

An aerial night view of a city, likely New York City, with numerous skyscrapers and buildings illuminated with lights. The overall color palette is a deep blue, giving it a monochromatic, futuristic feel. The text is overlaid on this background.

Tribal and Minority Community Toolkit

Broadband
Grant
Opportunity
Analysis

Introduction / User's Guide



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Introduction

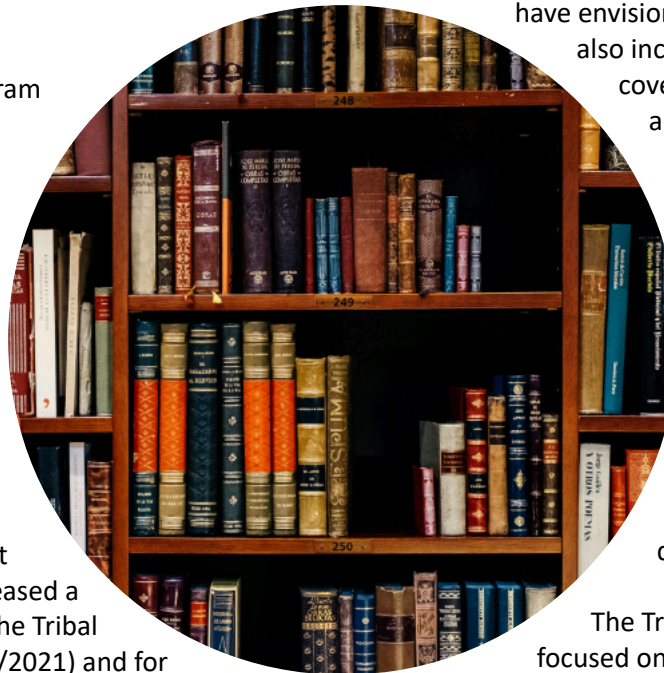
On December 27th, 2020 the *Consolidated Appropriations Act, 2021* was signed into law. It provided \$900 billion in stimulus relief and \$1.4 trillion in omnibus spending, for a total of \$2.3 trillion.

In particular, it provided a series of NTIA grants that will benefit tribal entities, minority communities, and the telecommunications firms that serve them. The grants include:

- Tribal Broadband Connectivity Program (\$1 billion)
- Connecting Minority Communities Pilot Program (\$285 million)
- Broadband Infrastructure Program (\$300 million)

These grant programs are expected to release funds quickly, which means that prospective recipients must be prepared to act quickly.

The NTIA hosted a series of webinars in Q1 and Q2 of 2021, describing each of the grant programs in increasing detail. The NTIA released a Notice of Funding Opportunity (NOFO) for the Tribal Broadband Connectivity Program (due 8/17/2021) and for the Broadband Infrastructure Program (due 9/1/2021). The release of the NOFO starts a clock for each program. This Toolkit is designed to give applicants a head start by providing in one place a number of important resources.



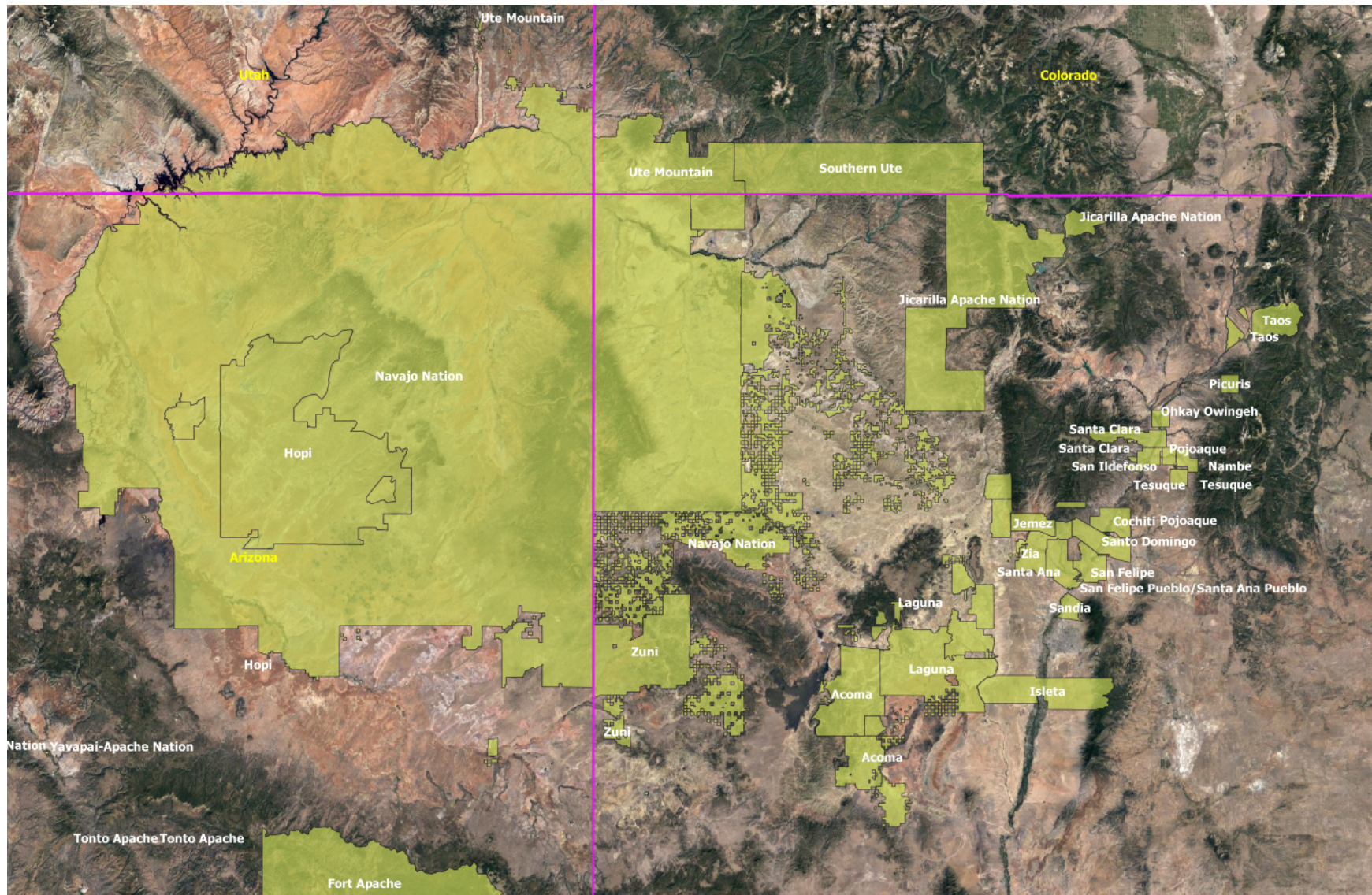
The NTIA released a set of *rules* for the Connecting Minority Communities Pilot Program. These were published in the Federal Register on June 15th, 2021. The rules are part of a two-step process. They create a framework for the upcoming NOFO.

Version 2.00 of the *Tribal and Minority Community Toolkit* is a major release, reflecting the CMC rules released on June 15th that include conceptual approaches to the required analytics that one could not have envisioned from the legislation alone. *Version 2.00* also includes a refreshed set of FCC fixed broadband coverage data and an easier-to-visualize approach to identifying areas eligible for infrastructure grants.

The Tribal and Minority Communities Toolkit offers a powerful set of analytics that enables the user to assess an opportunity and move toward a business case. Related products, such as the *CBRS Toolkit* (an extensive suite of demographic, economic, and competitive data for fixed broadband and mobile broadband providers) enable the user to dig deep into specific geographic areas.

The Tribal and Minority Communities Toolkit is focused on the first two grant programs (Tribal Broadband and Connecting Minority Communities). The CBRS Toolkit, a general purpose planning tool, is well-suited to the needs of most infrastructure-oriented business planning, because it covers 100% of the US (in a series of *state* and *national* products) and because it addresses the needs of fixed and mobile providers and includes competitive data.

Figure 1: Tribal Lands



Complexity

As an example of the complexity in the NTIA grants, the Connecting Minority Communities Pilot Program offers funding to Historically Black Colleges and Universities (HBCUs), Tribal Colleges and Universities (TCUs), and Minority-Serving Institutions (MSIs) and others within a 15-mile radius of a qualifying institution. The offering must serve a community in which the median household income is not more than 250% of the poverty line. The poverty line, in turn, is not a single number. It is calculated based on geography and family size. To determine whether a particular small geographic area qualifies is therefore a complex calculation, involving economic and geospatial data sets.

Minority-Serving Institutions

The Act highlights Historically Black Colleges and Universities and Tribal Colleges and Universities. It also identifies five other demographic groups and the post-secondary educational institutions that seek to serve them:

- Alaska Native-serving Institutions
- Native Hawaiian-serving institutions
- Hispanic-serving institutions
- Asia American and Native Pacific Islander-serving institutions
- A Native American-serving, nontribal institution

The Connecting Minority Communities Pilot Program focuses on Minority-Serving Institutions. While HBCUs and TCUs are listed by government agencies Minority-Serving Institutions (MSIs) are more difficult to identify, and the list of qualifying institutions changes each

year. There are 18 different grant *programs* within the US Department of Education that fund Minority-Serving institutions:

- Asian American and Native American Pacific Islander-Serving Institutions (AANAPISI) Program
- Asian American and Native American Pacific Islander-Serving Institutions (AANAPISI F) Program, Part F
- Alaska Native and Native Hawaiian-Serving Institutions (ANNH) Program
- Alaska Native and Native Hawaiian-Serving Institutions (ANNH F) Program, Part F
- Historically Black Colleges and Universities (HBCCU)
- Master's Degree Programs at Historically Black Colleges and Universities (HBCCU Masters)
- Historically Black Graduate Institutions (HBGI)
- Hispanic-Serving Institutions (HSI)
- Hispanic-Serving Institutions STEM and Articulation (HSI STEM) Program
- Minority-Serving Engineering Improvement Program (MSEIP)
- Native American-Serving Nontribal Institutions (NASNTI) Program
- Native American-Serving Nontribal Institutions (NASNTI F) Program, Part F
- Predominantly Black Institutions (PBI F) Program, Part F
- Predominantly Black Institutions (PBI A) Program, Part A
- Promoting Post-baccalaureate Opportunities for Hispanic Americans (PPOHA) Program
- Strengthening Institutions Program (SIP)
- Strengthening Institutions Program (SIP F), Part F
- American Indian Tribally Controlled Colleges and Universities (TCCU) Program

Figure 2: Eligible Institutions (dots and areas in orange): ANNAPISI, ANNH, HBCUs, HSI, NASNTI, PBI, and TCUs.

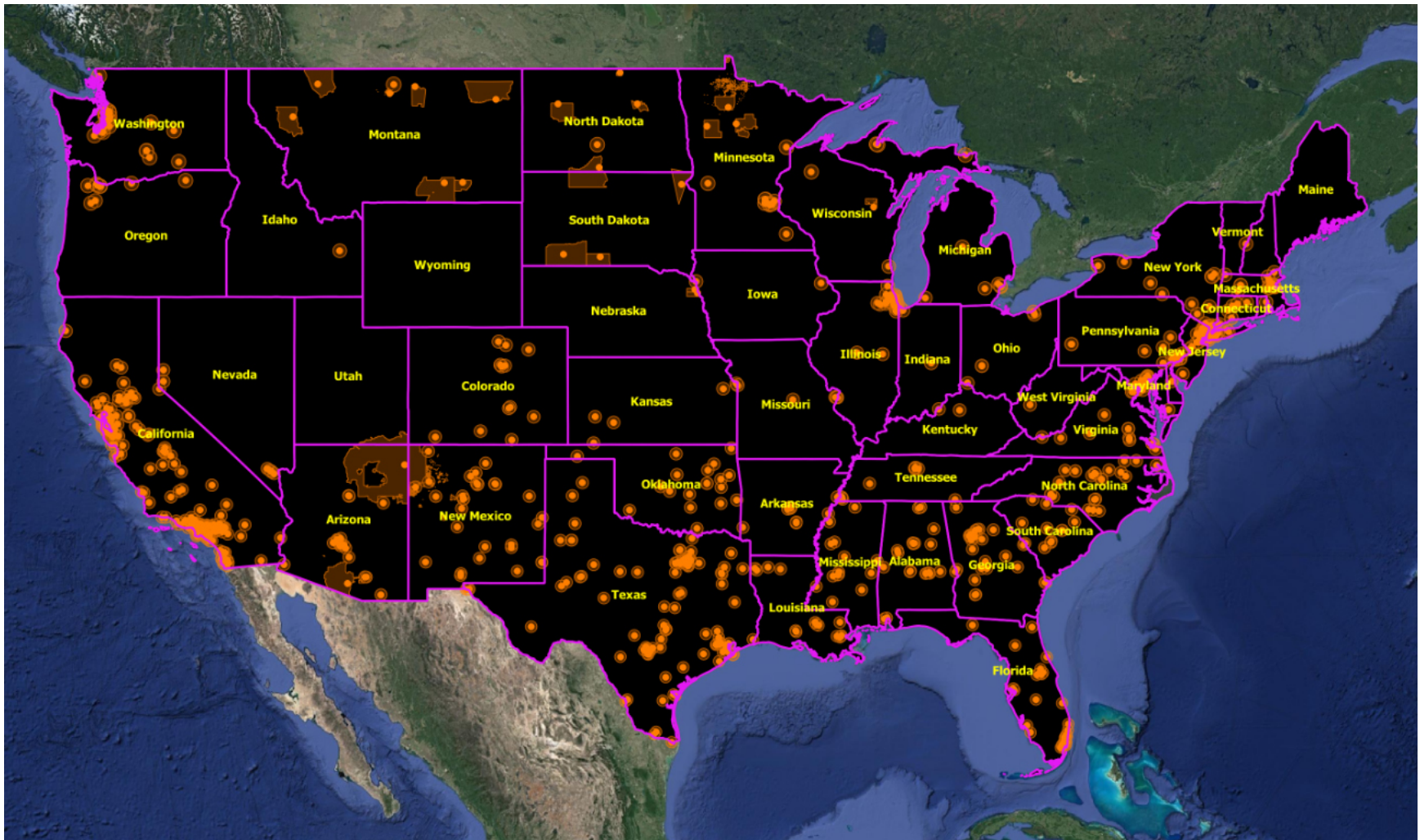
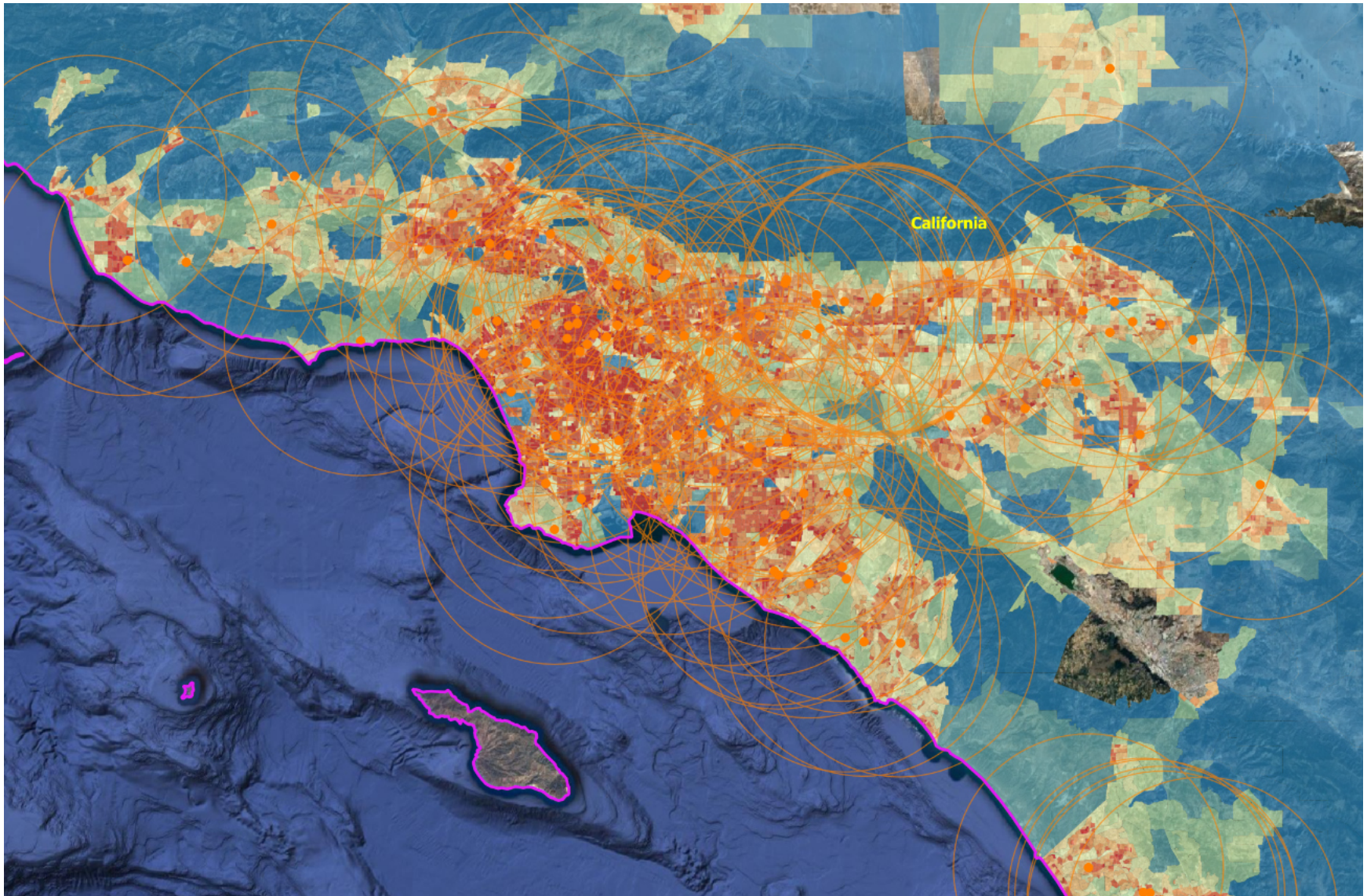


Figure 3: Los Angeles with Population Density and Eligible Institutions (dots and 15-mile radius circles) Superimposed



The rules published on June 15th merge the “F” and “non-F” versions of matching programs together. They also generously allow institutions that do not currently qualify – but conceptually could qualify with appropriate waivers – to apply for grants. The rules are also generous in the suggested process for identifying qualifying geographies. The reader is instructed to look up the average number of people per household then round up, to determine the maximum allowable median household income. A tract with 2.1 people per household is rounded up to 3 people per household, which results in higher than expected estimate of the poverty line, which results in a higher than expected income cutoff. Also, if any part of a Census tract falls within the specified coverage area (normally a 15 mile circle but, in the case of many Tribal Colleges and Universities, the tribal boundaries) then the entire tract qualifies. The effect of this generous interpretation is that it greatly expands the eligible geography.

The rules also indicate that an applicant may submit its own data to support its eligibility. The rules focus on Census tracts by default. The rules state “Census tracts are the smallest geographic units for which median household income estimates are available”. Actually, median household income and all of the other required data sets are also available at a block group level (approximately three times the resolution of a tract) from the same data source although – admittedly – it is extremely difficult to extract block group data from the Census bureau’s consumer-facing tool (data.census.gov) for more than a tiny area at a time.

The Tribal and Minority Community Toolkit includes *both* tract (for essential calculations) *and* block group (for everything else) data. This arguably creates a double-dipping opportunity: (1) if an area qualifies at a tract level, take it – you’re done! (2) if it doesn’t qualify at a tract level it is likely that some of the component block groups

will qualify. The tool facilitates calculations using the specified methodology but with the more granular data set, which would arguably fit into the “user supplied” category, even though it comes from the exact same data source (the 2019 5-year American Community Survey) specified by the NTIA. One could also argue for a composite of tract and block group areas. See Figure 7 for an example of how such data might be presented together.

Another significant twist in the CMC rules is that it assigns tribal boundaries to be the defining border for many (but not all) Tribal Colleges and Universities (TCUs). Of the 37 TCUs 30 are located on tribal land. Of those 30, 22 have the tribal boundary as the border while 8 have a traditional circle. The NTIA has not offered a specific rationale, but in most cases the more generous border prevails.

The Toolkit maps circles and land areas to the tracts they overlap. It also maps tracts to the block groups they subsume (block groups sum to tracts, like a perfectly designed puzzle). This is all available as a set of spreadsheets. It can also be seen graphically and can be selected and exported from the visual Toolkit, if desired.

Granular data is beneficial in every respect. It helps in developing a detailed plan. It helps in persuading a reader that you are informed. Finally, it is helpful in telling a nuanced story of the likely benefits of a proposed program.

Included Resources

The Toolkit contains the following data sets:

- A current list (name and location) of Historically Black Colleges and Universities.
- A current list (name and location) of Tribal Colleges and

Figure 4: CMC Eligible Areas by Tract, 15-Mile Circles

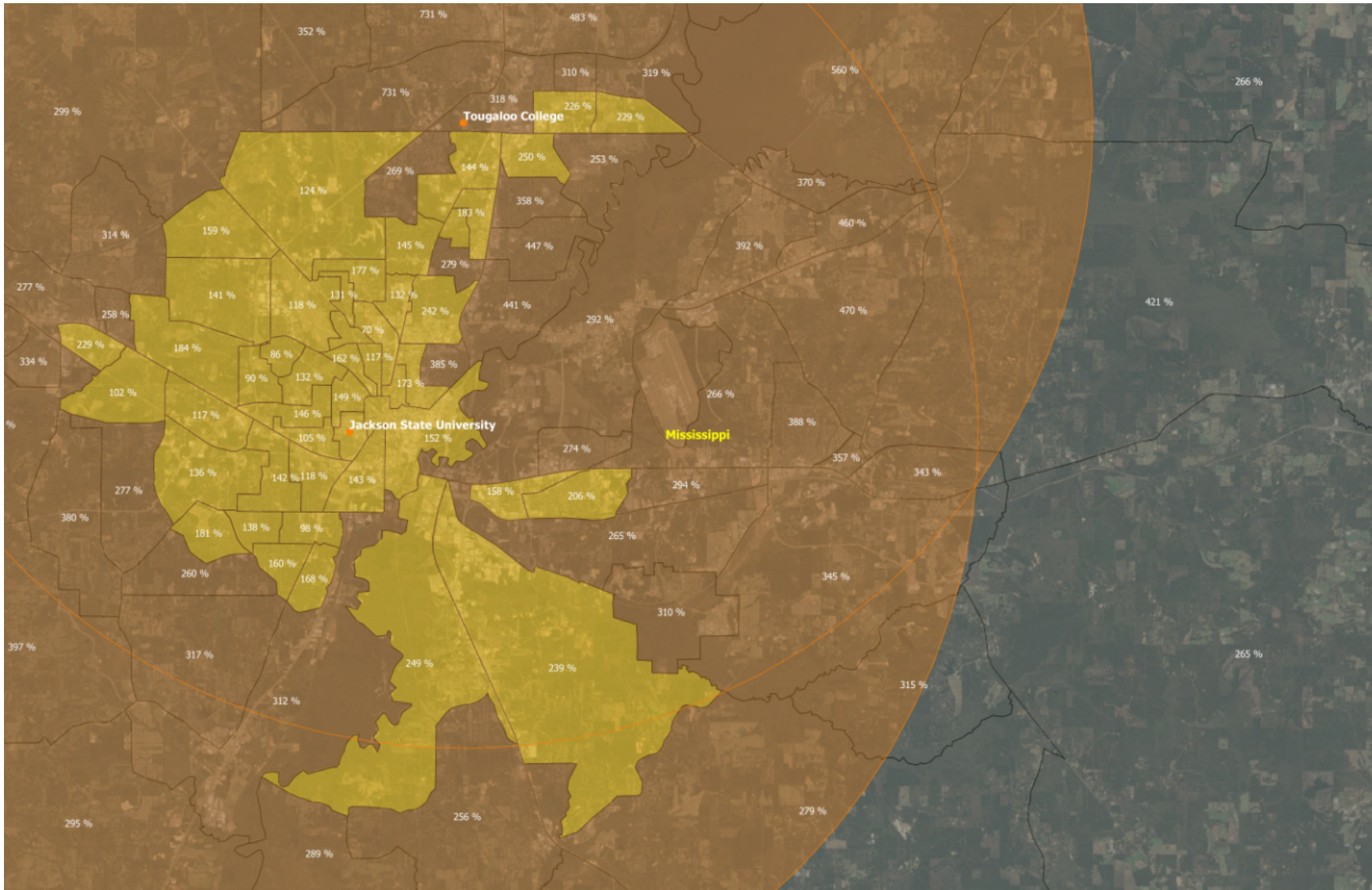
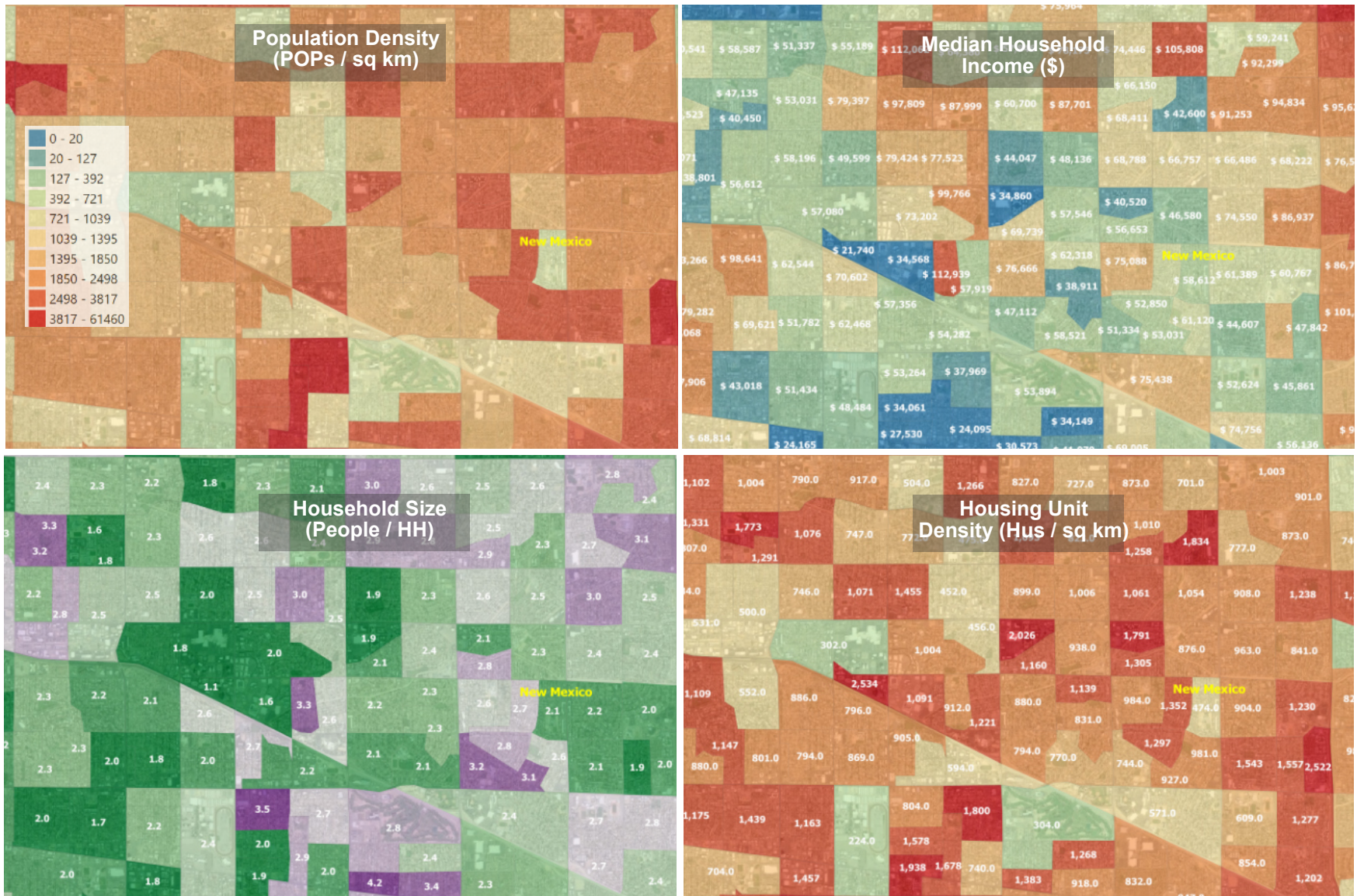


Figure 6: Demographic Data



- Universities.
- A current list (name and location) of eligible Minority-Serving Institutions (ANNAPISI, ANNH, HSI, NASNTI, and PBI) as determined by the methodology described in the previous section.
- The geography enclosed in a 15-mile radius of each institution. In some cases the circle is replaced by a set of tribal boundaries.
- Calculations, based on the average household size, rounded up, resulting in a calculated poverty threshold within each tract or block group near a qualifying academic institution.
- Identification of those tracts that appear to qualify for the NTIA Connecting Minority Communities Pilot Program based on the ratio of median household income to the poverty line, and their inclusion within the 15-mile radius.
- Identification of those block groups that would appear to qualify, if a similar methodology were applied to this higher resolution data set.
- Inputs required to identify eligible geographies (tract and block group):
 - Household size
 - Median household income
 - Poverty threshold as a function of household size
- Key demographic inputs (block group):
 - Population density
 - Household density
 - Housing unit (physical structures, whether currently occupied or not) density
- Key income inputs (block group):
 - Income per capita
 - Mean income per household
 - Median income per household
 - Average household size
- Estimated poverty line
- SNAP (a.k.a. food stamps) household participation rate
- Important contextual data:
 - A wide variety of streamable background maps (physical geography, roads, etc.) from leading map content providers, as well as solid backgrounds (for readability).
 - Geographic boundaries (block groups, tracts, zip code tabulation area, counties, states, and congressional districts) alone, or with associated numerical codes and/or names.
 - FCC license areas (BEAs, BTAs, CMAs, EAGs, MEAs, MTAs, PEAs, REAs, RPCs), relevant to those who may be providing wireless solutions.
 - Roads (primary and/or secondary, with or without labels).
 - Elevation data. The user may, optionally, view the underlying terrain in a color-coded format that reflects land elevation, hills, and valleys. Imposing natural boundaries often dictate services areas. The data is both visual and numerical.
- The data sets take several forms that can be used in any combination:
 - Visual data in a geographical information system tool (where layers can be enabled or disabled).
 - Color-coded layer information (enabling rapid assessment of large geographic areas)
 - Numerical text layers (enabling the user to see exact numbers)
 - Selectable data (enabling the user to select a geographic area and extract that specific data from a

- large database).
- Excel spreadsheet data (enabling the user to view and manipulate all of the data that ships with the tool).

Many of these included resources are described in greater detail in the coming pages.

Demographic Data Sets

It is important to understand the significance of the various demographic data sets:

- *Housing Units* reflect the number of physical structures (single family homes, apartments, condominiums, mobile homes, etc.) in which a household could reside. The occupancy rate is the ratio of (rented HUs + owner-occupied HUs) / total HUs.

In a city with 100% occupancy housing units could – conceptually – equal households, although such a situation rarely, if ever, exists.

- *Households* are the number of groups of people (family and non-family) that live together. A household would generally have a single fixed internet connection to the home. We know the number of households and the population associated with the households for each census block.
- *Group Quarters* are larger groups who do not live in households. Group quarters include university dormitories, nursing homes, and prisons, as examples. The population in group quarters is distinct from the population living in

households.

- *Population*. This is the total number of people living in an area, regardless of their housing situation. This total population includes those living in households (the vast majority, whether in family or non-family households) plus those living in group quarters.

Income-Related Data

The Toolkit provides a number of layers of data describing income and income-related programs:

- *Annual Income per Capita*. This is annual aggregate income divided by total population.
- *Mean Annual Household Income*. This is annual aggregate household income divided by total households. The portion of the population that lives in group quarters (college dormitories, nursing homes, and prisons, as examples) is excluded.
- *Median Annual Household Income*. The median annual household income is a number above which half the households earn more and below which half the households earn less. In most geographic areas median income is lower than mean income because a few larger earners pull the mean upward. Median income is considered the best indicator of household buying power for non-luxury goods.
- *Poverty Line*. The Act refers to the “poverty line”. Both the US Census Bureau and the US Department of Health and Human Services (HHS) provide poverty metrics. The Census

Figure 8: Infrastructure: existing coverage at 25-3 plus CAF II, RDOF, and USDA Commitments plus Tribal Lands

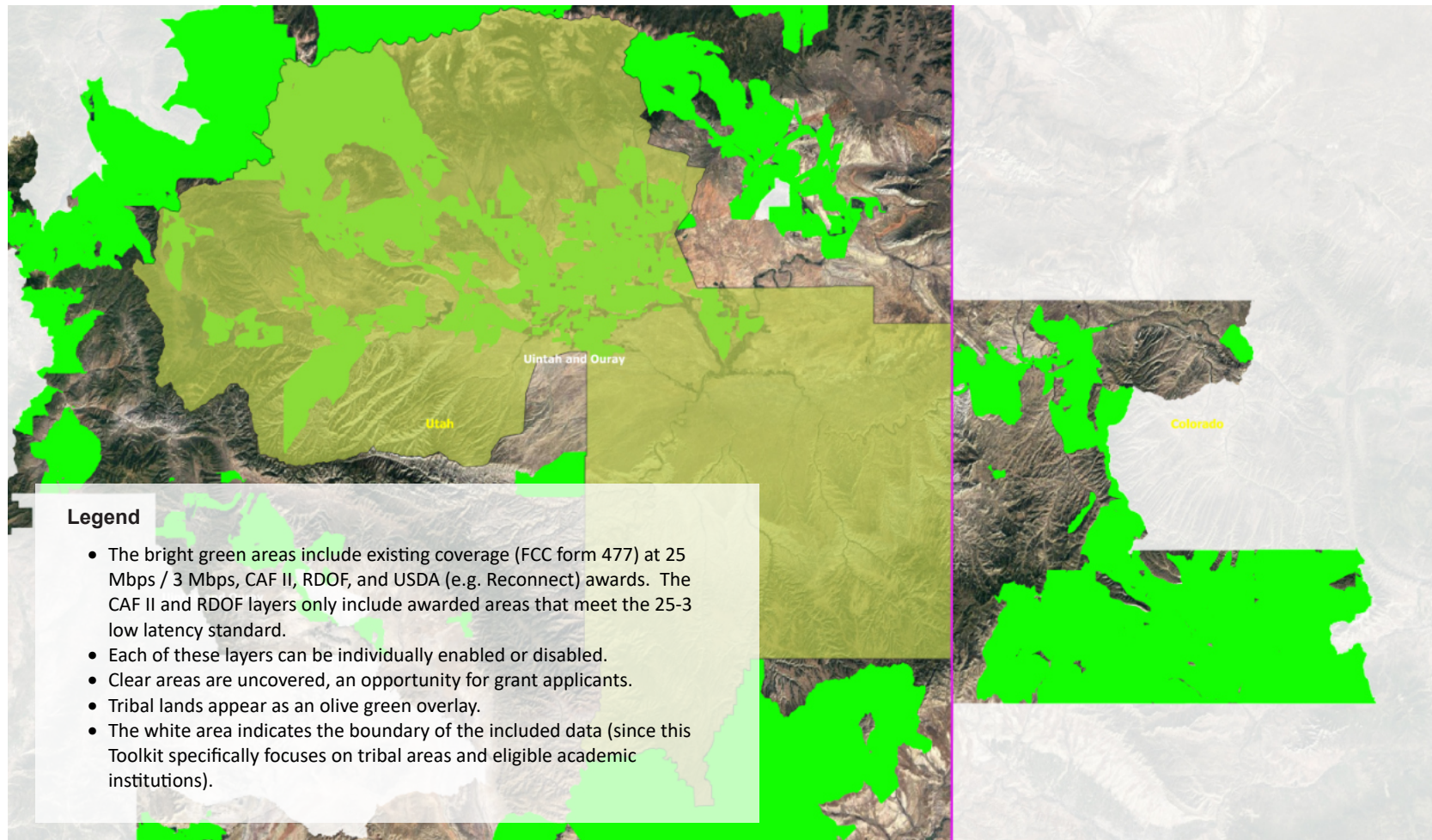
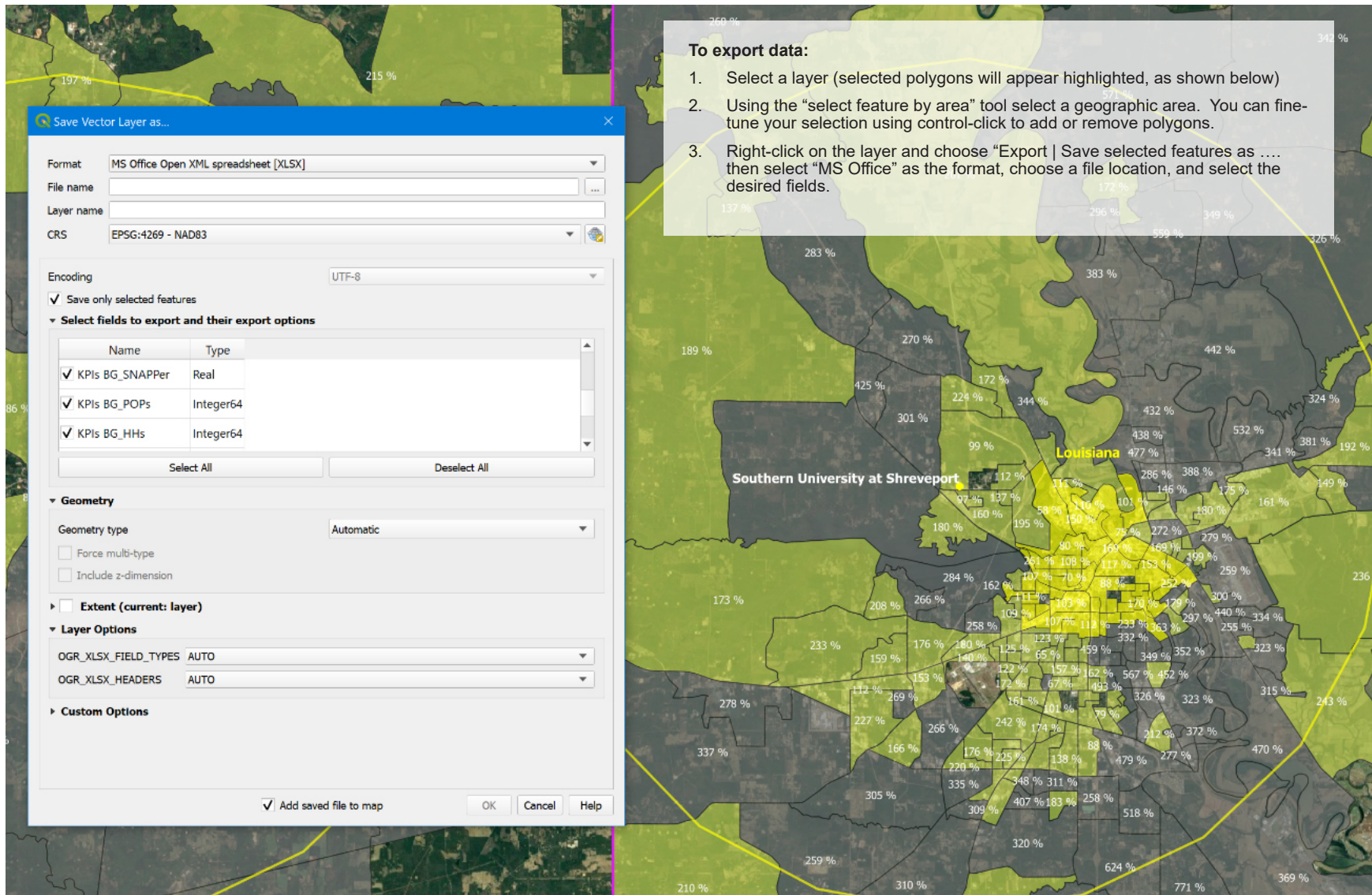


Figure 9: How to Select then Export Data



To export data:

1. Select a layer (selected polygons will appear highlighted, as shown below)
2. Using the "select feature by area" tool select a geographic area. You can fine-tune your selection using control-click to add or remove polygons.
3. Right-click on the layer and choose "Export | Save selected features as" then select "MS Office" as the format, choose a file location, and select the desired fields.

Bureau uses “Poverty Thresholds” for statistical purposes. It is a 48-cell matrix that includes family size, number of children, 1 and 2 person units, and whether or not an individual is elderly. There is no geographic dimension. In contrast, the Department of Health and Human Services uses a relatively simple “Poverty Guidelines”. The latter can be calculated based on family size and geography (Alaska vs. Hawaii vs. the Contiguous 48 States). The NTIA decided to use a national average of the Census Bureau “Poverty Threshold”, a calculation, the way the NTIA uses it, that is dependent only upon household size. The reader rounds the average household size in a geographic area up to the next integer value then performs a lookup.

- *250% Threshold.* Areas that qualify for funds under the *Connecting Minority Communities (CMC)* pilot must have a median household income that does not exceed 250% of the poverty line. This ratio is calculated using the poverty line (described above), and median annual household income. The results are shown visually as color coded polygons (lime green vs. gray) and as numerical labels for each block group within a 15-mile radius (or equivalent tribal boundary) around each qualifying institution. An identical calculation and geographic visualization is done at a tract and block group level.
- *Household Size.* The household size is calculated for each block group using the total number of households and the total population in households (excluding the population in group quarters).
- *SNAP Participation Rate.* The Supplemental Nutrition Assistance Program (SNAP), a.k.a. food stamps, participate

rate is shown as a percentage of households within each block group. A household receiving SNAP benefits is eligible for Lifeline subsidies and, presumably, for benefits under the \$3.2 billion *Emergency Broadband Benefit Program (EBBP)*, which is also part of the *Consolidated Appropriations Act, 2021*. The EBBP is administered by the FCC and USAC.

Opportunity Zones

Opportunity Zones were created by the 2017 Tax Cuts and Jobs Act to spur economic development and job creation in distressed communities. Opportunity zones have been designated in all 50 states and in every inhabited US territory (American Samoa, Guam, Northern Mariana Island, Puerto Rico, and the US Virgin Islands). Investors benefit from deferral or exclusion of capital gains. The community benefits from financial investment. They are designed to encourage investment in areas with high socioeconomic needs. The statute excludes specific luxury investments (e.g. golf courses) and specific “sin industries”, but is otherwise applicable to any business.

The Toolkit visualizes Opportunity Zones either as bright green polygons (if one wishes to find them on a map) or as clear tiles in an ocean of whited out space. Understanding the location of Opportunity Zones relative to other measurable metrics – particularly indications of need – is extremely powerful. It enables a business to deploy capital in locations that are likely to have a favorable social impact while offering investors unique tax incentives. Local governments (urban and rural) may wish to encourage outside investment based on the juxtaposition of Opportunity Zones with important needs identified by other layers of data.

Figure 10: Elevation Data

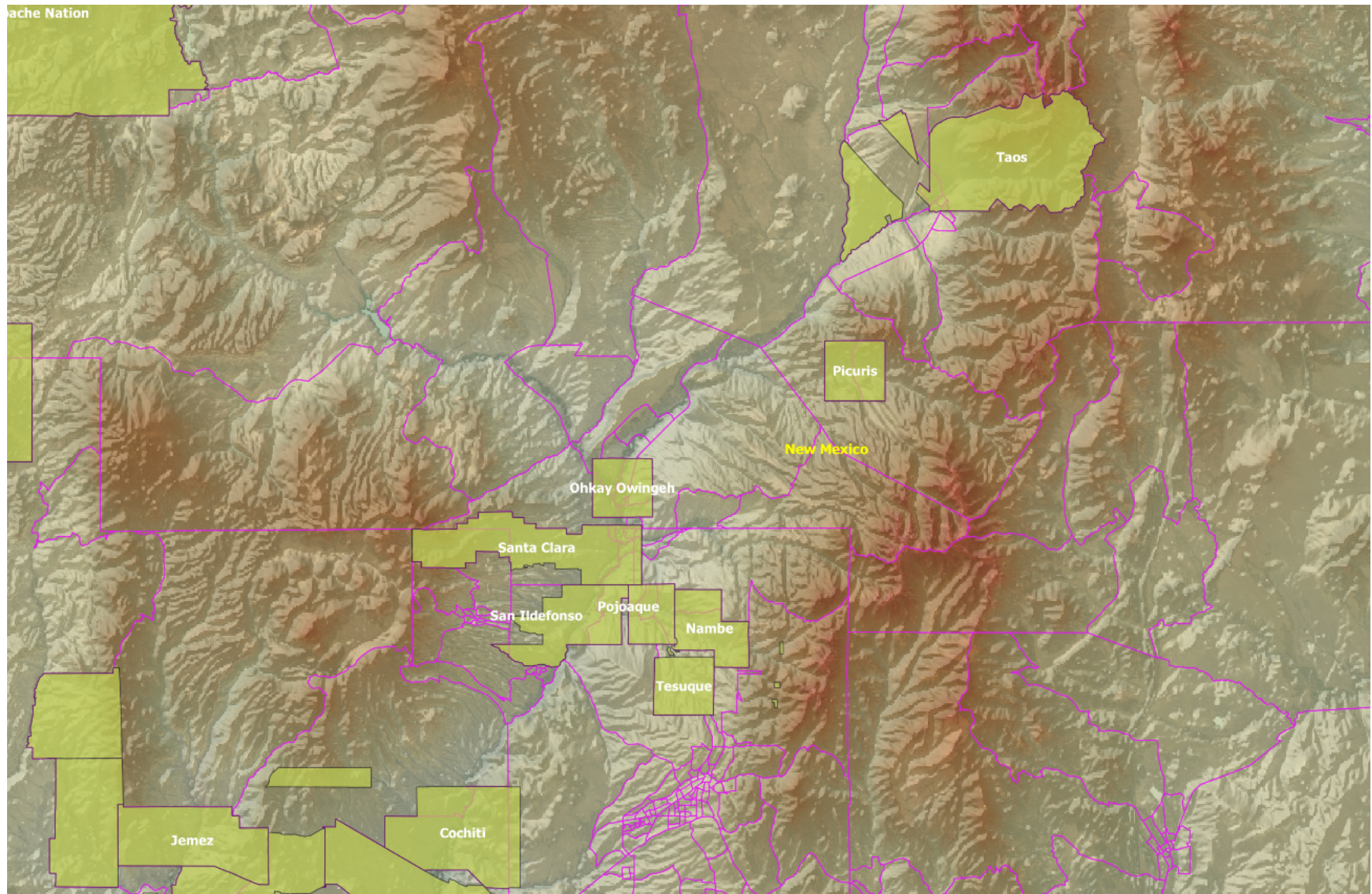


Figure 11: Spreadsheet Format

Historically Black Colleges and Universities	Tribal Colleges and Universities	Eligible Minority-Serving Institutions	Hispanic-Serving Institutions	Alaska Native and Hawaiian	Predominantly Black Institutions	Asian American and Native Pacific Islander-Serving Institutions	Native American-Serving Tribal Institutions	Unit ID Number	Office of Post-Secondary Education ID Number	Name of Institution	Street Address	City	State	5-Digit Zip Code	Web Site
HBCU	TCU	MSI	HSI	ANNH	PBI	AANAPISI	NASNTI	UnitID	OPEID	Name	Street	City	State	Zip	Web
	1	1		1				180203	02517500	Aaniih Nakoda College	269 Blackfeet Avenue Agency	Harlem	MT	59526	www.ancollege.edu
		1	1					126182	00134500	Adams State University	208 Edgemont Blvd	Alamosa	CO	81101	www.adams.edu
						1		188429	00266600	Adelphi University	South Ave	Garden City	NY	11530	www.adelphi.edu/
			1					133872	03115500	AdventHealth University	671 Winyah Drive	Orlando	FL	32803	www.ahu.edu
		1	1					126207	00758200	Aims Community College	5401 W. 20th St.	Greeley	CO	80634	www.aims.edu
1								100654	00100200	Alabama A & M University	4900 Meridian Street	Normal	AL	35762	www.aamu.edu/
1								100724	00100500	Alabama State University	915 S Jackson Street	Montgomery	AL	36104	www.alasu.edu
		1		1			1	442523	04138600	Alaska Christian College	35109 Royal Place	Soldotna	AK	99669	www.alaskacc.edu
			1	1			1	102669	00106100	Alaska Pacific University	4101 University Dr	Anchorage	AK	99508	www.alaskapacific.edu
		1				1		188526	00288500	Albany College of Pharmacy and Health Science	106 New Scotland Avenue	Albany	NY	12208	www.acphs.edu
1								138716	00154400	Albany State University	504 College Drive	Albany	GA	31705	www.asurams.edu/
		1			1			138682	00560100	Albany Technical College	1704 South Slapppy Boulevard	Albany	GA	31701	www.albanytech.edu
1								175342	00239600	Alcorn State University	1000 ASU Dr Ste 359	Alcorn State	MS	39096	www.alcorn.edu
		1	1					108807	00111100	Allan Hancock College	800 South College Drive	Santa Maria	CA	93454	www.hancockcollege.edu/
1								217624	00341700	Allen University	1530 Harden Street	Columbia	SC	29204	www.allenuniversity.edu/
		1	1					445461	00149916	Altierus Career College-Bissonnet	9700 Bissonnet St-Ste 1400	Houston	TX	77036	www.altierus.edu
		1			1			443748	00149917	Altierus Career College-Norcross	1750 Beaver Ruin Rd-Ste 500	Norcross	GA	30093	www.altierus.edu
		1	1					137801	00149900	Altierus Career College-Tampa	3319 W Hillsborough Ave	Tampa	FL	33614	www.altierus.edu
		1	1					238193	00383200	Alverno College	3400 S 43rd St	Milwaukee	WI	53234	www.alverno.edu
		1	1					222567	00353900	Alvin Community College	3110 Mustang Rd	Alvin	TX	77511	www.alvincollege.edu
		1	1					222576	00354000	Amarillo College	2011 S. Washington	Amarillo	TX	79109	www.actx.edu
						1		490081	04227100	America Evangelical University	1818 South Western Avenue Suite 409	Los Angeles	CA	90006	www.aeu.edu/
		1	1					142887	00162800	American Academy of Art	332 S Michigan Ave	Chicago	IL	60604	www.aaart.edu
1								219505	01046000	American Baptist College	1800 Baptist World Ctr Dr	Nashville	TN	37207	www.abcnash.edu
		1				1		109208	00123200	American River College	4700 College Oak Dr	Sacramento	CA	95841	www.arc.losrios.edu/
				1		1		240736	01001000	American Samoa Community College	P.O. Box 2609	PagoPago	AS	96799	www.amsamoa.edu
		1	1					241128	01194101	American University of Puerto Rico	Carretera Estatal #2 Km.48.1	Manati	PR	00674	aupr.edu
		1	1					241100	01194100	American University of Puerto Rico	Carr. #2 Km.14.4 Bo. Hato Tejas	Bayamon	PR	00960	aupr.edu
		1				1		164465	00211500	Amherst College	Boltwood Avenue	Amherst	MA	01002	www.amherst.edu
		1			1			100690	02503400	Amridge University	1200 Taylor Rd	Montgomery	AL	36117	www.amridgeuniversity.edu
		1				1		168740	00223800	Andrews University	4150 Administration Drive Room 136	Berrien Springs	MI	49104	www.andrews.edu
		1	1					222822	00666100	Angelina College	3500 South First	Lufkin	TX	75902	www.angelina.edu
		1	1					222831	00354100	Angelo State University	2601 W. Avenue N	San Angelo	TX	76909	www.angelo.edu
		1	1					109350	00111300	Antelope Valley College	3041 West Ave K	Lancaster	CA	93536	www.avc.edu
		1	1					448886	00108103	Arizona State University-Downtown Phoenix	411 N Central Ave	Phoenix	AZ	85004	www.asu.edu/
		1	1					407009	00108101	Arizona State University-West	4701 W Thunderbird Road	Glendale	AZ	85306	www.asu.edu/
1								104160	00107100	Arizona Western College	2020 S. Avenue 8E	Yuma	AZ	85365	www.azwestern.edu
		1			1			106306	00108700	Arkansas Baptist College	1600 Dr. Martin Luther King Jr. Drive	Little Rock	AR	72202	www.arkansasbaptist.edu
		1				1		107318	02348200	Arkansas State University Mid-South	2000 W. Broadway	West Memphis	AR	72301	www.asumidsouth.edu
		1						109651	00111600	Art Center College of Design	1700 Lida St	Pasadena	CA	91103	www.artcenter.edu
		1	1					440651	03544300	Atenas College	Paseo del Atenas #101	Manati	PR	00674	www.atenascollege.edu
		1			1			138901	01216500	Atlanta Metropolitan State College	1630 Metropolitan Parkway SW	Atlanta	GA	30310	www.atlm.edu
		1			1			138840	00854300	Atlanta Technical College	1560 Metropolitan Pkwy SW	Atlanta	GA	30310	www.atlantatech.edu/
		1	1					241216	02505400	Atlantic University College	Colton St. # 9	Guaynabo	PR	00970	www.atlanticu.edu
		1			1			100830	00831000	Auburn University at Montgomery	7440 East Drive	Montgomery	AL	36117	www.aum.edu
		1			1			138956	00559900	Augusta Technical College	3200 Augusta Tech Drive	Augusta	GA	30906	www.augustatech.edu
		1	1					143118	00163400	Aurora University	347 S Gladstone Ave	Aurora	IL	60506	aurora.edu
		1				1		222983	00354300	Austin College	900 N Grand Ave	Sherman	TX	75090	www.austincollege.edu
		1	1			1		109785	00111700	Azusa Pacific University	901 E Alosta	Azusa	CA	91702	www.apu.edu
		1				1		164580	00212100	Babson College	231 Forest Street	Wellesley	MA	02457	www.babson.edu
		1		1			1	206817	00314700	Bacone College	2299 Old Bacone Rd	Muskogee	OK	74403	www.bacone.edu
		1	1					109819	00111800	Bakersfield College	1801 Panorama Dr	Bakersfield	CA	93305	www.bakersfieldcollege.edu
		1			1			161864	00206100	Baltimore City Community College	2901 Liberty Heights Avenue	Baltimore	MD	21215	www.bccc.edu
		1			1			210230	02440300	Baylor Medical College of Health Science	1002 Monroe Ave	Waco	TX	76798	www.baylor.edu

Needed Infrastructure

The Tribal Broadband Connectivity Program allows funds to be spent on infrastructure – among many other purposes – but requires the NTIA to consult with the FCC to “prevent duplication of funding”.

The Toolkit includes four important data sets for the geographies relevant to this Toolkit (the combined footprint of tribal lands plus post-secondary institutions qualifying under the CMC program):

- *Qualified Broadband.* All areas currently covered at or above 25 Mbps / 3 Mbps, low latency.
- *Federal Commitments.* All areas expected to receive federal funding for future broadband deployments that meet or exceed the minimum standard. These include:
 - RDOF awards (low latency)
 - CAF II awards (baseline and above, low latency)
 - USDA awards (grants and loans, Reconnect and other program). In most cases these will exceed the minimum standard.

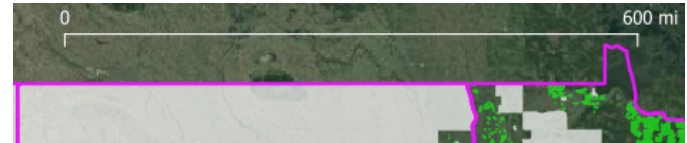
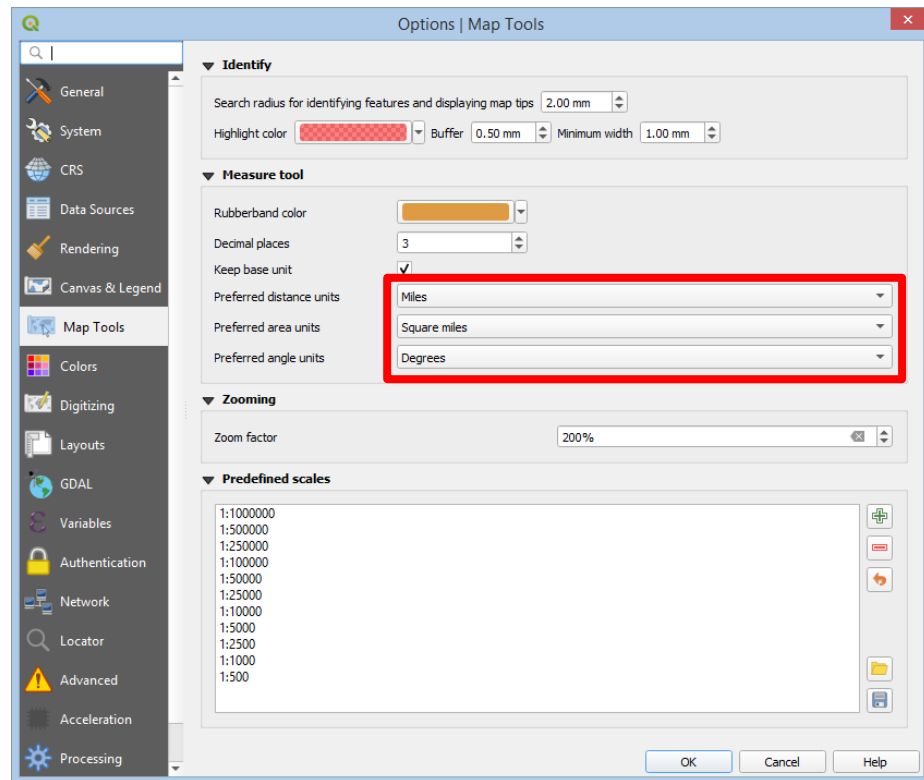
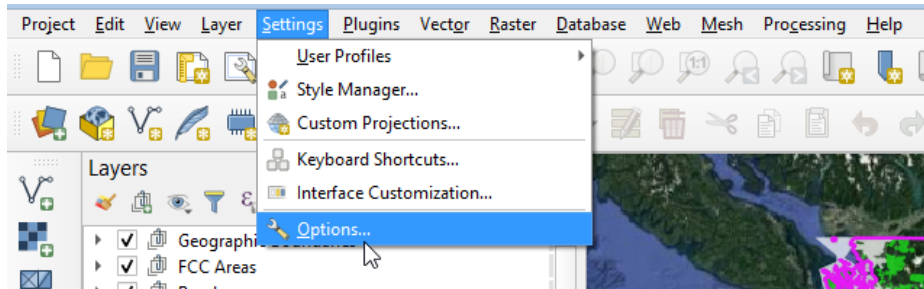
These data sets will be very helpful in identifying possible areas of deployment under the Tribal Broadband Connectivity Program. The RDOF and CAF II data sets are “pre-filtered” to show only qualifying (25-3 low latency) areas. It is important to note that state funding (not shown) is also relevant. Finally, many of the areas identified as covered by FCC 477 data are not – in fact – fully covered. The NTIA is open to other sources of data that demonstrate on a block-by-block basis that a deficiency exists. Stay tuned for a likely future Toolkit that will cover the entire nation and will include additional important data sets.

Geocoded Data

The visual portion of the Toolkit includes a number of important features:

- *Scrollable / pannable user interface.* A user can easily zoom in for a closer view or zoom out for a more distant view using the mouse’s wheel. Similarly, a user can grab the image and drag it in any direction. One can start in Florida, zoom out then fly to Hawaii or Alaska (with the national tool) then zoom in again for a detailed view. As the user manipulates the screen all of the underlying data scrolls and pans accordingly.
- *Many layers.* The Toolkit includes many layers of data that can be individually toggled on or off. The Toolkit is designed to show one graphical layer at a time. Each layer is translucent, so that the underlying map is visible.
- *Meaningful colors.* Numerical data is displayed using a range of colors. In most cases the scale runs from blue (low values) to red (high values). The color scheme provides a hint as to the type of data. In each case there are ten color thresholds that represent quantiles (an equal number of data points). There is no absolute meaning to “red” or “blue” across data elements, since the color scheme changes with each data element to reflect the underlying range of the data. The colors are designed to provide a visual cue to help the user see patterns and identify outlying values within any particular data set. Each data set has a legend that the user can see by clicking the “expand” triangular icon next to the “Visual” label

Figure 12: Setting the Legend to Miles



for the data set. The legend displays the exact range of values associated with each color.

- *Numerical overlays.* Most of the data sets (all of demographic and economic data) display not only colors, but also numbers. With demographic and economic data it is desirable to turn on the numerical overlay to see the exact value of each underlying region, especially when zoomed in to a small geographic area. If the user zooms out it is generally desirable to turn off the numerical display and enjoy a rich mosaic of color. If numerical text continues to be displayed when zoomed out the text associated with adjacent regions starts to overlap and quickly becomes unreadable.
- *Geographic Boundaries.* The Toolkit includes a long list of boundaries that can be turned on or off. These include state lines, county lines, congressional districts, zip code (ZCTA) boundaries, census tracts, census block groups, and census blocks.
- *License Areas.* The FCC has licensed spectrum over the years using different geographic boundaries. Some users of the Toolkit may own spectrum. The toolkit therefore includes boundaries for the most widely used license areas. These include: Cellular Market Areas (CMAs), Basic Trading Areas (BTAs), Major Trading Areas (MTAs), Regional PCS Areas (RPCs), Economic Areas (EAs or BEAs), Major Economic Areas (MEAs), Regional Economic Areas (REAs), Economic Areas Groupings (EAGs), and Partial Economic Areas (PEAs).
- *Boundary names and other data.* In most cases the name of the boundary (e.g. the state or county) can be displayed.

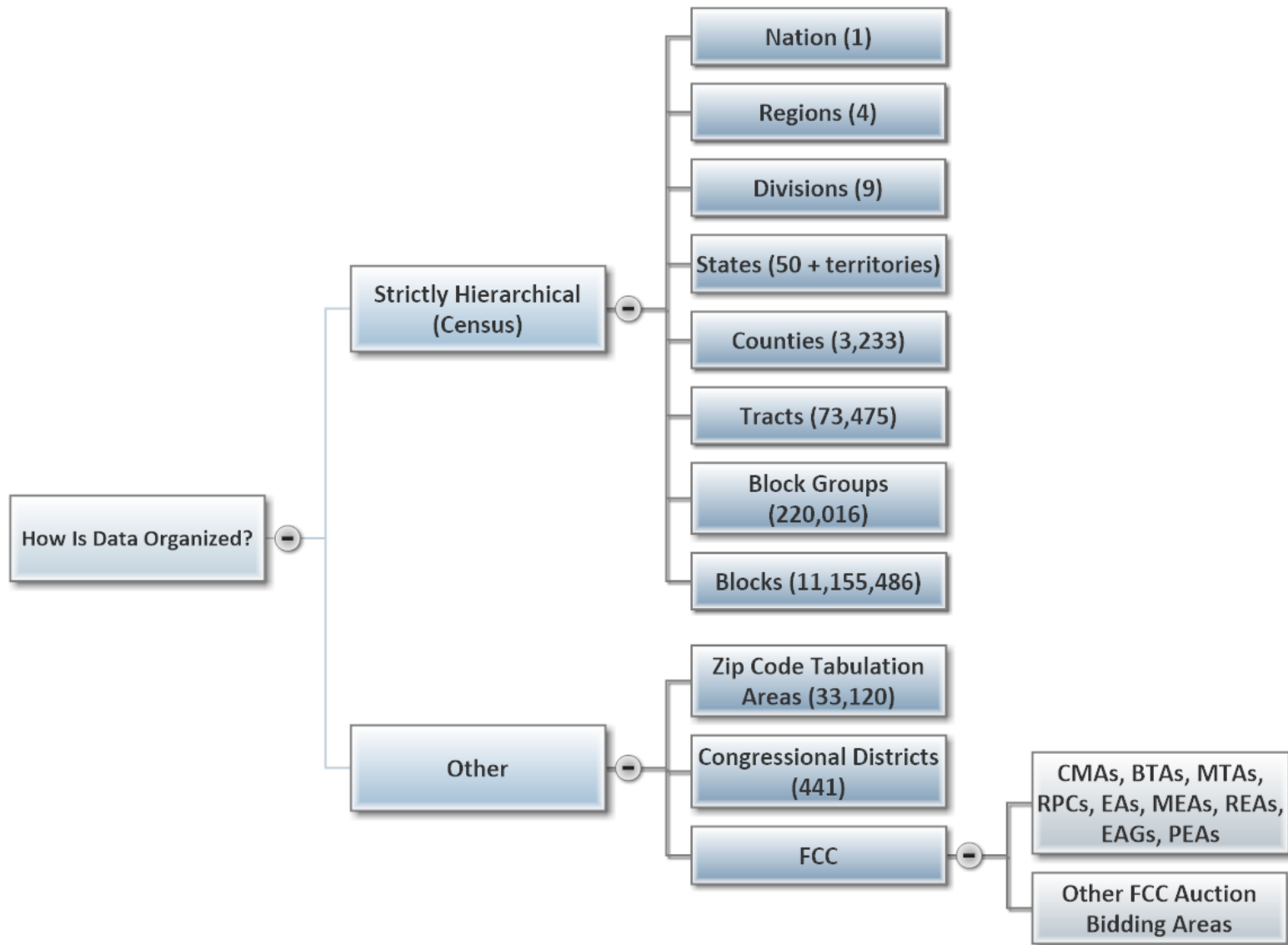
Alternatively a code may be displayed. The Census Bureau has a hierarchical numbering scheme called FIPS that begins at the state level (2 digits) then goes to the county level (2+3 = 5 digits) then to the tract level (2 + 3 + 6 = 11 digits) then to the block group level (2 + 3 + 6 + 1 = 12 digits) then to the block level (2+ 3+ 6 +1 +3 = 15 digits). If a user wishes to pull up spreadsheet data that corresponds to a visualize image it is helpful to turn on the numerical display for FIPS, take a screen shot, then look for the corresponding data set of spreadsheet data. Since everything is hierarchical one can select a county (the first 5 digits of the FIPS) by selecting all the block group data with the desired county code in the first 5 digits, as an example.

- *Roads.* The Toolkit includes primary and secondary roads, with or without name labels. Road layers may be turned on or off. Alternatively, one might choose an underlying map that includes road and place labels. Google, Bing, and OpenStreets, in the Maps folder, each include this option.
- *Choice of Units for Distance and Area Measurements.* In the United States people discuss distances in miles and areas in square miles or perhaps acres. The scientific community tends to use kilometers and square kilometers. The FCC and the Census Bureau have increasingly adopted metric units in their publications.

1 km = 0.621371 statutory miles. Similarly 1 square kilometer = 0.386102 square miles. A square mile is equal to 640 acres or 258.999 hectars.

The Toolkit can display the map legend in either kilometers or miles. *Figure 10* shows how to change from one set of units

Figure 13: Hierarchy of Geographic Boundaries



to another.

The internal databases of the Toolkit, including the spreadsheets, represent units in meters, square meters, kilometers, and square kilometers.

Graphical Versus Tabular

To build a business case one needs real data, not just a pretty picture. The Toolkit includes a comprehensive set of geocoded spreadsheet data (see examples in *Figure 8*) that matches the demographic and economic data sets in the visual tool. Each data set includes:

- *Numerical Code.* A numerical identifier for the region (typically a FIPS code), either a block or block group or a fragment of a block.
- *Name of Region or Entity.* The name of the region (e.g. a state and county or tribal nation) or an entity (a college, university).
- *Calculated Metrics.* Examples include areas, percentages, prorated metrics, growth factors, median household income, etc.
- *Raw “Counter” Data.* Raw data. The most important elements are housing units (structures), households (people), population (people), and the population included in households. Census polygons are hierarchical. Each block group, for instance, sums all of the blocks within it.

- *Population Estimates / Forecast.* In addition, the Toolkit includes separate population estimates / forecasts for every county in the 50 United States plus for the District of Columbia and Puerto Rico, based on the most recent yearly data from the Census Bureau. Recent county-level growth rates are used to produce near-term forecasts through the date of the auction (July 1, 2020).

Optimizing Performance

Geographical Information Systems, such as the QGIS browser, are data crunching machines and miraculous pieces of software in that they seek to visualize overwhelmingly large amount of data elegantly. The Visual Toolkit, as an application, has been highly optimized for performance, using as few computer resources as possible to achieve its objectives. Even so, it is helpful for every user to be aware of factors that impact performance:

- *Computer Hardware.* Every GIS application demands significant hardware resources. Ideally, one would run the Toolkit on a computer with a 64-bit operating system, lots of RAM, reasonable processing power, and fast disk access (ideally SSD). The current version of QGIS and the current highly optimized version of the Toolkit will both run with modest resources.
- *Application Loading Time.* Expect any GIS application to take a few minutes to load. Think of it as an opportunity to get a fresh cup of coffee. During the load process it connects to all of the linked data sets and prepares to load the associated data on demand. It doesn't work like Microsoft Word, where one clicks on a document and, an instant later, the document appears. Once loaded, though, the application is designed to

be responsive, with a few caveats.

- *First Time Loading a Layer.* The first time a user loads a visual layer after launching the application in QGIS the application may pause for a few seconds as it finds the desired data. Afterwards, one can select and deselect that data layer and expect the text and graphics to appear and disappear almost instantaneously, because it has been cached by the application. One can then sometimes zoom in and out and pan with minimal delay.
- *Streaming Maps.* In theory, streaming maps can cause the user interface to be slow because map data must be retrieved from a remote server. In practice, with the current version of QGIS and with a fast internet connection, the delay is negligible. Do be careful not to enable multiple maps at the same time. Doing so will multiply the volume of data that must be downloaded. Also, the user will see only one map at a time, so most of the effort will be wasted. If the user is in an airplane or has a slow internet connection or no connection at all then the user should disable the map by unchecking the map layer. If one is unsure about the impact of the map it is easy to disable it and to enable, instead, a solid color background (gray, black, white) to see if the application becomes visibly more responsive. Dark solid backgrounds, while not as pretty as a map, are wonderful for reading detailed overlaid data.
- *Text Overlays.* A text overlay can sometime slow the display. This is generally the case when text is enabled with a high resolution data set and the user is zoomed out. Imagine, for instance, looking at the continental United States, viewing data at the block group level, with text enabled. QGIS would

attempt to write 200,000 numerical values on the screen, one number for each polygon visualized. The user interface would be slow and the resulting image would be a mess. It is best to turn off text overlays before you zoom out then decide what text is appropriate at the new zoom level. Up close, one might be interested in block group FIPS codes, but zoomed out one might be interested in state boundaries and state names, as an example. High resolution boundaries (e.g. block group boundaries) when zoomed out can also slow the user interface and flood the resulting image with a single color of ink (reflecting the color of the boundaries). The implications of most of these decisions will become obvious the first time one uses the application.

Data Sources

The carefully curated data in the Tribal and Minority Communities Toolkit comes primarily from a small number of exceptionally high quality government sources:

- US Census Bureau
- Federal Communications Commission
- Department of Education (DE)
- Department of Health and Human Services (HSS)
- U.S. Geological Survey (USGS)
- U.S. Congress (legislative text)

The more significant sources include:

- US Census Bureau, American Community Survey. The ACS surveys 3.5 million households + 185,000 persons in group quarters per year on subjects ranging from household income

to demographics to physical space and amenities to devices and connectivity to monthly household expenditures. These are converted into single-year and 5-year estimates and other data products. The Toolkit uses the 2019 5-year estimates, which were published on December 10th, 2020.

- US Census Bureau, Population and Housing Estimates (PEP), The International Data Base, County Business Patterns, and a wide range of geographic boundary products and definitions. Extremely important are well-documented processes, which give the numerical data important context and meaning.
- The Federal Communications Commission. The FCC collects fixed and mobile coverage by technology by operator, as well as other service metrics and publishes detailed auction results. The CBRS Toolkit (available separately, in state and national versions) includes visualized fixed and mobile competitive deployment data (Form 477). This tool, the Tribal and Minority Community Toolkit, includes FCC reverse auction (CAF II and RODF) funding commitments for geographies that meet or exceed the FCC's definition of broadband, as well as USDA (e.g. ReConnect) funding commitments. Visibility into funding commitments is important for infrastructure-oriented grants to prevent a duplication of funding.
- The US Department of Education (DE) provides a variety of data sets describing the nation's colleges and universities and their eligibility for various federal programs.

Video Tutorials

Video tutorials exist to help new users get started, understand the sophisticated functionality, enable and disable options, and effectively use the various Toolkit products. Be sure to visit <https://www.youtube.com/channel/UCDgYo4d8RJfvfE294CbsbHQ>.

Next Steps

The New Initiatives page includes a complete set of information on the Tribal and Minority Community Toolkit. It includes the latest manuals and links to tutorial videos:

<http://cbrstoolkit.com/pages/initiatives>

The Toolkit team will be happy to answer your questions / discuss your needs by phone or video conference.

You can reach us at **support@cbrstoolkit.com**.