form 477 Data Program, WC Docket No. 11-10
Connect America Fund, WC Docket No. 10-90
Rural Digital Opportunity Fund, WC Docket No. 19-126

Dear Ms. Dortch:

USTelecom – The Broadband Association (USTelecom), ITTA – The Voice of America's Broadband Providers (ITTA) and the Wireless Internet Service Provider Association (WISPA) and their members, (collectively "the Broadband Mapping Consortium" or "the Consortium") have proposed a long-term solution to make our nation's fixed broadband mapping more accurate and granular to meet the needs of policymakers, consumers, and broadband service providers.[1] In order to demonstrate to the Commission and other stakeholders that our proposed solution is achievable and can be done nationally in a timely and cost-effective manner, we invested in a Proof of Concept Pilot ("Pilot"), managed by CostQuest Associates, with our collective members, AT&T, CenturyLink, Chariton Valley, Consolidated, Frontier, Riverstreet, TDS, Verizon, and Windstream. Many other providers contributed their coverage and address data to the Pilot.

The Consortium is pleased to submit to the Commission the attached report summarizing the key findings and methodology from our Pilot. Using state-of-the-art technology and a combination of public and commercial datasets, the Pilot demonstrates that it is now possible to identify and precisely locate virtually every structure in a geographic area that is capable of receiving broadband service; this is referred to as the Broadband Serviceable Location Fabric ("Fabric"). Developing the Fabric in our two

[1] *See* Letter of B. Lynn Follansbee, VP Law & Policy, USTelecom to Marlene H. Dortch, Secretary, FCC, WC Docket Nos. 11-10, 10-90 (Mar. 21, 2019).

Pilot states of Missouri and Virginia demonstrates that it is not only possible to do so for the entire country, but it is necessary to achieve our nation's broadband goals.

Millions of Americans continue to lack access to the opportunities enabled by broadband. Policymakers have uniformly agreed on the need to address this challenge. Key to closing the digital divide is an understanding of the precise number and locations of those without access to broadband. While national estimates of the broadband gap have been possible through existing FCC broadband availability reporting, information has not been available at a sufficiently granular level for policymakers to truly identify where broadband is lacking, and thus, where resources can be allocated most efficiently.

Our report shows that regardless of format of broadband reporting (shapefile, propagation map, address, etc.), the reliability and validity of reporting is driven by the quality of the underlying data. The Fabric provides this crucial, but presently missing, link. In addition to other important metrics, our Pilot shows as many as 38 percent of additional rural locations in Virginia and Missouri are unserved by participating providers in census blocks that would have been reported as "served" in today's FCC Form 477 reporting approach. These locations are homes and small businesses hidden from service providers and policymakers simply because of a lack of knowledge fueled by gaps in data—gaps that we can now fill.

The Commission is currently seeking comment in the above-referenced proceedings on how to establish a national dataset of broadband serviceable locations, and how such information could be used to support broadband deployment through programs such as the recently announced Rural Digital Opportunity Fund. To inform these proceedings, we are pleased to submit this report for review by all stakeholders. We appreciate the Commission's continued leadership to improve the information it collects on broadband availability and to close the digital divide.

Respectfully submitted,

By: ___Jonathan Spalter/s/_____
Jonathan Spalter
President & CEO
USTelecom – The Broadband Association

By: ___Genevieve Morelli/s/_____
Genevieve Morelli
President
ITTA

By: ___Claude Aiken/s/_____
Claude Aiken
President & CEO
WISPA

Broadband Mapping Initiative: Proof of Concept

Summary of Findings

Jim Stegeman, President/CEO

August 2019

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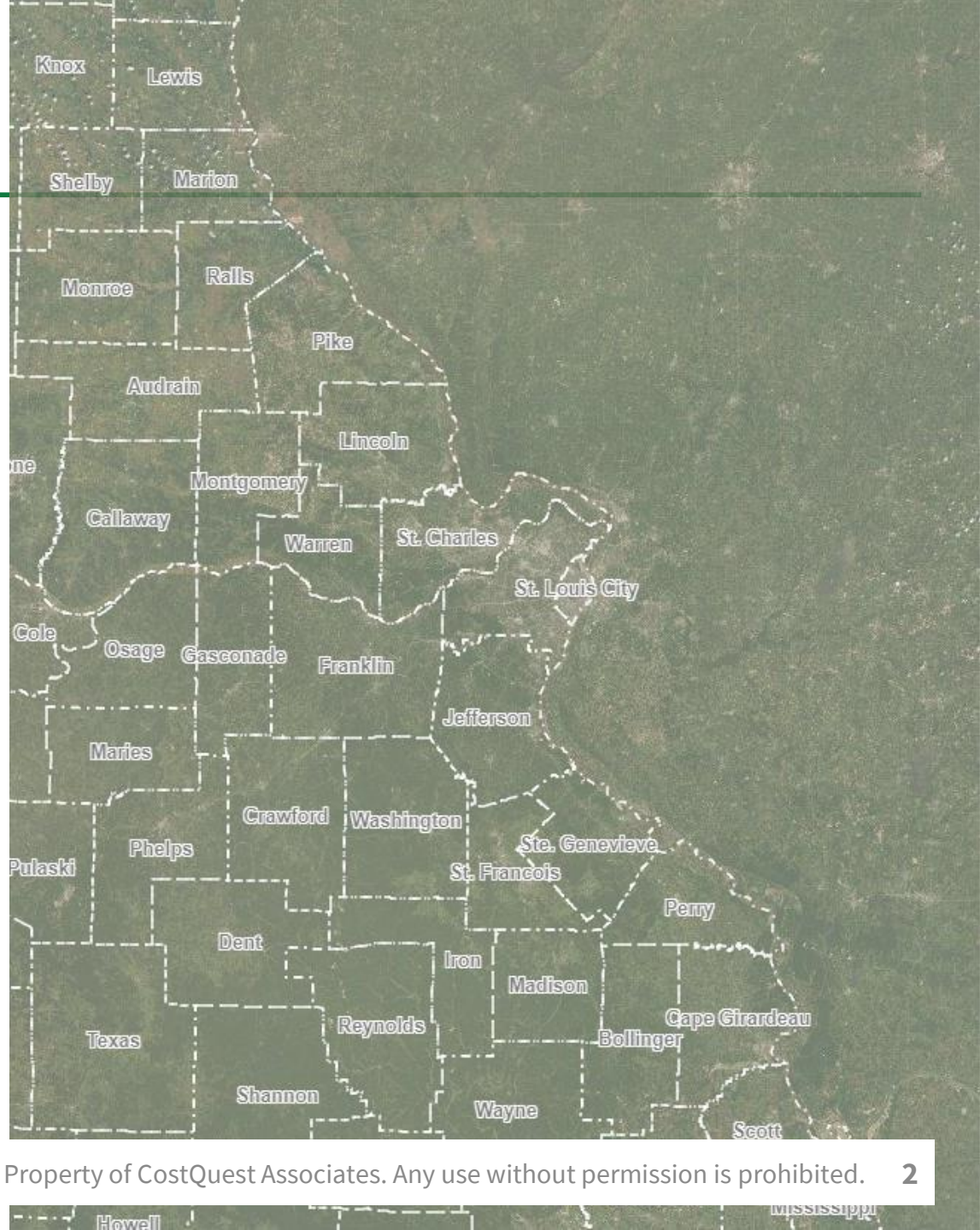

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Executive Summary – The Broadband Mapping Initiative

Millions of Americans continue to lack access to the opportunities enabled by broadband. Key to closing the digital divide is an understanding of the precise number and location of those who don't have access to broadband. While national estimates of the broadband gap have been possible through existing FCC broadband availability reporting, information has not been available at a sufficiently granular level for policymakers to truly identify where broadband is lacking, and thus, where resources can most effectively be deployed. Policymakers have uniformly agreed on the need to address this challenge.

Recognizing the need for better data, and the opportunity that new data sources and technologies make possible, a coalition of leading broadband innovators launched the Broadband Mapping Initiative in April 2019. The Initiative launched a two-state Pilot in Missouri and Virginia to demonstrate the feasibility of identifying the precise number and location of every structure in the states that require broadband access – referred to as the Broadband Serviceable Location Fabric (Fabric or BSLF). This Fabric of broadband serviceable structures makes it possible to precisely map where broadband is available and more importantly, *where it isn't*. The Pilot, managed by CQA, is a collaboration between USTelecom, ITTA, WISPA, AT&T, CenturyLink, Chariton Valley, Consolidated, Frontier, Riverstreet, TDS, Verizon, and Windstream.

The Pilot shows as many as 38% of additional rural locations are unserved in census blocks that would have been reported as "served" in today's FCC Form 477 reporting approach. These locations are homes and businesses hidden from service providers and policymakers simply because of a lack of knowledge fueled by gaps in data—gaps that we can now fill.

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Executive Summary – The Broadband Mapping Initiative

Key Findings:

- **The Pilot was a Success.** Using state of the art technology and a combination of public and commercial datasets, it is now possible to identify and precisely locate virtually every structure in a geographic area that is capable of receiving broadband. Developing the Fabric for two states shows it is possible to do so for the entire country.
- **Pinpointing Service Availability.** Creating the Fabric revealed that in just two states over 450,000 homes and businesses exist that are counted as "served" under current 477 reporting that are not receiving service from participating providers. While not every broadband provider chose to participate in this Pilot – so the actual number of unserved may be lower – that still leaves the potential for substantial misrepresentations about service availability.
- **The Counts Count.** We measured broadband availability by locations in a census block. The Fabric revealed that *48% of the location counts in rural census blocks are different from current estimates*, in many cases significantly different.

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Executive Summary – The Broadband Mapping Initiative

Key Findings (cont'd):

- **Timely and Cost Effective.** A nationally developed dataset of all broadband serviceable locations consistent with the approach demonstrated in the Pilot can be achieved in 12-15 months. The cost to do so will vary depending on the mix of open source or proprietary data sources, but a national Fabric could potentially be developed for between $8.5-$11 million in upfront costs and $3-4 million in annual updates.
- **Location, Location, Location.** Broadband availability is about connections, but providers must know exactly where a structure is in order to provide that link. The presumed geocoded location for 61% of rural homes and businesses are off by over 7.6m (25 feet) and 25% are off by over 100m (328 feet) – more than a football field! This distance can significantly impact the cost to deploy to an unserved location – making or breaking a decision to deploy for a provider.
- **Reporting Enhanced.** Regardless of format (shapefile, propagation map, address, etc.) the quality and validity of reporting is driven by the quality of the underlying data on which the report is overlaid.

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Executive Summary – The Broadband Mapping Initiative

Our methodology aggregates hundreds of millions of data points, applies statistical scoring, and managed crowdsourcing to pinpoint the exact locations of virtually every structure that is a candidate for broadband. Our effort seeks to contribute a source of truth to the ecosystem that is the next step in ensuring that agencies, policymakers, and providers are empowered with the data to bring our communities online. Based on current knowledge, there are at least 21 million Americans[1] that don't have broadband internet. To help solve this coverage issue, the FCC has committed over $20.4b in public funding over the next 10 years.

We've mapped Missouri and Virginia and we're excited to share some of our findings in the slides to follow. With your help, we'll expand our efforts to the entire U.S. by the end of next year. Let's continue to bridge the digital divide, together.

[1]FCC broadband report 2019 located at

https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2019-broadband-deployment-report

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Key Pilot Findings - Rural Missouri & Virginia

Key Findings

[1] *Not every broadband provider chose to participate in this Pilot, so the actual number of unserved may be lower.*

RURAL LOCATION COUNTS

38%

of total Rural Locations in Census Blocks reported to be served are UNSERVED[1]

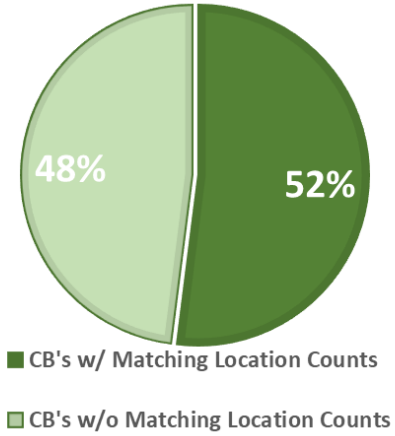
The FABRIC identifies unseen locations

445,000+

48%

of Rural Census Block Fabric Location Counts Don't Match Currently used Estimates of Location Counts

The FABRIC corrects these counts

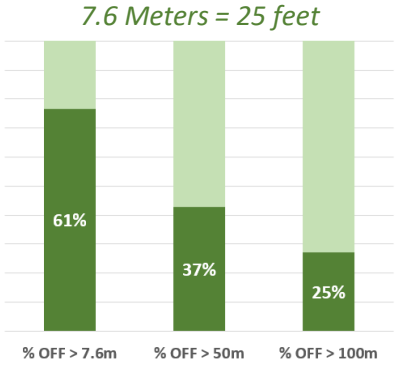


RURAL DISTANCE DIFFERENCES

61%

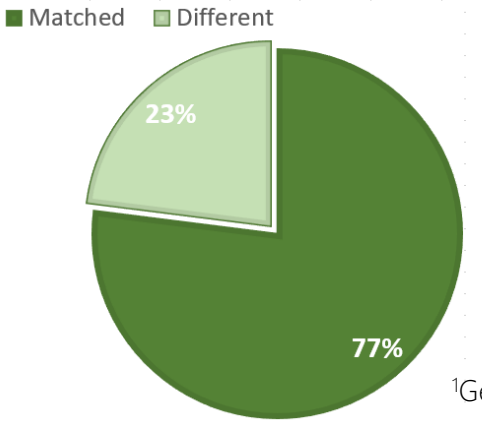
of Rural Pilot provided geocoded[1] Locations NOT at the correct structure location

The FABRIC corrects theses coordinates



25%

of Rural Pilot Locations are off by over 100m



23%

of Rural Pilot Locations NOT geocoded[1] to Correct Census Blocks

The FABRIC trues-up these locations

[1]Geocoded = Use of Geocoding Tool

Bottom Line

The FABRIC greatly improves the accuracy of Census Block location counts

The FABRIC provides much improved accuracy for location coordinates

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Key Pilot Findings – Unserved Locations Now Viewable

With the Fabric we are NOW able to reflect the locations of those homes and businesses that are unserved.

In the 4 slides to follow, we transition from the coverage viewpoint as of today (whole census blocks) to the identification of unserved locations. The 10 census blocks shown are in east, central Missouri. The locational data are actual carrier supplied coverage addresses.

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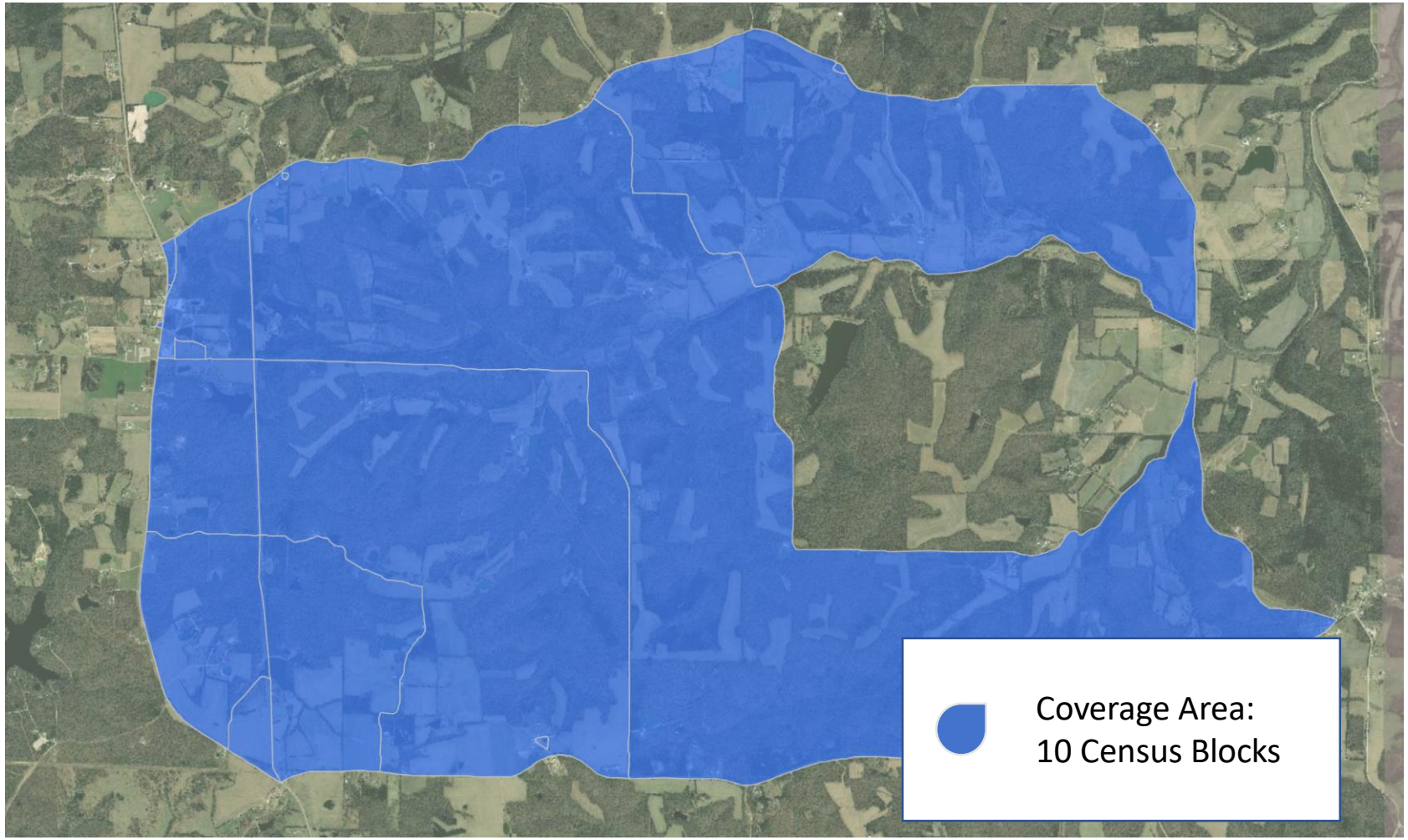
Key Pilot Findings – Unserved Locations Now Viewable

10 Census Blocks in MO that would be identified as SERVED in today's 477

"One-served, All-Served"

Blue area represents the coverage of the 10 Census Blocks



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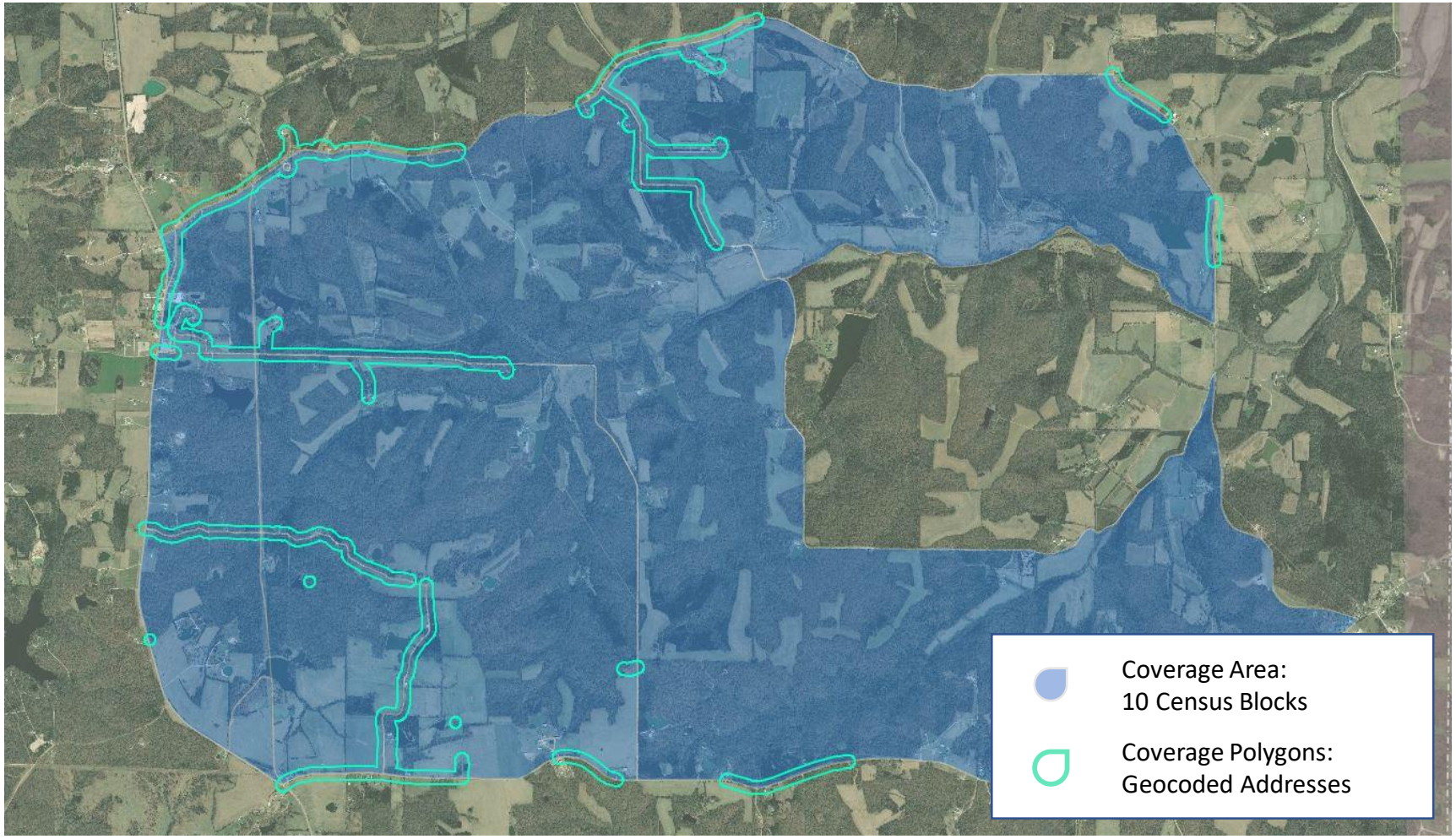
Key Pilot Findings – Unserved Locations Now Viewable

Polygon approach for 477 coverage in these 10 census blocks

Polygons Based on:

- Geocoded addresses served
- 150ft buffers on roads

We now have knowledge of Served



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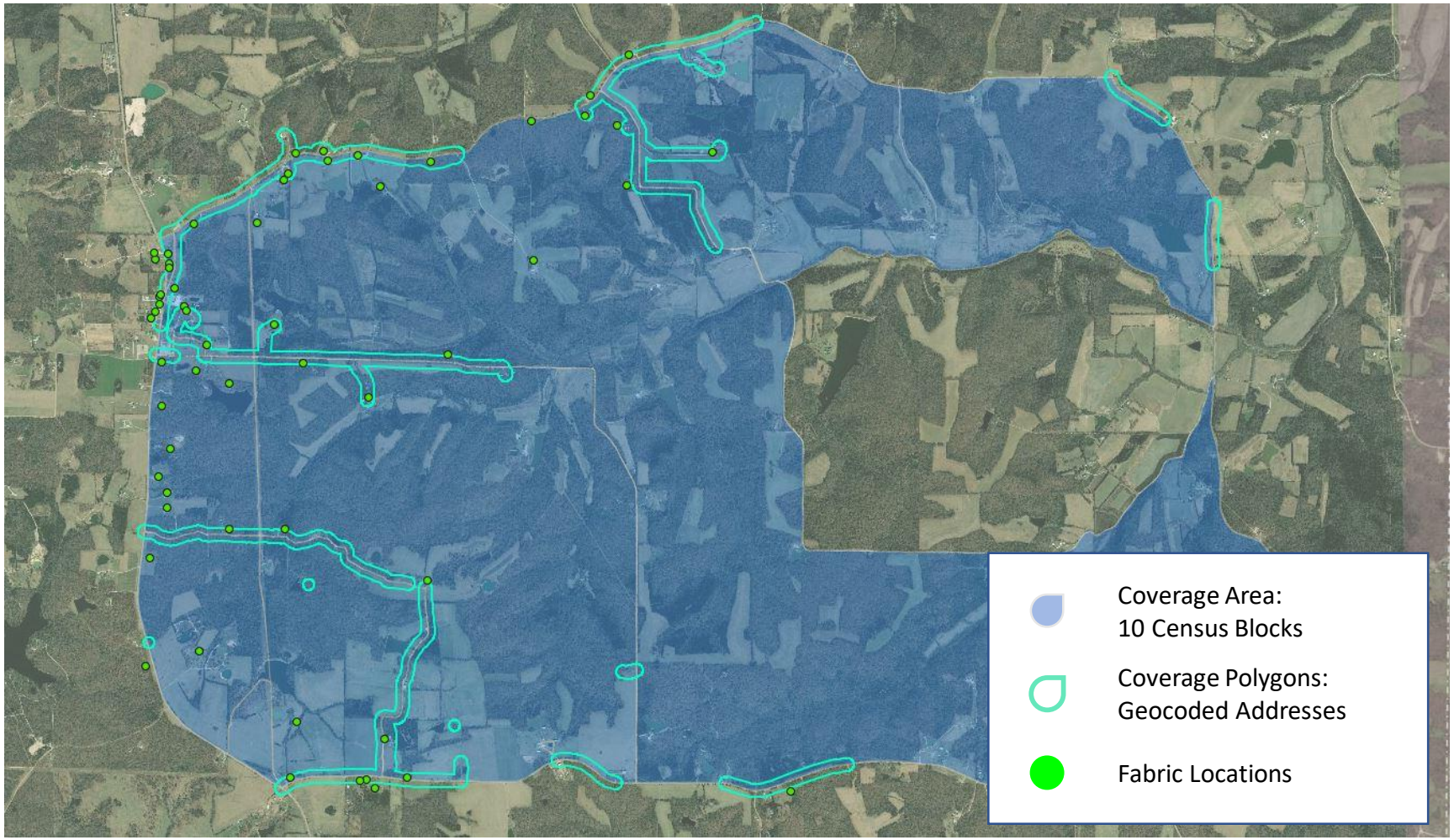
Key Pilot Findings – Unserved Locations Now Viewable

Polygons are created using commercial geocoding of addresses in these 10 census blocks

Green dots represent Fabric locations associated with addresses used to create polygons

It is clear the polygons based on poor geocoded information will miss locations



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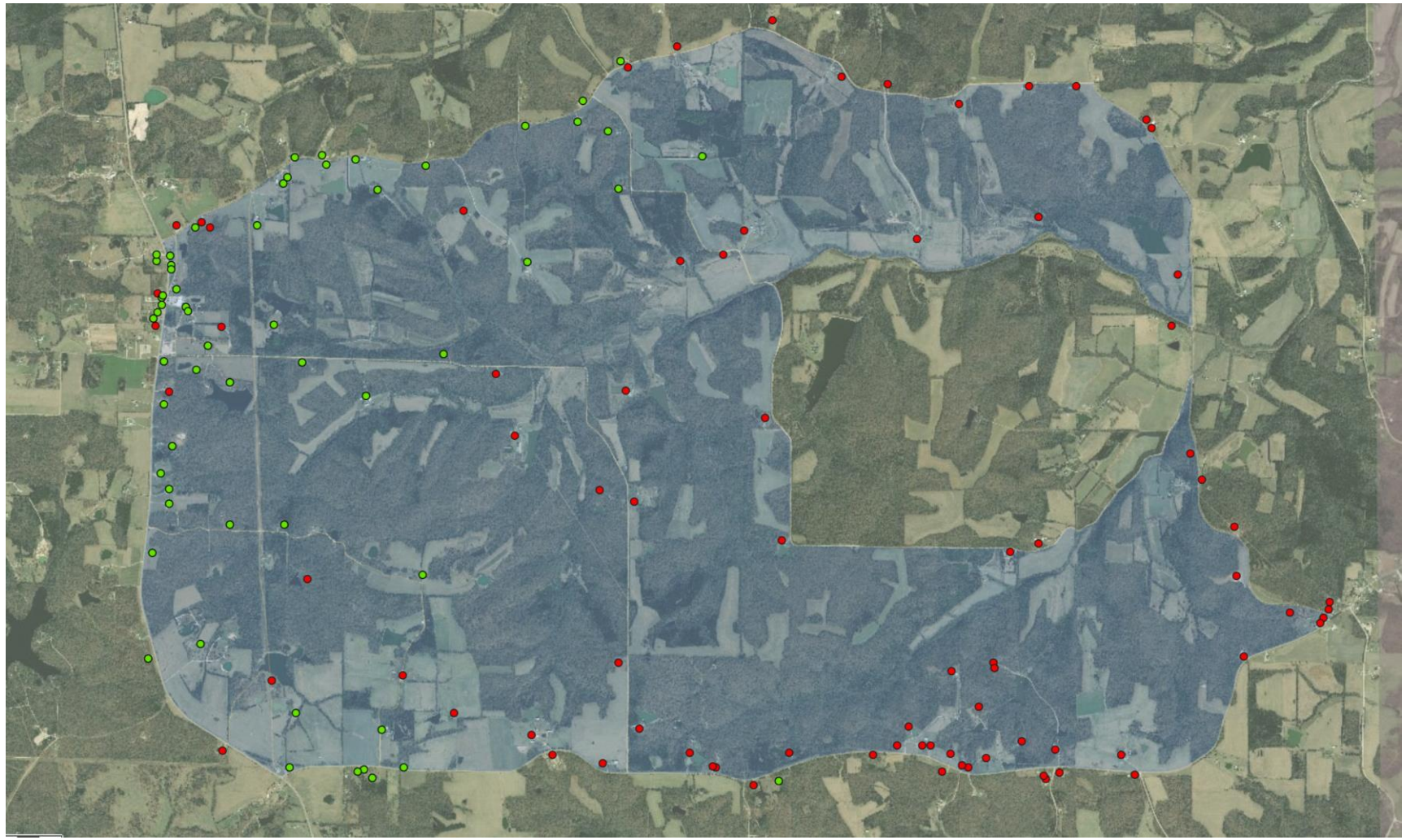
Key Pilot Findings – Unserved Locations Now Viewable

The BIG COVERAGE REVEAL

The Fabric process allows us to now see extent of the of Served (green dots) and Unserved(red dots) locations in this 10 Census Block area

- Coverage Area: 10 Census Blocks
- Unserved Fabric Locations
- Fabric Locations



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NATIONAL FABRIC CONSIDERATIONS

Things to consider

Address Data Normalization:

- Consider creating address format standards for carrier filings
- Efforts need to be focused on identifying multi-dwelling units and the determination of count of units

Serviceable Structure:

- FCC should define what a serviceable structures represents
- Requirements for the assignment of structures into residential and business categories needs to identified

Parcel Attribute Normalization:

- Assessor LandUse identification along with a few other key fields are key drivers of fabric identification and customer type (e.g., residential) determination. A national effort to produce guidelines for assessor's use would lead to an improved fabric product
- Some areas of the country lack public parcel information. These parcel boundaries constrain processing of all the various layers of data. A national effort to create a complete national parcel layer would lead to an improved fabric product

National Fabric	Open Source[1]	Proprietary[2]	Key Issues
Budget	**Upfront: $22M - $24.5M** **Annual Updates: $7M - $8M** • Beneficial to use some proprietary data • Would rely heavily on Visual Verification • Fabric could be made publicly-available (but still may require some restrictions on use)	**Upfront: $8.5M - $11M** **Annual Updates: $3M - $4M** • Superior initial product • Would rely on third-party data • Fabric would be restricted in use but could still be used publicly	• Visual Verification is a large cost-driver but is a key driver of quality • Without third party, proprietary data, obtaining and normalizing public parcel attributes is labor-intensive and costly • Continuing from the proof of concept will save 8-12 months of time
Timeline	**Continue From Proof of Concept*: 12 – 15 months** **** This pilot has advanced the process by 8-12 months*** ***Does not account for time related to procurement/contracting***		

[1]Open Source = Creation of National Fabric assuming use of only Open Source data
[2]Proprietary = Creation of National Fabric assuming use of both Open Source and Proprietary data

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Problem

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How Do We Pinpoint Which Americans Still Need Broadband?

Targeted Broadband Deployment Requires an Increasingly Granular Viewpoint

- In the last 20 years, Federal broadband reporting has evolved from Zip Code to Census Blocks reporting which has continued to clarify the location and extent of the digital divide
- If we continue to evolve this policy to a location specific level, new data sources and new methods will be necessary
- In no way do our findings reflect a criticism of prior approaches and methods, rather they reflect that if policy objectives change, data sources, methods and outcomes will change
- Data sources will continue to improve over time as resources are focused at a national level

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How Broadband Availability Is Currently Reported

- Form 477 Census Block data is self-reported and certified by carriers semi-annually
  - The current intent of 477 is to reflect where service can or could be provisioned at a Census Block level
  - The notion of a Census Block-level standard could overstate broadband availability
  - By design, current 477 reporting doesn't describe broadband availability for a specific location

- Connect America Fund (CAF) participants file location data in the HUBB Portal
  - Although HUBB filings require location-specific reporting, experience and submitted data demonstrate unexpected complexity of location-specific reporting for rural areas
  - In rural areas, a structure-accurate location can be difficult to generate using current commercially available tools
  - For a CAF carrier, translating deployment information into a geocoded format usable by HUBB can be complex

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Solution

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The Future of Broadband Reporting

The Broadband Serviceable Location Fabric (BSLF or Fabric) addresses a significant barrier to understanding the digital divide by supporting structure level mapping

- **Problem:** At least 21 million Americans[1] are not receiving broadband service
  - To more specifically identify the count and location of the unserved, the precision of broadband mapping should be improved
- **Solution:** The BSLF aggregates hundreds of millions of data points, applies statistical scoring, and managed crowdsourcing to pinpoint the exact locations of virtually every structure that is a candidate for broadband. The BSLF is the foundation for precise service maps, accurately targeted funding, and improved progress reporting.

This section helps frame the issue and the solution to identifying served and unserved locations

[1]FCC broadband report 2019 located at

https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2019-broadband-deployment-report

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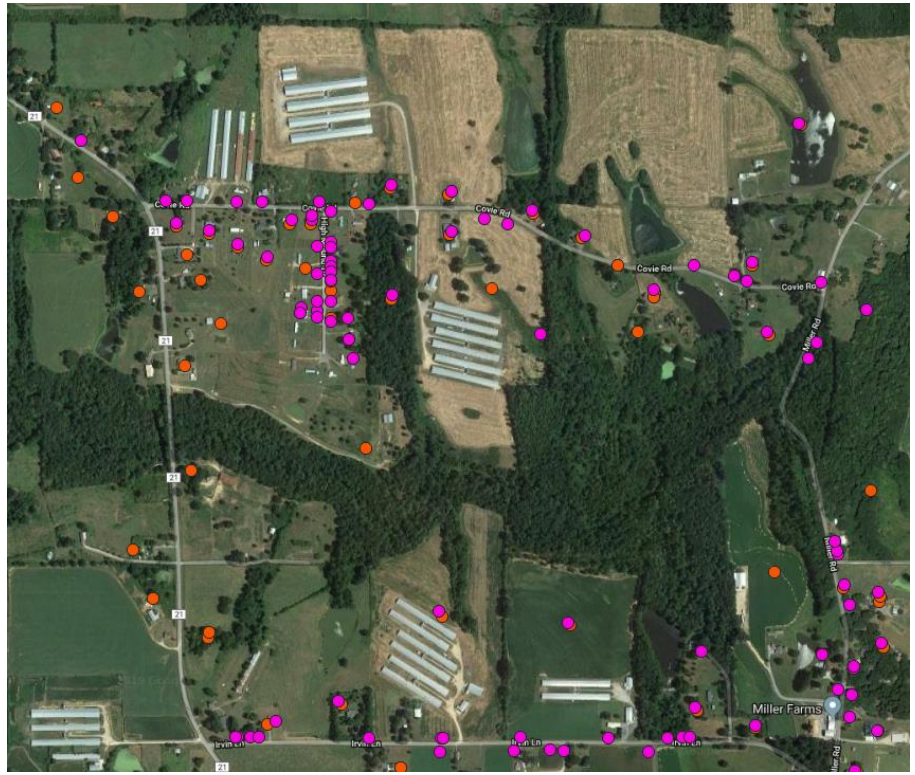
Where the Fabric Makes a Difference: Targeting Locations



Dots shown represent the results of entering the same service addresses into two geocoders. It is unclear how many locations exist in this area or where service would be installed.

The Fabric uses multiple data sources to better identify the locations (green triangles) of homes and businesses that would need service.

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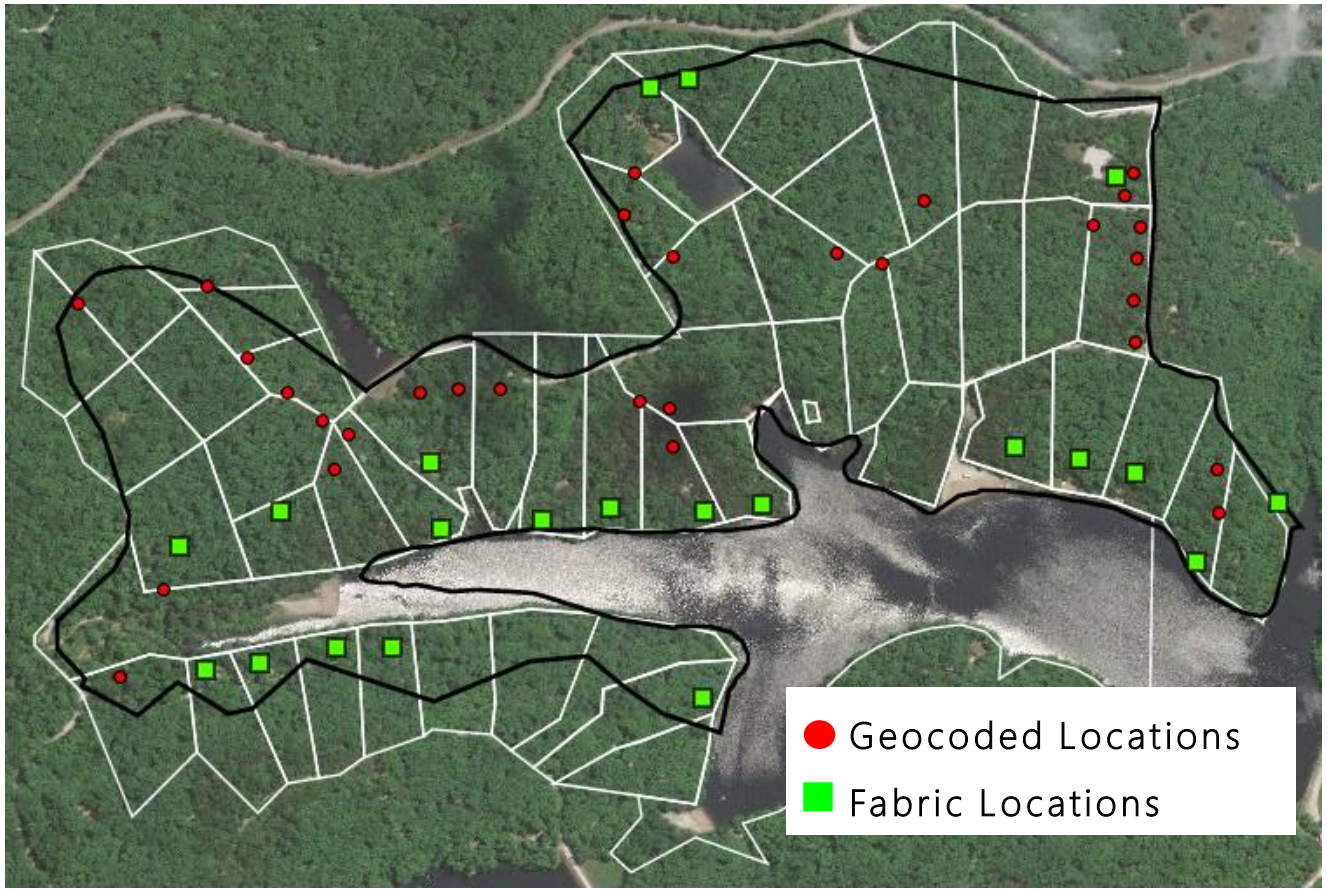
Where the Fabric Makes a Difference: Counting Locations



Visual inspection suggests Fabric count is more realistic

The number of locations identified for the same census block can vary substantially depending on the data source.

In this example, there is a 55% differential in location counts:

- 2011 Census Housing Units = 47
- Geocoded Locations filed in the HUBB = 30
- Fabric Locations = 21

Are all the locations served?

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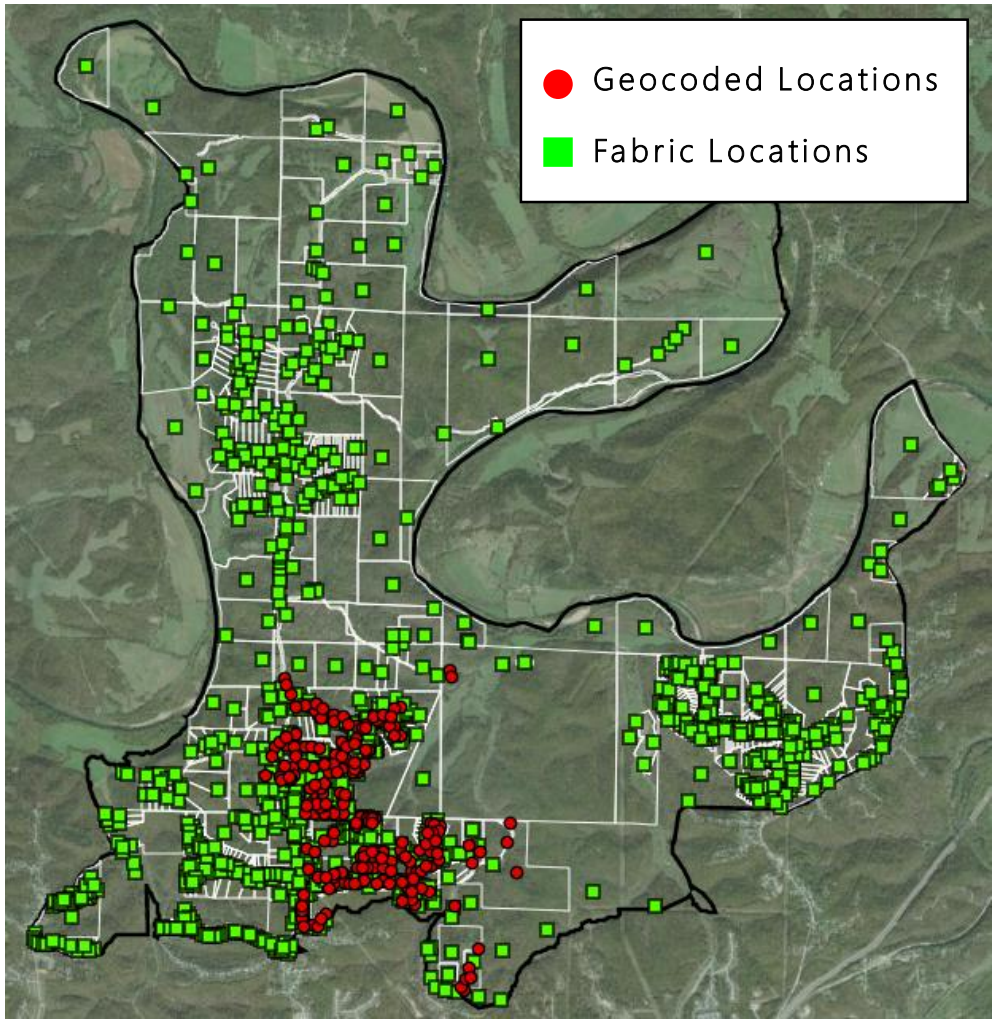
Where the Fabric Makes a Difference: Counting Locations



The number of locations identified for the same census block can vary substantially depending on the data source and data vintage.

In this example, there is a 32% differential in location counts:

- 2011 Census Housing Units = 260
- Geocoded Locations filed in the HUBB = 196
- Fabric Locations = 380

The Fabric identified 120 additional locations beyond build out requirements

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Where the Fabric Makes a Difference: Accurate Geocoding

Geocoded vs. Fabric Locations

Geocoding in rural areas often identifies a latitude/longitude at or near the roadside. The Fabric generates a latitude/longitude specific to the rooftop of each structure.

In this example, the difference for just eight locations submitted to the HUBB was over 521 meters (1709 feet).

Structure-accurate coordinates can support location reporting and network planning

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How It Works – Overview

- To create the Fabric, multiple data sources, scoring routines, and a managed visual review plan are required
  - Data sources include: Parcels, property attributes, georeferenced building footprints, and roads
  - Scoring provides a level of certainty
  - Managed Visual Review process is used in areas of uncertainty
- The Fabric and an Address Catalog are complimentary requirements to achieve the goal
  - Georeferenced locations in the Location Fabric are needed to provide a granular view of broadband areas and gaps
  - Addresses are needed to give the locations a frame of reference and bridge to other systems

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How It Works – Managed visual review

- While statistical routines applied to various forms of data can guarantee some certainty, there are areas of the country that need a review by a human to provide certainty
- Our Managed Visual Review method is a crowd sourced labor approach
  - Managed Visual Review is a process of using various managed human resources (including crowd labor) to visually inspect, and/or review specified data
    - Used areas of uncertainty and provide an acceptable quality level
    - Can be used to test overall quality
    - Can be used to form the basis of machine learning
    - Provides an unbiased result
- Caveat: while Managed Visual Review is critical to addressing uncertainty, it needs to be weighed against potential cost
  - Higher certainty pushes the need for greater review

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How the Fabric is Created

- Goal: Identify the structure(s) needing service
- Challenges:
  - Secondary structures (barns, garages, etc.)
  - Addresses aren't automatically geo-referenced
  - Defining what structures are "serviceable" or funded needs to be clearly defined by policymakers

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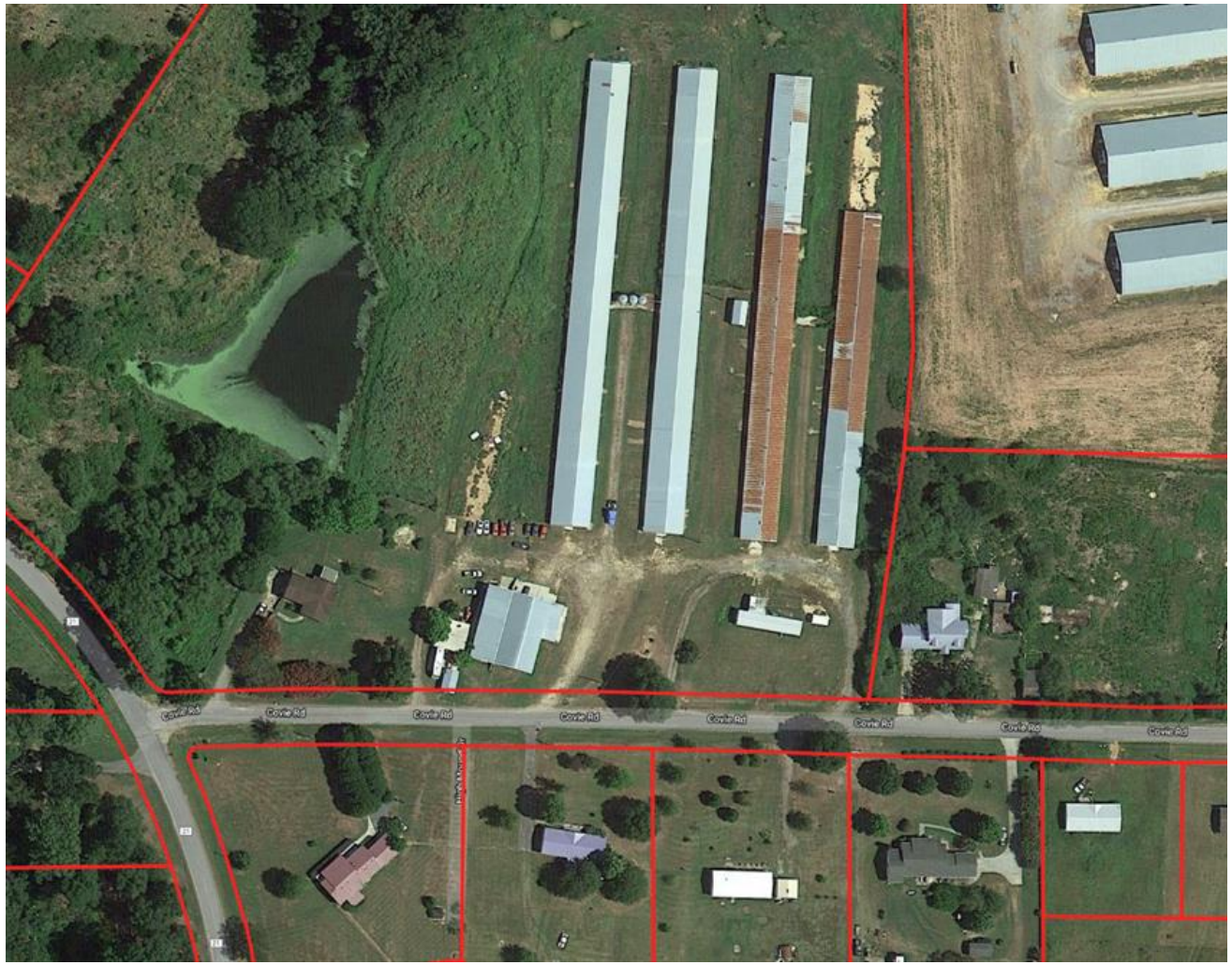
How the Fabric is Created

Step 1:

- Overlay parcel data
- Use Tax Assessor and parcel attribute data to categorize parcels
  - Are there multiple locations?
  - Does the land use indicate there may be a serviceable structure?
  - Consider improvement value, information on secondary structures, etc.



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How the Fabric is Created

Step 2:

- Incorporate building footprint data
  - Footprints identify candidate locations for the Fabric
  - Footprints improve the interpolation of textual address data with real-world accuracy of where serviceable structures are

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How the Fabric is Created

Step 3:

- Using parcel attribute data and building footprints, logic is applied parcel by parcel to interrogate and aggregate data
- The Fabric identifies serviceable structure(s), circled, on each parcel

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The Fabric Compared to Geocoders

Shown: Results of the Fabric compared to two geocoders

- Geocoder A (pink dots) missed two locations and added two extra
- Geocoder B (orange dots) missed four locations
- Poor and inconsistent geocoding hampers deployment, customer service, and compliance reporting

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Findings – Location Results

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A Success

First and foremost, the **Pilot was a Success.** Using state of the art technology and a combination of public and commercial datasets, we are able to show it is now possible to identify and precisely locate virtually every structure in a geographic area that is capable of receiving broadband. Developing the Fabric for two states shows it is possible to do so for the entire country.

In this section, we provide analytics, based on the Fabric, that showcase its benefits.

In the four slides that follow, we start the analytic review by showing how the Fabric shows that today's actual location counts are different from the current estimates being used.

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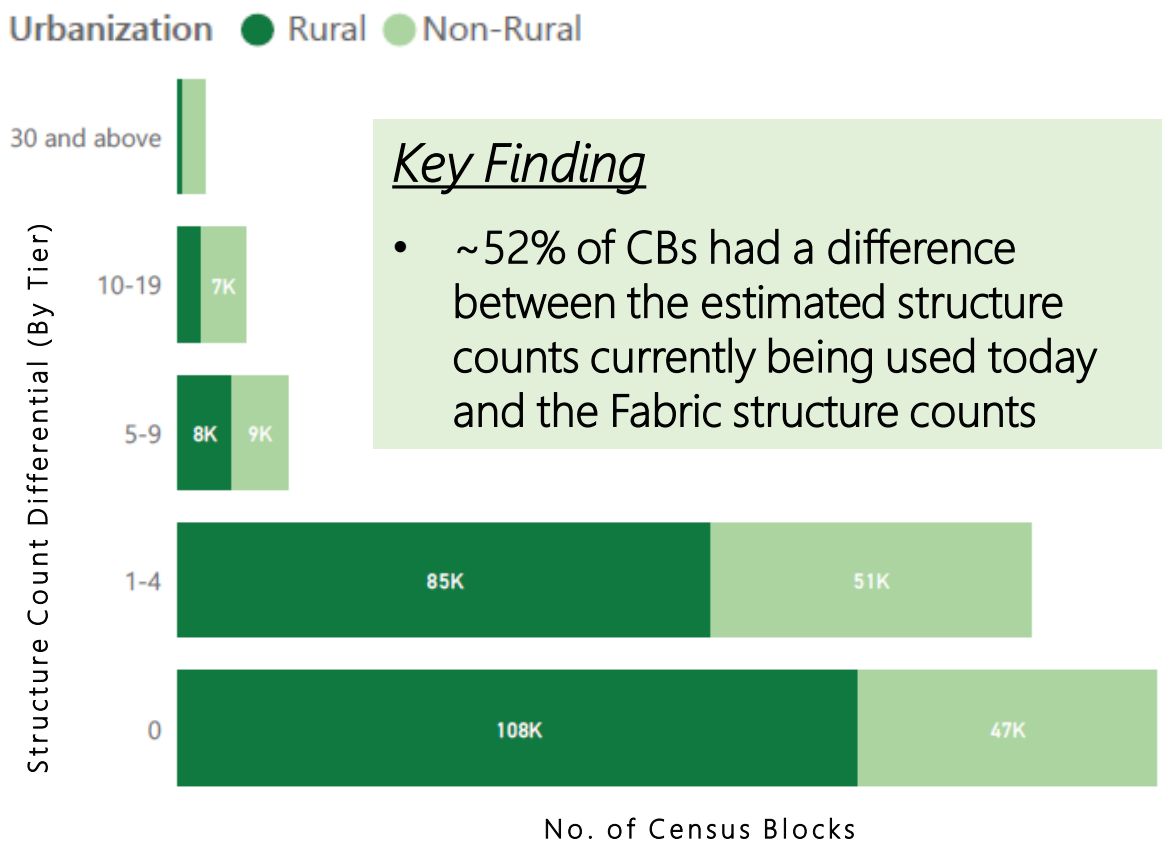
Missouri Structure Counts[1]: Fabric vs. Census & Business Estimates

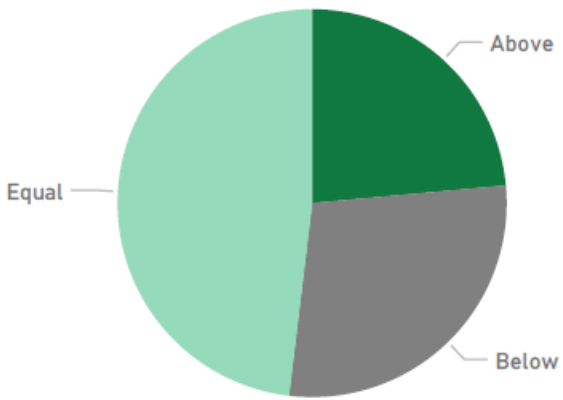
*[1]Data represents a comparison between serviceable structures identified in Broadband Location Fabric and Census 2011 **and** Business 2012 structure estimates*

Structure Count Differential (Absolute Value)



Key Finding

- ~52% of CBs had a difference between the estimated structure counts currently being used today and the Fabric structure counts



Absolute Differential: Fabric vs Census	% Census Block Counts	Census Block Counts	Area mi²	MO Fabric-Census	HU2010
Variation	51.90%	168,043	52,973	-349,399	2,270,427
Equal	48.10%	155,731	15,769	0	442,302
Total	**100.00%**	**323,774**	**68,742**	**-349,399**	**2,712,729**

**Area mi² = Total square miles of census blocks counted*

***Fabric-Census = Differential in structure count between Fabric and corresponding Census data*

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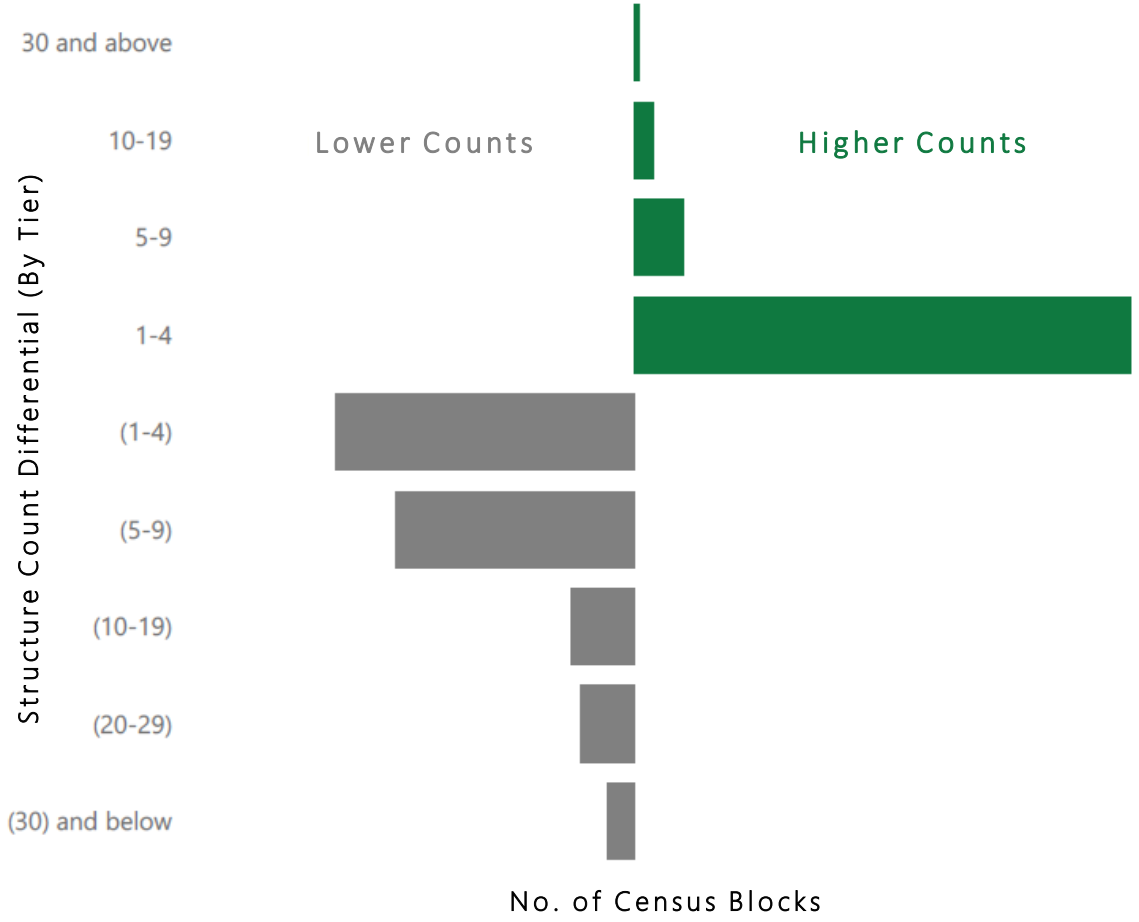
Missouri Structure Counts[1]: Fabric vs. Census & Business Estimates

*[1]Data represents a comparison between serviceable structures identified in Broadband Location Fabric and Census 2011 **and** Business 2012 structure estimates*

Structure Count Differential



Differential: Fabric vs Census	% Census Block Counts	Census Block Counts	Area mi²	HU2010
Above	45.37%	76,239	32,252	737,064
Below	54.63%	91,804	20,721	1,533,363
Total	**100.00%**	**168,043**	**52,973**	**2,270,427**

MO Fabric-Census Groups less	% Census Block Counts	Census Block Counts	Area mi²	MO Fabric-Census	HU2010
30 and above	0.31%	515	225	32,582	41,083
10-19	1.46%	2,453	1,487	36,936	93,691
5-9	3.88%	6,517	4,670	40,839	126,889
1-4	39.72%	66,754	25,869	110,176	475,401
(1-4)	23.98%	40,300	7,067	-40,300	283,658
(5-9)	19.12%	32,125	8,624	-92,945	398,061
(10-19)	5.11%	8,585	2,551	-64,998	182,434
(20-29)	4.29%	7,211	1,854	-122,922	261,156
(30) and below	2.13%	3,583	625	-248,767	408,054
Total	**100.00%**	**168,043**	**52,973**	**-349,399**	**2,270,427**

**Area mi² = Total square miles of census blocks counted*

***Fabric-Census = Differential in structure count between Fabric and corresponding Census data*

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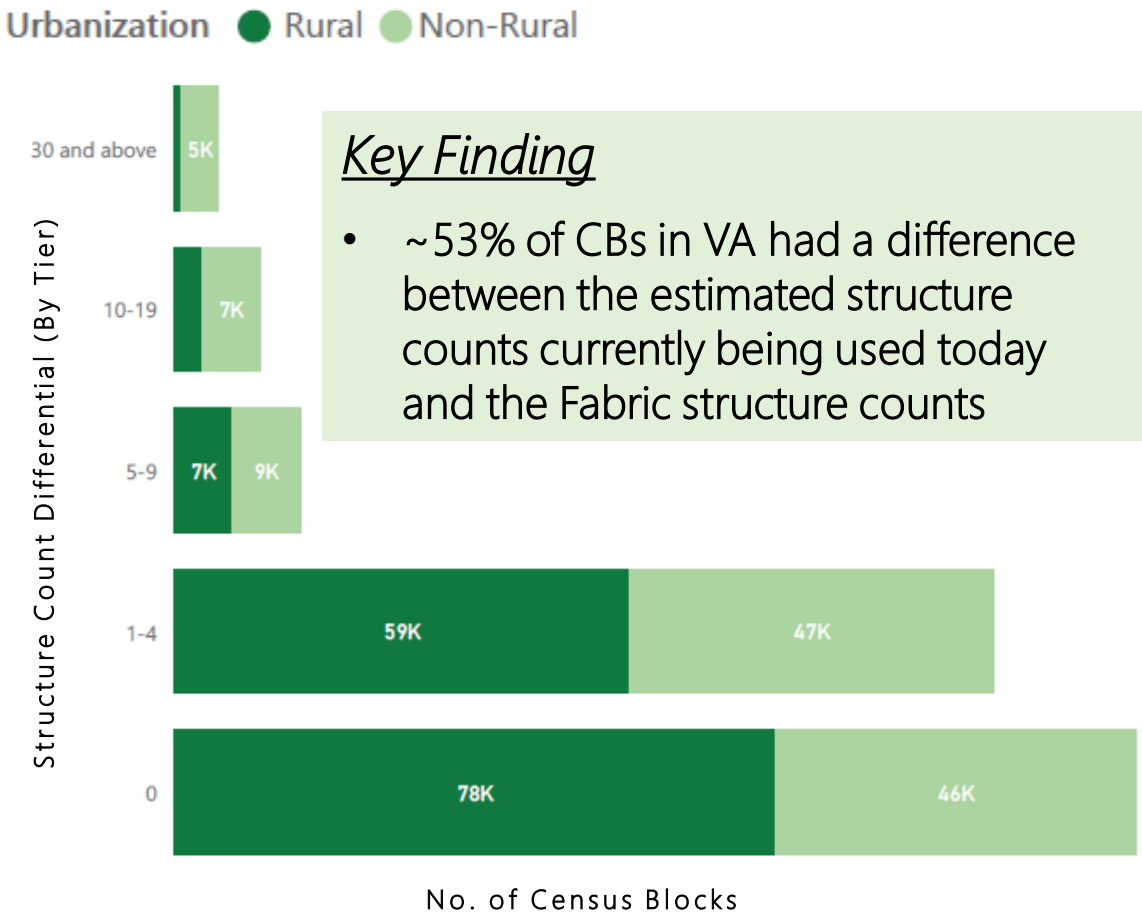
Virginia Structure Counts[1]: Fabric vs. Census & Business Estimates

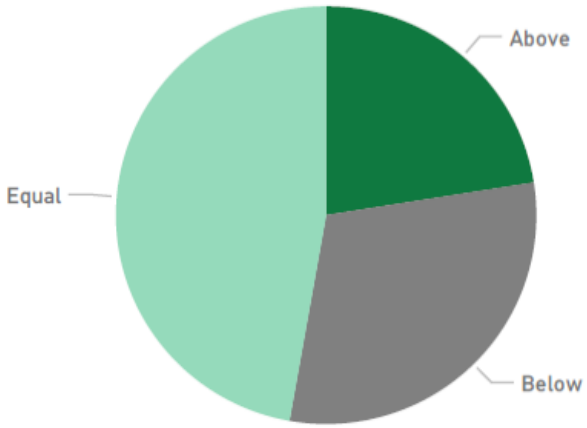
*[1]Data represents a comparison between serviceable structures identified in Broadband Location Fabric and Census 2011 **and** Business 2012 structure estimates*

Structure Count Differential (Absolute Value)



Key Finding

- ~53% of CBs in VA had a difference between the estimated structure counts currently being used today and the Fabric structure counts



Absolute Differential: Fabric vs Census	% Census Block Counts	Census Block Counts	Area mi²	VA Fabric-Census	HU2010
Variation	52.79%	138,720	32,355.23	-391,649	2,971,091
Equal	47.21%	124,036	7,134.86	0	393,848
Total	**100.00%**	**262,756**	**39,490.08**	**-391,649**	**3,364,939**

**Area mi² = Total square miles of census blocks counted*

***Fabric-Census = Differential in structure count between Fabric and corresponding Census data*

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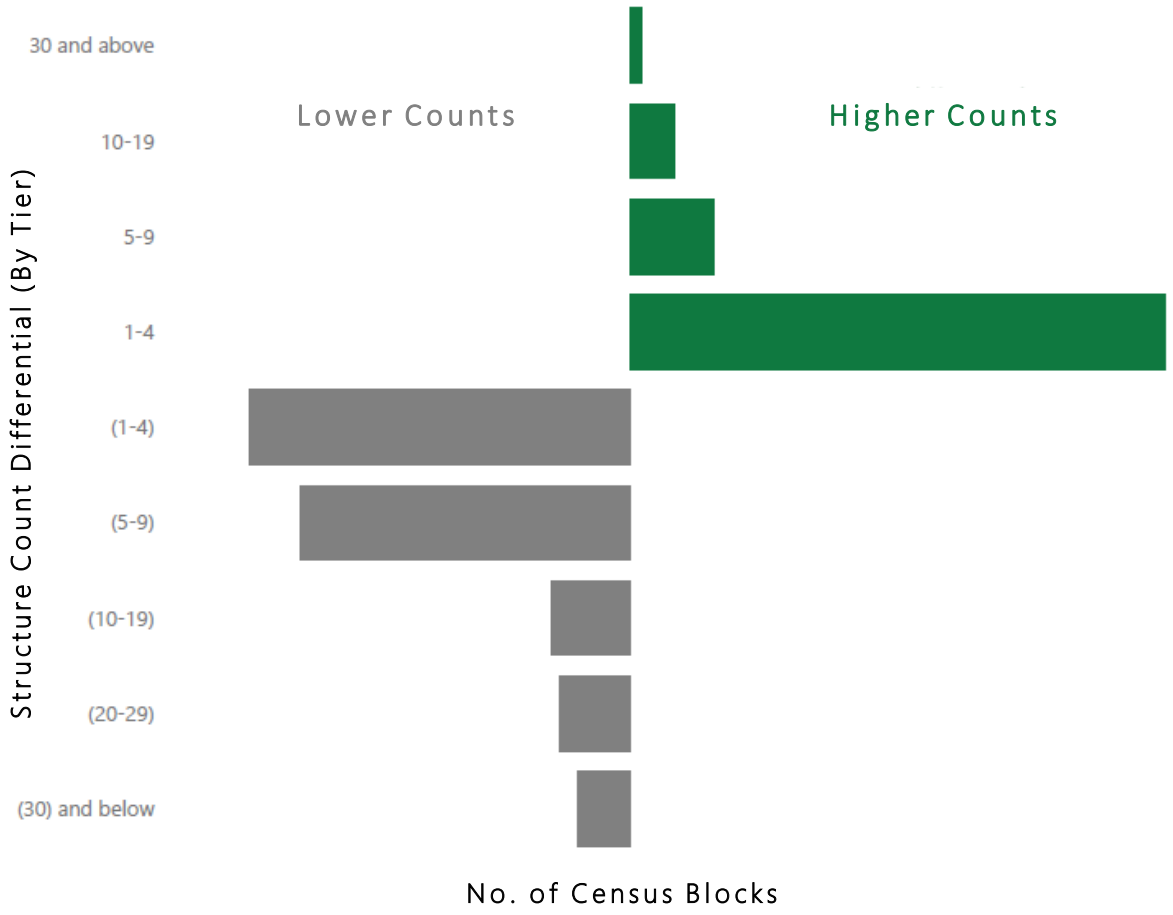
Virginia Structure Counts[1]: Fabric vs. Census & Business Estimates

*[1]Data represents a comparison between serviceable structures identified in Broadband Location Fabric and Census 2011 **and** Business 2012 structure estimates*

Structure Count Differential



Differential: Fabric vs Census	% Census Block Counts	Census Block Counts	Area mi²	HU2010
Above	42.63%	59,135	17,162.32	1,028,418
Below	57.37%	79,585	15,192.91	1,942,673
Total	**100.00%**	**138,720**	**32,355.23**	**2,971,091**

VA Fabric-Census Groups less	% Census Block Counts	Census Block Counts	Area mi²	VA Fabric-Census	HU2010
(10-19)	4.94%	6,847	2,256.32	-52,017	197,397
(1-4)	23.90%	33,156	3,697.43	-33,156	289,823
(20-29)	4.46%	6,181	2,043.38	-107,632	272,615
(30) and below	3.29%	4,569	1,074.50	-391,362	721,886
(5-9)	20.78%	28,832	6,121.29	-82,884	460,952
10-19	2.84%	3,941	2,375.62	59,860	189,754
1-4	33.70%	46,749	10,419.72	81,632	529,370
30 and above	0.78%	1,086	599.28	86,788	108,106
5-9	5.30%	7,359	3,767.69	47,122	201,188
Total	**100.00%**	**138,720**	**32,355.23**	**-391,649**	**2,971,091**

**Area mi² = Total square miles of census blocks counted*

***Fabric-Census = Differential in structure count between Fabric and corresponding Census data*

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Unserved: Form 477 vs. Fabric

- Analysis to follow is based on customer address lists for both voice and broadband submitted to CQA by all carriers participating in the pilot
- Each carrier indicated whether an address would or would not be included, at any speed level, in their Form 477 filing
- We used this data to determine which locations identified by the Fabric would be considered served by a pilot carrier in each census block
- Because of the Fabric structure level detail, we were also able to identify other locations within the same census block that were not served by a pilot carrier which we categorized as "unserved[1]"
- Note that some addresses are unknown by carriers, highlighting potential gaps in data, rather than errors or omissions
- Because not all potential broadband providers in each state participated in the pilot project, it is possible that some of the locations we identified as unserved by a pilot carrier are served by a non-participating carrier

[1]The term UNSERVED means the location was not provided by the Pilot Carriers as broadband serviceable

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Missouri Form 477 Carrier Pilot Coverage Analysis

Key Findings

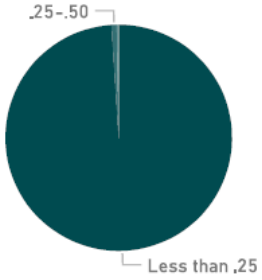
- 9% of Non-Rural locations UNSERVED
- 36% of Rural locations UNSERVED
- 300,000+ Missouri Fabric locations are unserved by Pilot Carriers

Location Fabric Data and Carrier Pilot 477 Data: MO Fabric

All counts represent unique structure locations

Non-Rural

Census Blocks by Size (sq mi)



1,467,436
Fabric Locations in Census Blocks with Carrier Pilot Data

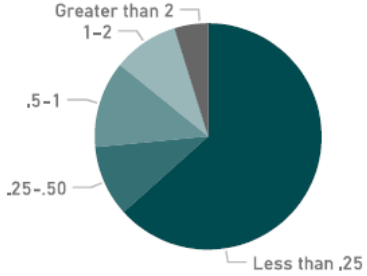
1,328,876
Fabric Locations in Pilot Carrier Form 477

138,560
Unserved Fabric Locations

9%
Unserved Non-Rural Fabric Locations

Rural

Census Blocks by Size (sq mi)



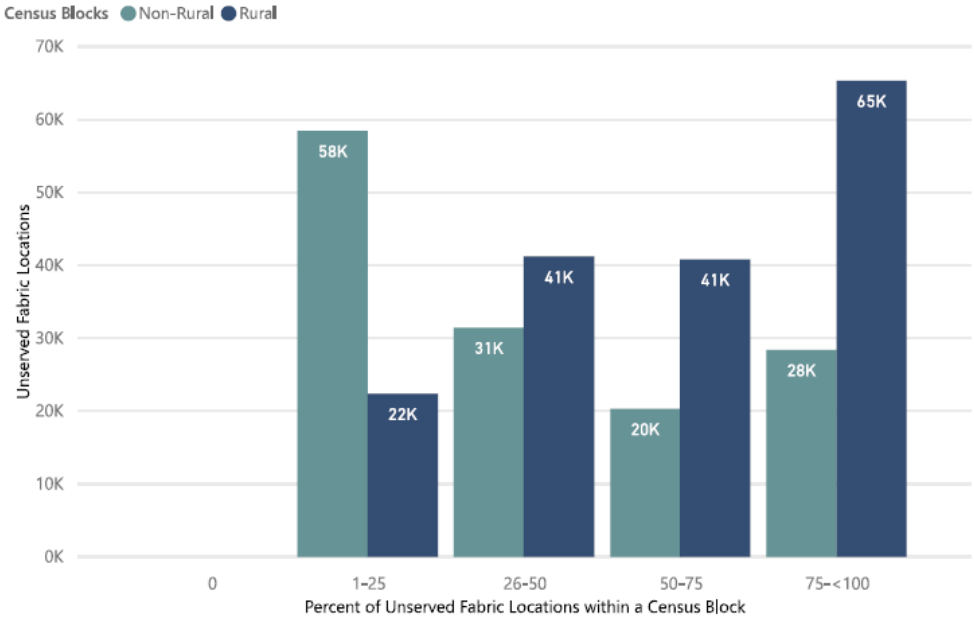
468,827
Fabric Locations in Census Blocks with Carrier Pilot Data

299,164
Fabric Locations in Pilot Carrier Form 477

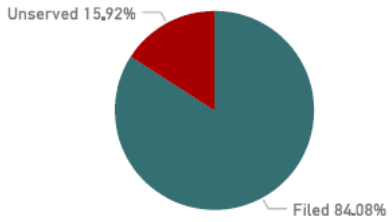
169,663
Unserved Fabric Locations

36%
Unserved Rural Fabric Locations

Unserved Fabric Locations



All 477 Pilot Locations vs Unserved Fabric Locations



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Virginia Form 477 Carrier Pilot Coverage Analysis

Key Findings

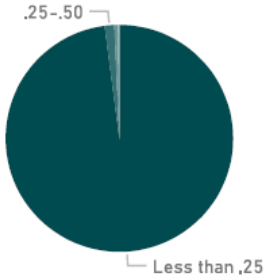
- 12% of Non-Rural locations UNSERVED
- 39% of Rural locations UNSERVED
- 500,000+ Virginia Fabric locations are unserved by Pilot Carriers

Location Fabric Data and Carrier Pilot 477 Data: VA Fabric

All counts represent unique structure locations

Non-Rural

Census Blocks by Size (sq mi)



1,903,257
Fabric Locations in Census Blocks with Carrier Pilot Data

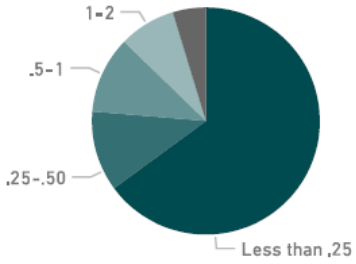
1,676,068
Fabric Locations in Pilot Carrier Form 477

227,189
Unserved Fabric Locations

12%
Unserved Non-Rural Fabric Locations

Rural

Census Blocks by Size (sq mi)



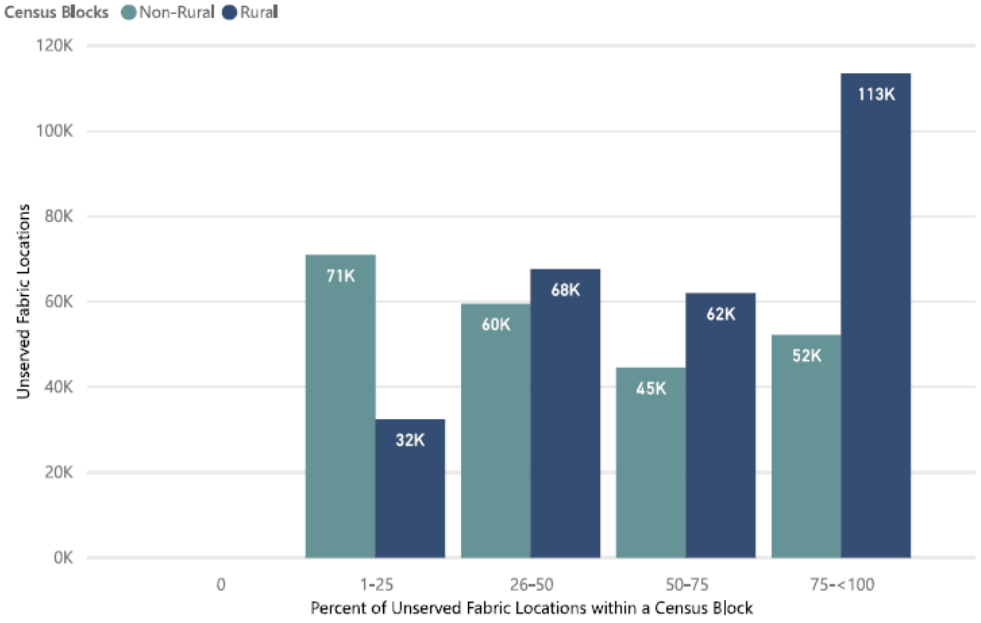
698,177
Fabric Locations in Census Blocks with Carrier Pilot Data

422,693
Fabric Locations in Pilot Carrier Form 477

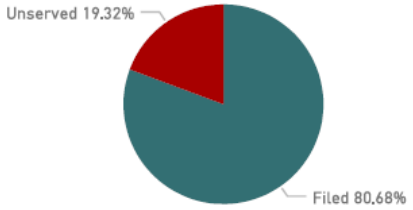
275,484
Unserved Fabric Locations

39%
Unserved Rural Fabric Locations

Unserved Fabric Locations



All 477 Pilot Locations vs Unserved Fabric Locations



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Locations: Missouri Location Distance Differential

In the first slide to follow, we compared the georeferenced locations provided by the carriers in this Pilot study to the structure-specific latitude/longitude generated by the Fabric process. From the comparison, we were able to determine how far geocodes can be from the serviceable structure.

In the second slide to follow, we look at Hubb data:

- CAF funded, built out broadband locations are submitted into the HUBB by carriers in Missouri as part of their CAF II compliance requirements
- Each location is submitted with latitude/longitude coordinates, which are often generated using some type of geocoding tool
- By comparing the HUBB publicly available geocoded coordinates in Missouri to the structure-specific latitude/longitude generated by the Fabric process, we were able to determine how far geocodes can be from the serviceable structure

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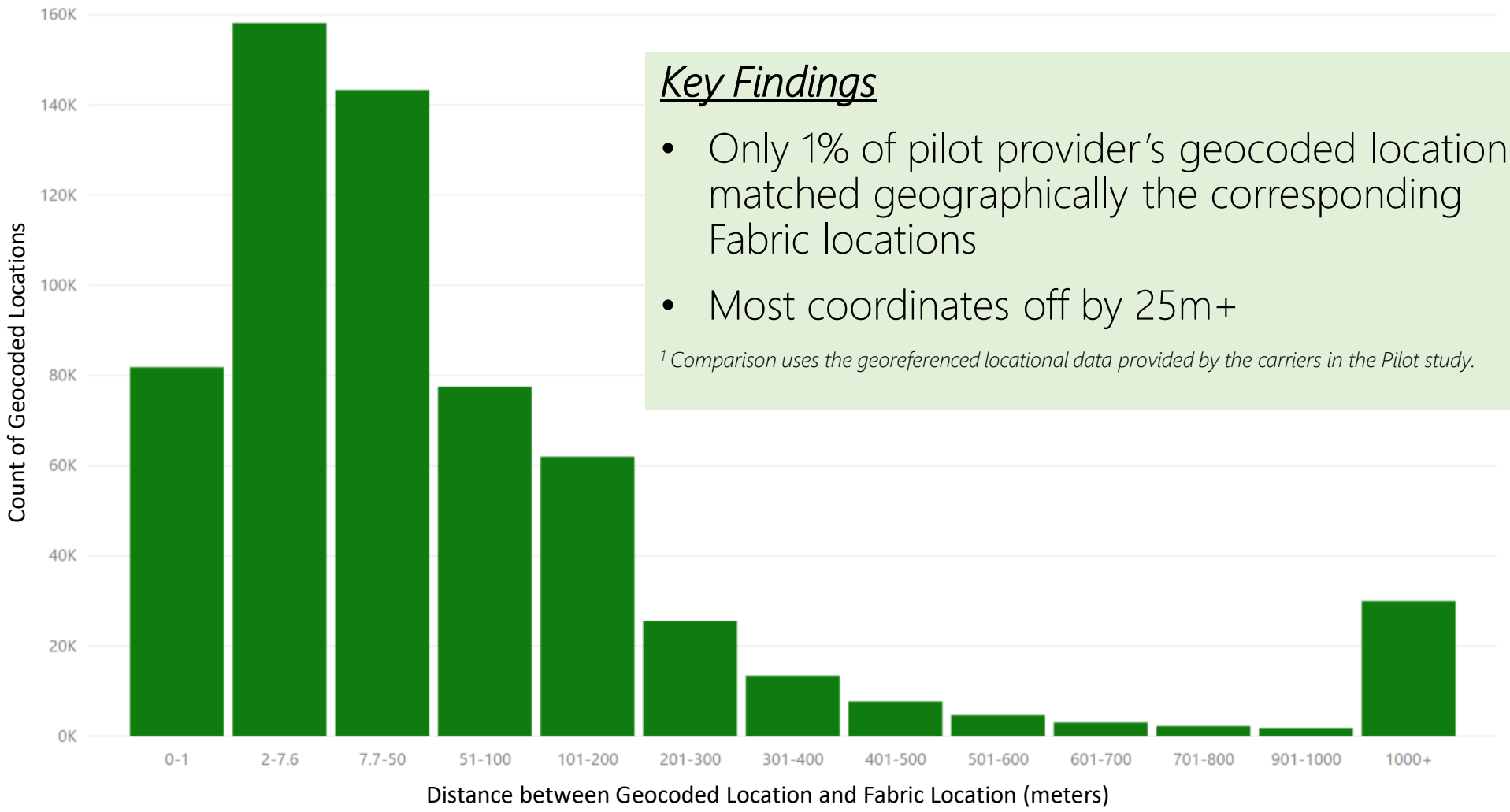
Aggregated Location Distance Differential: Geocoded[1] vs. Fabric



Key Findings

- Only 1% of pilot provider's geocoded locations matched geographically the corresponding Fabric locations
- Most coordinates off by 25m+

[1] *Comparison uses the georeferenced locational data provided by the carriers in the Pilot study.*

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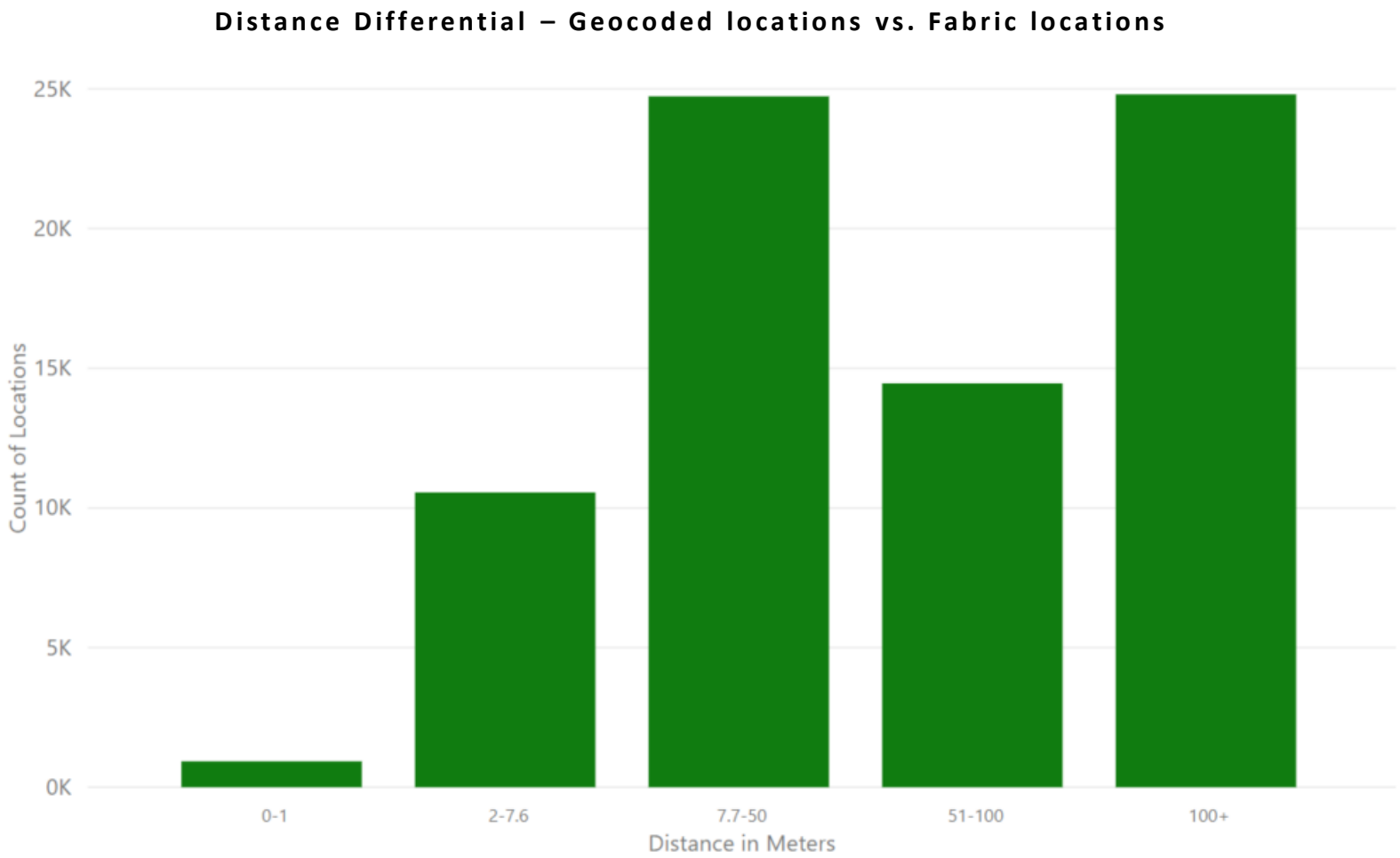
Missouri Location Distance Differential: Geocoded[1] vs. Fabric



Locations with 1,000m+ differential excluded as outliers

Key Findings

- 84% of geocoded locations > 7.6m from Fabric locations
- 55% of geocoded locations > 50m from Fabric locations

Average distance between geocoded & Fabric is ~130m

Context

7.6 meters is the HUBB accepted margin of error to determine if a filed location is in an eligible area. A difference of more than 50 meters could represent a different location, a different eligible census block, or skew build costs and network designs.

[1] *These locations, many of which were geocoded by a geocoding tool, were sourced from HUBB data as a point of comparison for this study.*

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Lessons Learned

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Lessons Learned – Analysis of Process

In developing this Proof-of-concept project to identify broadband serviceable locations, we have learned the following:

- By combining multiple, commercial datasets and using managed, trained "crowd" labor, it is possible to accurately develop a dataset of broadband serviceable locations
- As such, BSLF output represents a significant improvement in quality and accuracy compared to existing data sources in the marketplace (building footprints, addresses, parcels, tax assessment)
- BSLF will improve over time with refinement of data sources + visual verification
- Identifying location (latitude/longitude) coordinates corresponding to a structure is easier than association of addresses and unit counts with a location
    - Challenges: Non-addressable locations, poor quality address information, etc.

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Lessons Learned – Analysis of Process (cont'd)

- Defining what is a serviceable location will require a collective effort
- In identification of addresses, proprietary address data is more complete than open-source
- County assessor qualification of land use and situs address of a parcel are key drivers of BSLF process, but data quality varies (very poor - excellent)
- Address data is only used in the linkage of external sources to the BSLF
- Linkage of the BSLF to carrier data is good, but not 100%
  - Ideally, the BSLF will be adopted by carriers internally and BSLF keys will replace addresses in filings

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Lessons Learned – Analysis of Process (cont'd)

- Machine Learning and Artificial Intelligence will be expanded in future iterations to improve the quality of location identification
- No primary source to arrive at unit counts (business + residential) where parcels have more than one
  - Sparsely populated county assessor data and third-party data linkage issues create issues
- Visual verification has improved the quality of BSLF
  - Clarifies conflicting data
  - Provides an excellent source for statistical modeling/machine learning
  - Can be improved with better visual imagery
  - But, having a managed, trained, skilled set of reviewers is essential

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Lessons Learned – Trends in Attaining Confidence

- Confidence that a Fabric point exists or not is lower in rural areas than non-rural
- Confidence improves with better assessor data, improved building polygons, parcel boundaries, and visual verification (best conducted as last step)
  - Assessor data provides knowledge of building counts, building value, land-use (e.g., vacant, single family residential), building size, etc.
    - These are key variables in attaining confidence
  - Building polygons provide knowledge that the location is a candidate, given that terrestrial broadband service is delivered to a structure
    - This data, counts and sizes, are key variables in attaining confidence
  - Parcels provide the geographic area over which to analyze data (assessor data, building polygons)
    - This data constrains the analysis

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Lessons Learned – Trends in Attaining Confidence (cont'd)

- Based on assessor, building and parcel data, we were able to obtain a level of confidence in the States studied in the Pilot:
  - Missouri - most confident in:
    - 96.7% of parcels in non-rural counties
    - 92.8% of parcels in rural counties
  - Virginia - most confident in:
    - 97.1% of parcels in non-rural counties
    - 93.3% of parcels in rural counties

[1] *Visual Verification:* A process of having a human review satellite imagery to address parcel areas of low confidence (e.g., assessor data is missing, no building polygons on parcel but the assessor has recorded building values, etc..)

- In our study, we conducted Visual Verification[1] to review over 140,000 records to confirm if a parcel had a Fabric point or not
  - This allowed us to correct the classification of over 70,000 records and allowed us to identify a better location on the parcel for many of the reviewed records
- Carrier data filed in the pilot allowed us to identify 100,000+ additional Fabric points
  - Even with this high confidence, additional data can improve the process

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Lessons Learned – Weaknesses in Data Resources

- Linkage between Tax records and geographic parcel records was challenging – vendors were imperfect, CQA fixed internally
- Vintage of aerial imagery affects input structure, footprint data and human-reviewed data
  - Some new/removed structures not always reflected, depending on timing
- County Assessor interpretation of parcel attributes (land use, improvement value, situs address, primary building area) and parcel geometry is non-standard – complicates matching and extraction of value
- County Assessor data quality differs significantly as does the amount of data provided

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Lessons Learned – Broadband Reporting

Through this project and in other venues we have dealt with various levels of coverage reporting: Address, Polygons (including Census Blocks)…All serve a specific function and provide specific results

Our findings:

- The quality of ALL is driven by the quality of the data sitting behind the generation of the report filing
- If addresses are reported
  - There are addresses unknown to carriers (ex. Never requested service)
  - Carrier addresses can represent any of:
    - Locations currently served
    - Locations that could be served
    - Addresses purchased from a third-party vendor
    - Ongoing question: How are these variances captured in a filing?
  - Addresses are not maintained to the same standard, creating quality and matching challenges
  - Some addresses cannot be georeferenced
  - Ongoing question: how are the textual addresses converted to an exact location on the earth's surface?

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Lessons Learned – Broadband Reporting (cont'd)

- If polygons are reported
  - Understanding the basis of the polygon shape is critical
    - If addresses have been geocoded, the accuracy of where points are placed behind a polygon varies greatly
    - If plant records are used, plant accessibility is not always reflected in the shape of the polygon…sometimes, the plant item is part of the transport network (middle mile), limiting local access
    - If internal customer locations are used, locations in the polygon created don't always all have access to service
- Both address and polygon reporting have challenges rooted in data standardization and conversion into various forms
- Addresses and polygons only report served areas; location specific data is necessary to improve quality of reporting by visualizing unserved areas

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Recommendations

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Recommendations – Address Standardization

- Address filings should be standardized - For example, see USPS (Guide HERE)
- Additional suggestions:
  - Address:
    - Order (with spaces between each entry):
      1. Street number
      2. Pre direction
      3. Street name
      4. Street suffix
      5. Post direction
    - Or as separate fields

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Recommendations – Address Standardization (cont'd)

- ADDRESS:
  - No extraneous data – ONLY street address, no building name or person
  - Do not include UNIT in the address field, place in separate field
  - No carriage returns, line feeds, tabs, double quotes, parenthesis
  - Refer to USPS for valid abbreviations for directional and suffix

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Recommendations – Address Standardization (cont'd)

- UNIT:
  - Valid UNIT abbreviation/ numbers or letters
  - One space between Unit and number
  - No extraneous data
  - No carriage returns, line feeds, tabs, double quotes, parenthesis
  - Refer to USPS for valid UNIT abbreviations

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Recommendations – Address Standardization (cont'd)

- CITY:
  - No extraneous data
  - Correct spelling/abbreviation
- STATE:
  - Valid 2 character state abbreviation (refer to USPS)
- ZIP:
  - 5 digit zip codes (refer to USPS zip lookup)
  - ZIP4 should have 4 digits

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Recommendations – Data Resources

- Create a standard classification to be adopted by tax assessors nationwide to describe land use
  - Include requirement for taxable status of a parcel (improvement value, building area, floors, units, etc.)
- Create standard definition of what a broadband serviceable structure is
  - What are the key qualities/criteria?

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Recommendations – Reporting

- Adopt a common, location-specific dataset (like the Fabric) and use data together
- Leverage location-specific data to:
  - Fill Address data gaps and identify address fall outs needing clean up
  - Enable creation of polygons for those using addresses or internal systems containing location coordinates
  - Fill gaps in polygon data creation

Our key takeaways: Addresses and polygons only provide information on what is reported to be SERVED, while provider reporting can be further refined with location-specific data. The Fabric is a foundation upon which additional rich data is layered. Adding granular coverage, build out, and cost data to the Fabric enables a true view of the SERVED **and** UNSERVED homes and businesses without access to broadband.

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Thank You

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Appendix

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Appendix A – Data Sources

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Data Sources - Single data source is not sufficient

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Data Sources

Parcels

(Polygons of land records)

- Sources:
  - Public: collection is at the county level, some free
  - Third-party: some nearly complete (151M plus)
- Issues:
  - Captures all land records, not only those requiring service
  - Parcels vary in density (e.g., apt. complex)
  - Some locations span multiple parcels

Imagery / Commercial Footprints

(Polygons of structures)

- Sources:
  - Public: Microsoft dataset (125M rooftops)
  - Third-party: some nearly complete (169M plus)
- Issues:
  - Captures all buildings, not only those requiring service
  - May not capture address or structure type

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Data Sources

Tax Attributes

(Characteristics from property tax records)

- Sources:
  - Public: collection is at the county level, some free
  - Third-party: some nearly complete (all counties)
- Issues:
  - Captures all taxable locations, not only those requiring service
  - Key attribute is landuse, which needs to be cleaned up

Address Datasets

(Addresses, some georeferenced)

- Sources:
  - Public: OpenAddress (175M to date)
  - Carrier Submissions
  - Third-party sources
- Issues:
  - Not all addresses represent a service location
  - Some service locations do not have an address
  - Geocoding may be required

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Data Sources

Roads

(Used to interpolate addresses)

- Sources:
  - Public: Tiger
  - Third-party sources
- Issues
  - Does not provide specific address, simply a range

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Appendix B – Definitions

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Definitions

2011 Census Housing Units (HUs): As defined by the Census, used in the following analyses to compare potential location counts

Address: Textual reference for a location (name on a map)

Address Catalog: A database of addresses

Broadband Serviceable Location: A building structure that currently has or potentially could require broadband service

Broadband Serviceable Location Fabric (BSLF or Fabric): A location-specific dataset of virtually every structure that is a candidate for broadband

CAF: Connect America Fund

Carrier Pilot Data: Data submitted to CQA as part of this project, including but not limited to: service addresses, geocoded coordinates, service status as Form 477 reportable or not, source of geocoded coordinates

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Definitions (cont'd)

Carrier Locations: Geocoded coordinates per address, submitted as pilot data

Census & Business Estimated Structure: Unique structure identified by 3rd Party and Census data

Fabric Location or Structure: Unique location or structure identified as a candidate for broadband by the fabric process, terms used interchangeably to match context of comparison

Geocoder: A tool that converts an address into a location on the Earth's surface

HUBB: High Cost Universal Broadband, the portal where CAF awardees must file their progress against CAF obligations (geocoded locations served, etc.)

Lat/Long: Latitude and Longitude coordinates

Location: A coordinate set (x,y) describing where broadband would be installed such as a structure or living unit

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Definitions (cont'd)

Non-Rural: Census Blocks designated as Non-Rural by the Census

Parcel: A plot of land, with boundaries, legally owned by an individual or entity

Parcel Attributes: Qualities of a parcel such as land use, property value, etc.

Parcel Centroid: The geometric middle of a parcel

Rural: Census Blocks designated as Rural by the Census

Served: A location that meets the Form 477 requirement for being "served" by broadband (speed agnostic)

Unserved: Location does not have broadband from a pilot carrier

Visual Verification: A process of having a human review satellite imagery to address parcel areas of low confidence (e.g., assessor data is missing, no building polygons on parcel but the assessor has recorded building values, etc..)

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Appendix C – Geocoding Comparison

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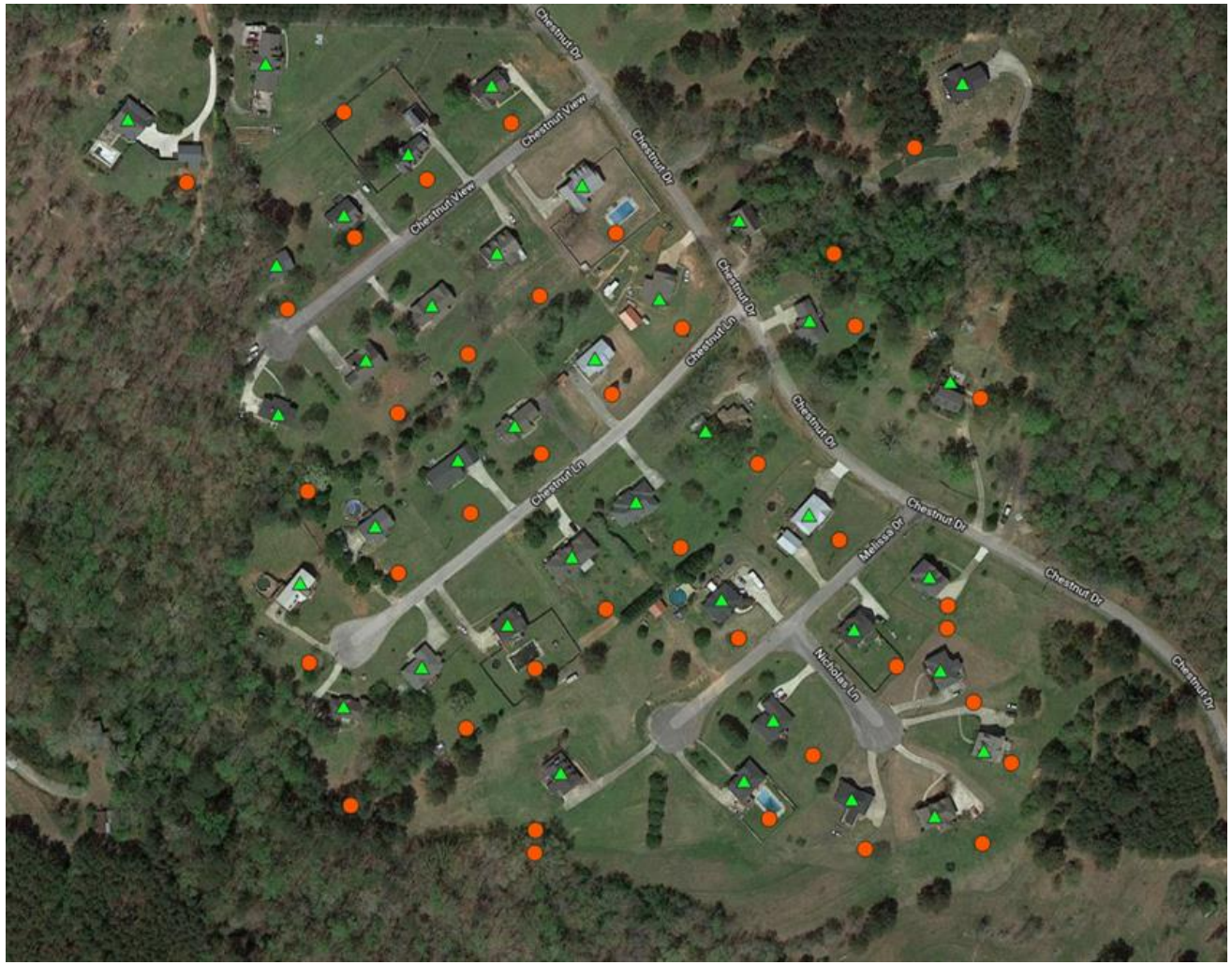
Appendix – Geocoding Comparison

- Comparison between output from a geocoder (orange) and the location fabric process (green)
- Sample 1:
  - Geocodes are generally correct to the parcel, but not to the building footprint



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Appendix – Geocoding Comparison

- Comparison between output from a geocoder (orange) and the location fabric process (green)
- Sample 2:
  - Geocodes are in the appropriate area, but the locations are not ideal

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APPENDIX – Geocoding Comparison

- Comparison between output from a geocoder (orange) and the location fabric process (green)
- Sample 3:
  - Sparsity of geocoded locations
  - The fabric was able to determine the appropriate serviceable structures
  - The orange geocoded locations are not ideal and there are locations without geocoded address points

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APPENDIX – Geocoding Comparison

- Comparison between output from a geocoder (orange) and the location fabric process (green)
- Sample 4:
  - An extreme case
  - Location identified in fabric
  - The remote residence/road is far off any established catalogued road

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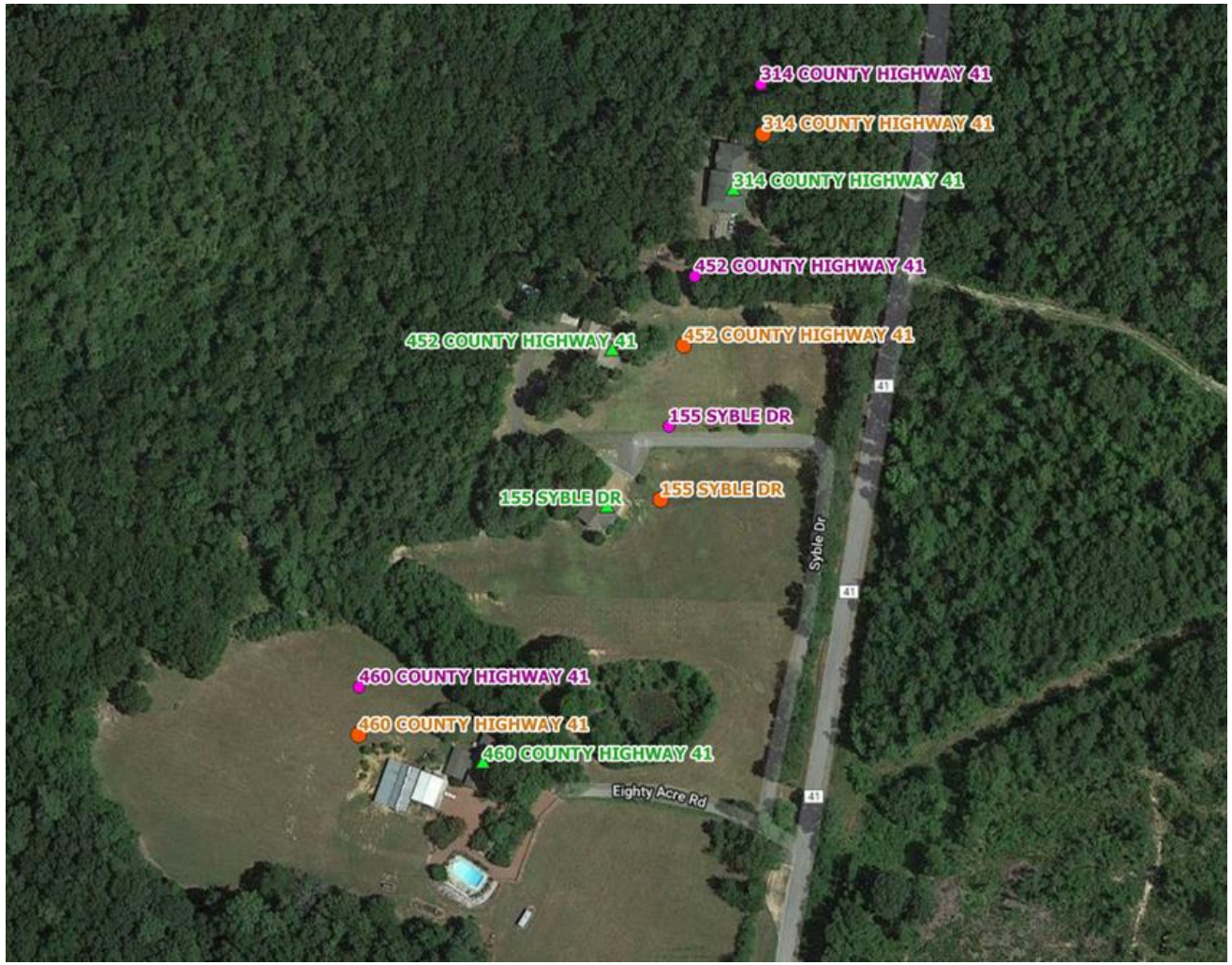
APPENDIX – Geocoded Address Comparison

- There is not agreement amongst geocoders if a location exists and where it is at
- Sample 1:
  - Orange represents one 3rd party geocoder, purple represents another
  - Green represents the location Fabric output



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Appendix D – The Filing Process

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THE FILING PROCESS - Report Filing Objective

- For the purposes of Federal Broadband Mapping and Federal USF determination
  - To receive a list of serviced locations or areas
  - To provide back to submitting ISPs a latitude and longitude for received locations/areas
    - To provide record level indicators of match quality and location quality
  - To work with the filer on address issues
  - To maintain a cross reference between a participant's submitted locations and the returned standardized information

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THE FILING PROCESS - Submission Types

- Two types of submissions
  - Address Provider
    - Provider with current and former service locations
  - Geographic area Provider
    - Provider with propagation/service area that they cover

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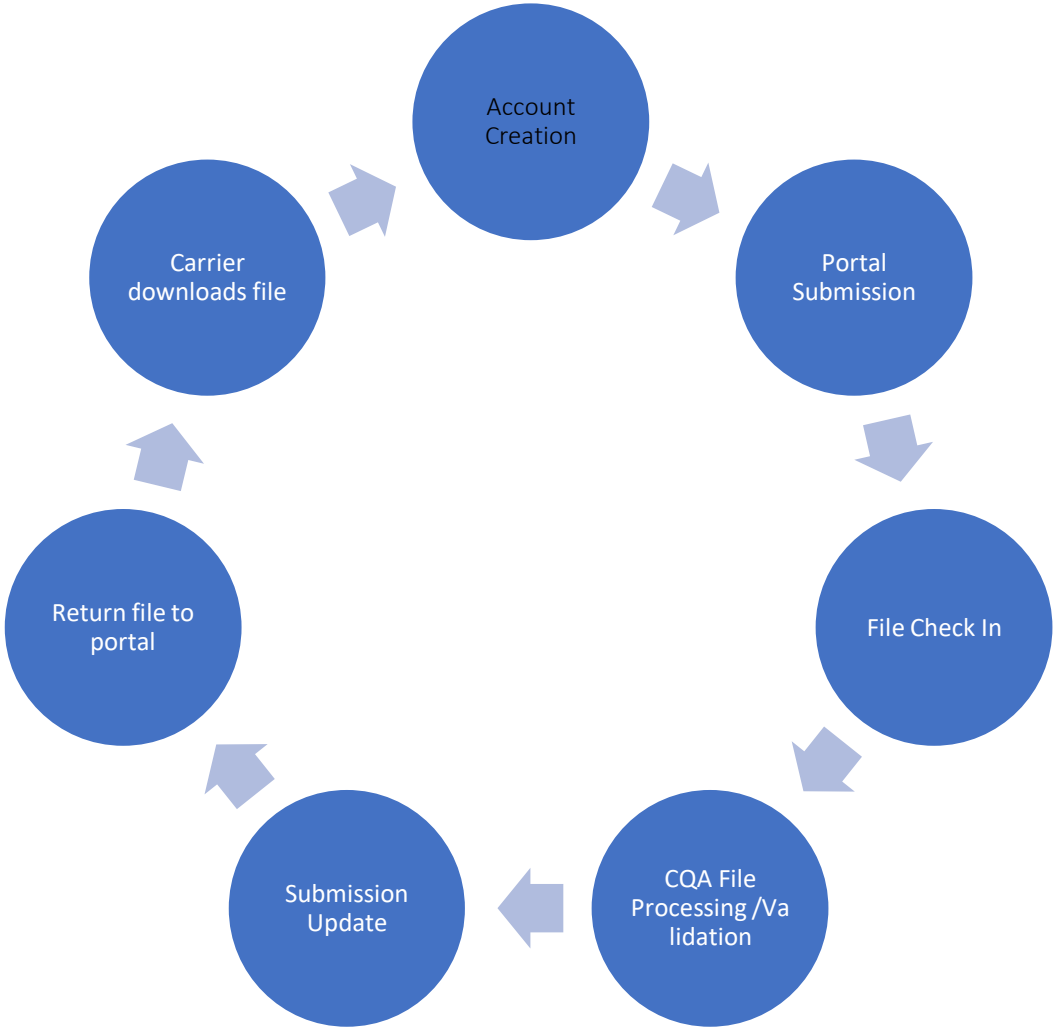
THE FILING PROCESS - Submission Portal

- The portal will
  - Secure data transmission
  - Only the firm providing information will know the status of their records
  - Allow for upload of submissions
  - Allow for 'check-in' of submission
  - Allow for receipt of system responses
  - Support level one file validation
  - Allow for creation of passwords, resets, authentication, etc.
  - Features will be limited and more manual in PoC versus production



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THE FILING PROCESS - What is returned

- Geography (Lat, Long)
- Geographic groups
  - Census County
  - Census Block
  - SAC
- Match indicators
  - MatchQuality – an indicator of how the match was made to address
  - LocationQuality-an indicator of the certainty of the location; parcel, rooftop, crowdsourced
- Keys
  - Company ID (provided by submitter and returned to submitter)
  - Location Key (returned with submission)

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