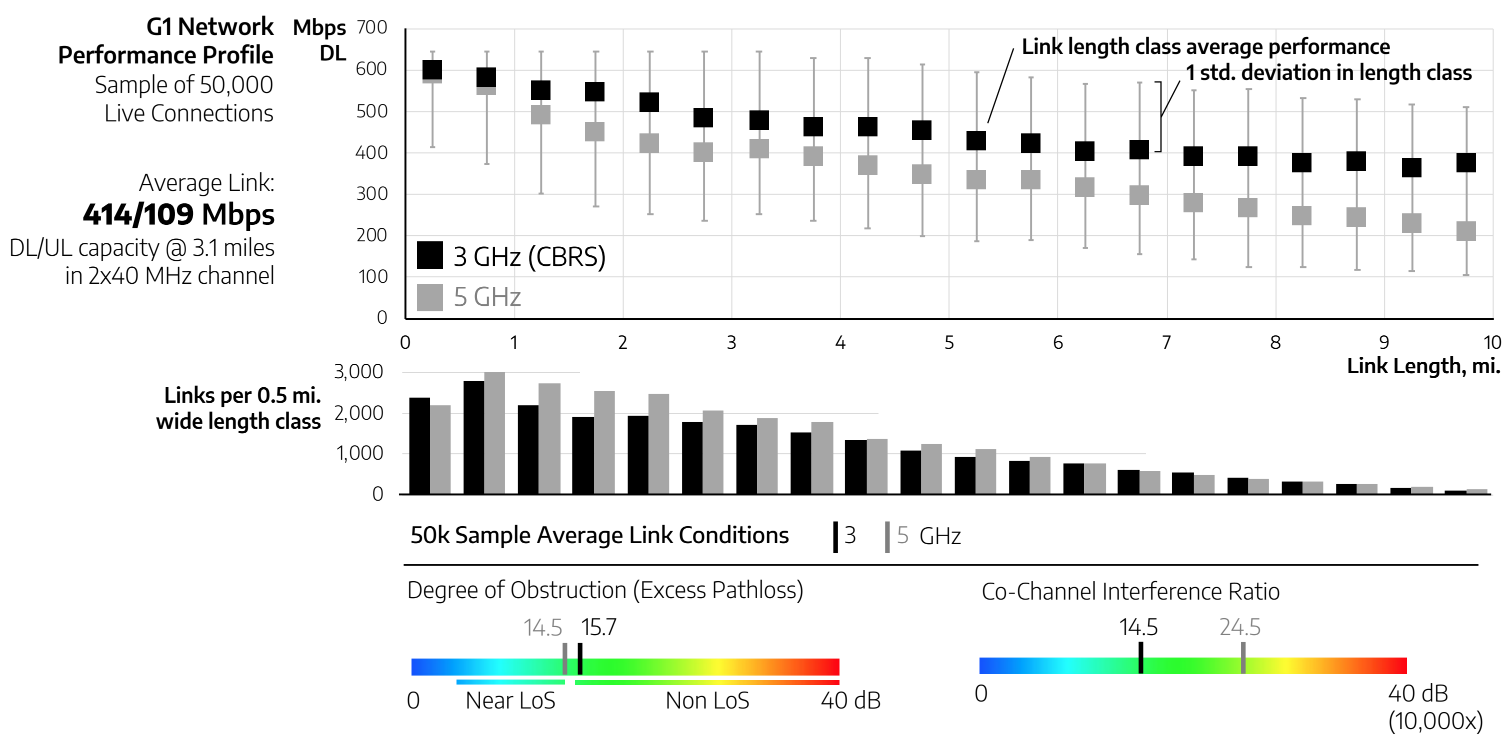
NETWORK ECONOMICS

COMPARATIVE DIGITAL DIVIDE DEPLOYMENT COSTS EXAMPLE

Introduction

As broadband offices across the US develop plans for implementation of the Broadband Equity, Access, and Deployment (BEAD) program in their respective states, it is critically important that they develop and maintain a clear and up-to-date view of network costs as a function of current technology choices, specifically in divide-project circumstances. As we noted in our recent study[1] of 132 state-funded fiber-based digital divide projects executed in 2019 through 2022, the prevailing preference toward exclusive use of fiber in the dialog around BEAD implementation will very likely result in complete exhaustion of the program's $42.45B funding well before reaching the 2021 Bipartisan Infrastructure Law's clearly-stated goal of making fast, affordable broadband available to every family in the United States.

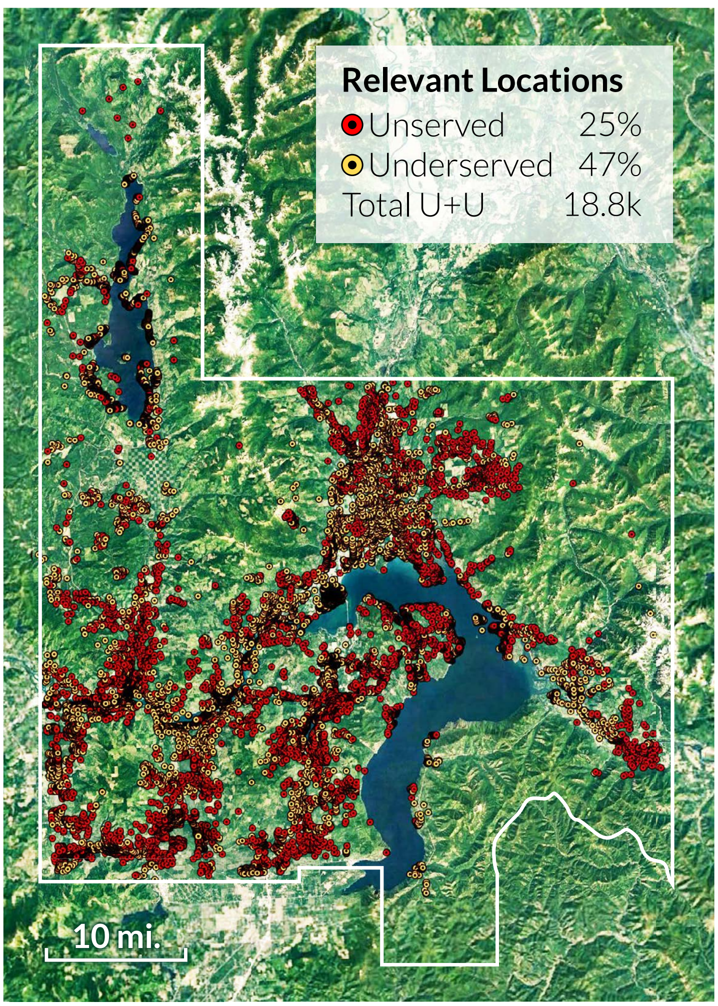
The good news is that broadband technology, like most categories of tech, does advance over time, given instances of investment in fundamental, step-function innovation. When they offer truly material steps forward, these advances can open up genuinely new possibilities in broadband deployment models. One such recent advance, the development of next-generation fixed wireless (ngFWA) technology, has been proven over the past year+ to do just that — see below a healthy sample of Tarana's leading ISP customers' real-world experiences with our G1 ngFWA platform — and note that we have R&D in full motion to double these speeds and enable even more creative spectrum usage models.

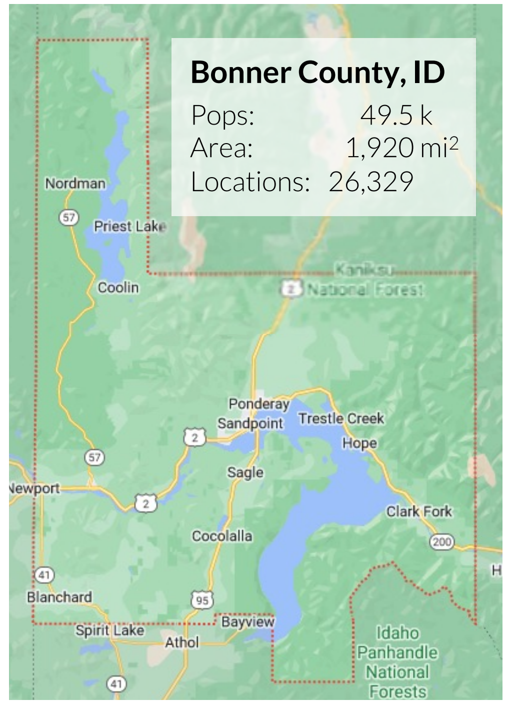


Un/Underserved Area Example

To help broadband office teams understand more clearly and concretely the comparative advantages of including ngFWA in their technology mix, we've modeled in detail deployments of both ngFWA and fiber in a representative divide-project example — specifically Bonner County, Idaho.

Bonner County (outlined at right) is a largely rural area located in the Idaho panhandle, near the state's northern border. It represents no small challenge for broadband deployment, with generally low household density, especially in the northwestern part of the county (the county's overall average is only 14 locations per mi^2), hilly terrain varying frequently between 2,000 and 6,300 ft. of elevation, and plentiful dense stands of tall trees throughout.



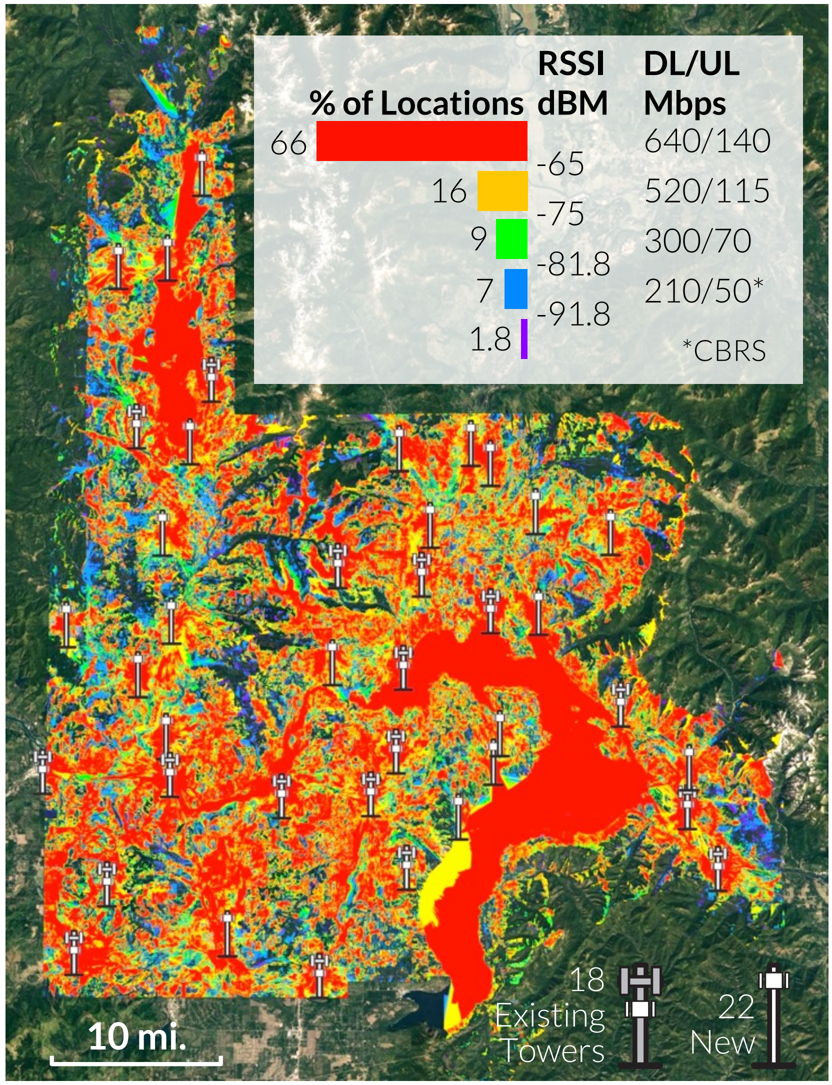


Given the challenging terrain and low population density, it's not surprising that 72% of the locations[2] in the county are unserved — with broadband speeds lower than 25 Mbps downstream and 3 Mbps upstream (i.e. 25/3) — or underserved (< 100/20).

Our broadband deployment cost modeling for the county included coverage for both the un- and underserved locations, in accord with the 2021 Bipartisan Infrastructure Law's stated intent. [We'll use "U+U" as shorthand henceforth here for "un- and underserved" for brevity's sake.] As a side benefit, given the extensive ngFWA coverage necessary to reach the U+U locations (see next section), a G1 divide-targeted deployment would also offer easy upgrade opportunities to many of the 2,715 Bonner locations (~10% of the total) that have service available between 100/20 and 1000/100 Mbps[3], given that 100/20 is the lower bound of G1's proven capabilities.

G1 ngFWA Deployment Model for Bonner County

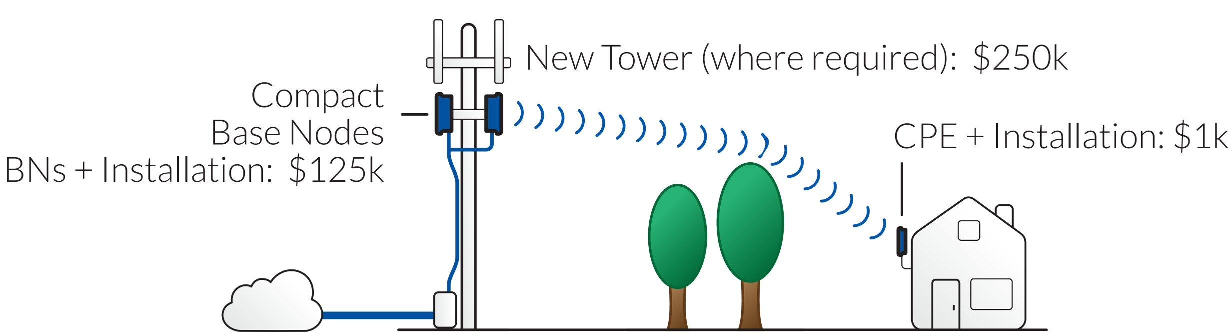
As a first step in modeling an ngFWA-powered approach to solving Bonner County's divide problem, we used Google Network Planner to estimate the G1 deployment necessary to cover as many of the county's U+U households as is practical. As shown at right, a design comprising 18 existing cell towers plus 22 new towers (with an average height of 140 ft.) would be sufficient to reach and serve 98.2% of the U+U locations in the county.



The remaining 345 locations are dispersed enough beyond the edges of the combined 40-tower coverage area that the marginal cost per location served for additional towers would be prohibitively high, since each new tower would reach only a handful of additional locations. Our cost modeling for the 1.8% locations assumes a more direct approach than broad tower coverage, either point-to-point wireless (with relays, as necessary) or fiber.

The design assumes use of a combination of licensed 3 GHz and unlicensed 5 or 6 GHz spectrum, the former to maximize coverage and the latter to augment capacity for closer-in and typically higher-density location sets. As noted above, the tower count required to reach 98.2% coverage of the disperse U+U locations enables the network to deliver its maximum 640/140 Mbps per link service to 2/3 of the target locations.

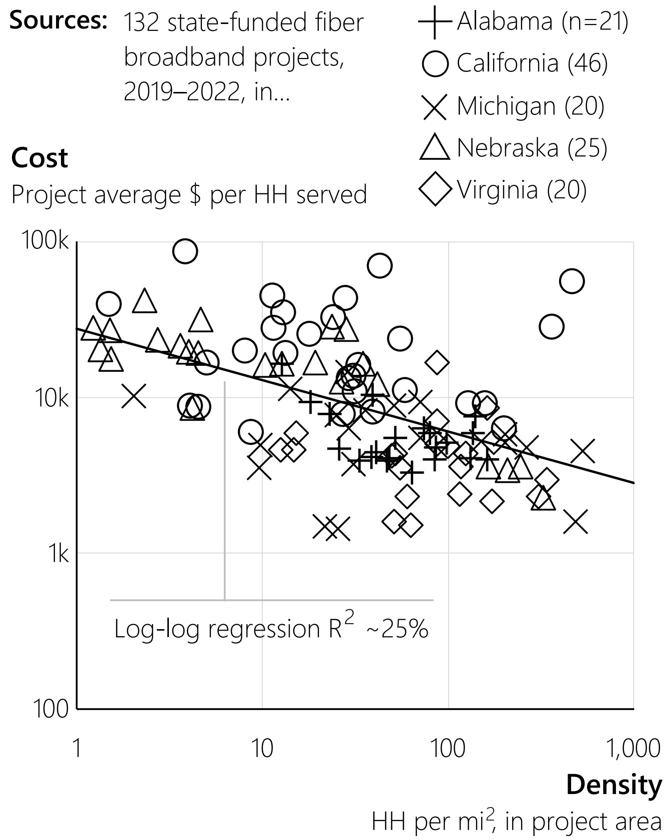
We use the following high-level cost elements for ngFWA's network economics profile in our final section. These are representative of costs reported by a number of Tarana customers who are currently deploying and/or now operating G1 in digital-divide projects.[4]



Fiber Cost Estimation Approach

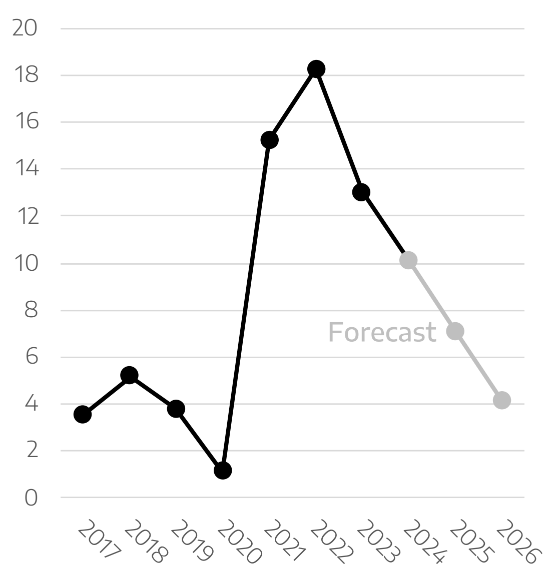
For comparison of ngFWA with a fiber-only approach to Bonner County, we estimated the costs of the latter using the relationship between cost per location and localized location density indicated by the 132-project (and 52.7k locations) sample in our 5-state digital-divide fiber study.[1] As reported there, the costs per household passed or served were reasonably well correlated with location density, with a non-linear relationship on both the density and cost axes, as shown at right.

Fiber Costs Profile in Digital-Divide Deployments



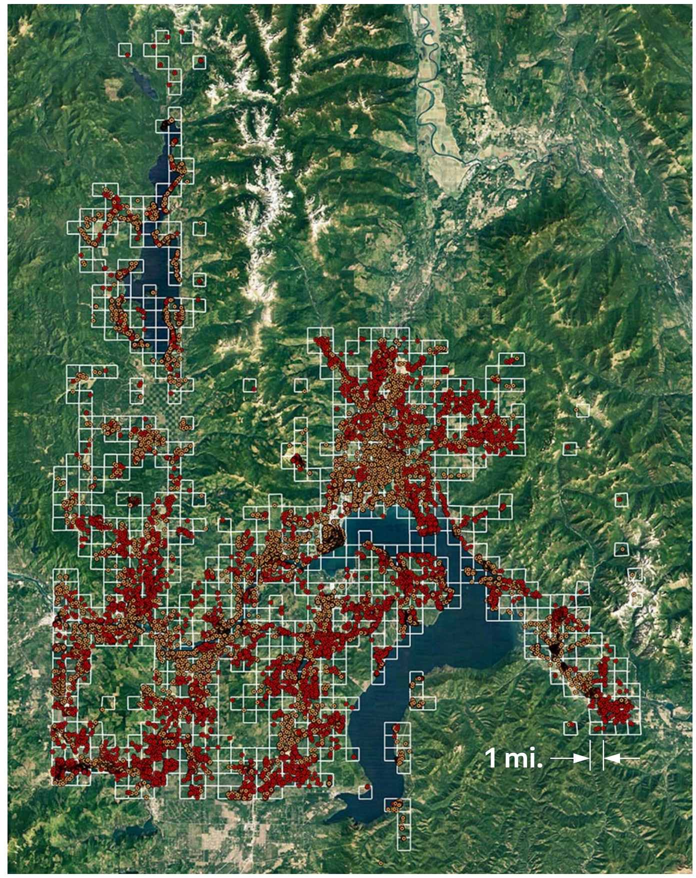
The second important baseline element in the all-fiber cost estimation model for Bonner County is accounting for inflation. As indicated by the US Bureau of Labor Statistics data shown at right, the producer price index for non-residential construction (which is the closest index the BLS has to activity that resembles fiber deployment) has gone through a significant spike in inflation since the 132-project sample was priced in their proposals. Note that this is likely underrepresentative, given the specialized-skills nature of fragile fiber deployment and termination. For this analysis we've assumed that the post-peak-COVID downward trend will continue in the coming years (as indicated by the gray Forecast segment). BEAD projects based on mile-by-mile fiber deployment starting in a couple years (once all the proposals are assessed and plans reach the implementation phase) will have cost structures roughly 1.75x higher per household passed or served than was the case in the 132-project sample priced in 2019–2021.

US Producer Price Index for Non-Residential Construction
(Annual Inflation Rate, %)

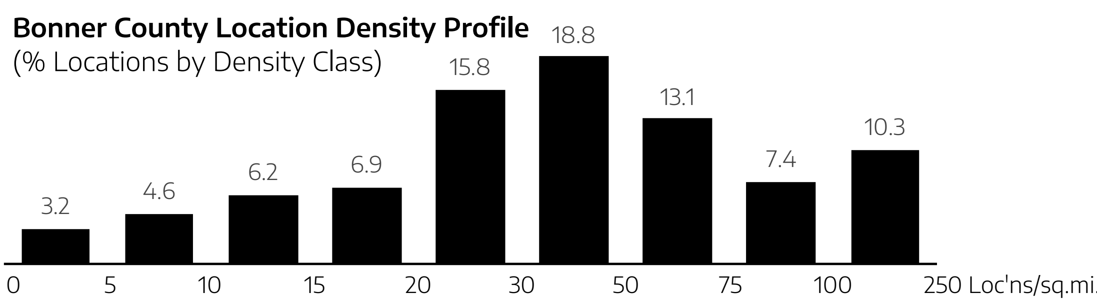


Source: US Bureau of Labor Statistics (note that this index is as close as BLS comes to something relevant to fiber deployment costs)

To apply the location-density-based fiber cost model to Bonner county, we next used a "finite-element method" approach, identifying the ~900 1-square mile areas within the county that included 1 or more locations (as shown at right), and then calculating the location density for each of these occupied square miles.

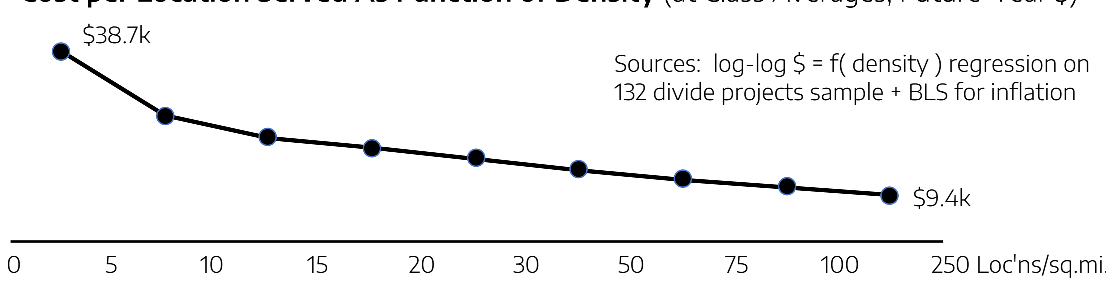


This analysis yields the following profile of locations count as a function of location density across the 900 occupied square miles.



Next, the application of the fiber-study cost model as a function of location density (including the inflation factor) yields this cost-to-serve profile per Bonner location class:

Cost per Location Served As Function of Density (at Class Averages, Future-Year $)



The above cost elements for ngFWA and fiber in the Bonner County example yield the following comparison:

Bonner County Network Economics Profiles		
Locations to pass	18,815	(un- + underserved)
Illustrative take rate	50%	
Locations to serve	9,408	

Two Scenarios					
Technology ——	**(1) Fiber**	**(2) Wireless**	**ngFWA**		
Cost estimate source ——	**132 DD Projects**		**Tarana ISPs**		
Cost of locations passed			$k ea.	Qty.	$M
Distribution fiber total, $M	185.5	New towers	250	22	5.5
(all greenfield)		Tower installs (inc. BN)	125	40	5.0
		Fiber or relays for 1.8%	10	345	3.5
		Total			14.0
$ per location passed	**9,861**				**741**
Cost of locations served					
Locations-passed total $M (from above	185.5				14.0
Laterals & connections, $M	45.7	CPEs & installation	1.0	9,408	9.4
Total $M	231.2				23.4
$ per location served	**24,578**				**2,483**

We think this says it all, by a factor of 10x. Contact us at taranawireless.com to engage further in our mission to close the divide efficiently and effectively for all American families.

Notes

[1] See www.taranawireless.com/fiber-study .

[2] In US broadband mapping parlance, the term "locations" serves as a generic reference to the combination of residences plus the full range of other building types with broadband users inside (e.g. hospitals, schools, restaurants, stores, etc.)

[3] Acquired from the FCC's broadband map for Bonner County, at https://broadbandmap.fcc.gov/home, with the technology filter set to "all wired and licensed wireless", as visited on May 31, 2023.

[4] For the 1.8% of locations (345 in total) not covered by ngFWA, a per-location-served cost of $10k was used to represent a likely mix of fiber and point-to-point wireless relay approaches to reaching them. Beyond the 40 towers in the modeled deployment, the number of additional locations reached by each additional tower was too low to justify their cost.