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U.S. DISTRICT COURT
N.D. OF ALABAMA

My name is Thomas Bryan[1]. I am a professional demographer and political redistricting expert witness. I have been retained by the State of Alabama to provide analysis and support in the case of *Singleton v. Merrill*.[2] A copy of my CV is attached to this report.

I am over 18 years of age and I have personal knowledge of the facts stated herein.

EXPERT QUALIFICATIONS

I graduated with a Bachelor of Science in History from Portland State University in 1992. I graduated with a Master of Urban Studies (MUS) from Portland State University in 1996, and in 2002 I graduated with a Masters in Management and Information Systems (MIS) from George Washington University. Concurrent with earning my Management and Information Systems degree, I earned my Chief Information Officer certification from the GSA.[3]

My background and experience with demography, census data and advanced analytics using statistics and population data began in 1996 with an analyst role for the Oregon State Data Center. In 1998 I began working as a statistician for the US Census Bureau in the Population Division – developing population estimates and innovative demographic methods. In 2001 I began my role as a professional demographer for ESRI Business Information Solutions, where I began developing my expertise in Geographic Information Systems (GIS) for population studies. In May 2004 I continued my career as a demographer, data scientist and expert in analytics in continuously advanced corporate roles, including at Altria and Microsoft through 2020.

In 2001 I developed a private demographic consulting firm "BryanGeoDemographics" or "BGD". I founded BGD as a demographic and analytic consultancy to meet the expanding demand for advanced analytic expertise in applied demographic research and analysis. Since then, my consultancy has broadened to include litigation support, state and local redistricting, school redistricting, and municipal infrastructure initiatives. Since 2001, I have undertaken over 150 such engagements in three broad areas:

1) state and local redistricting,
2) applied demographic studies, and
3) school redistricting and municipal Infrastructure analysis.

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[1] https://www.linkedin.com/in/thomas-bryan-424a6912/

[2] https://redistricting.lls.edu/wp-content/uploads/AL-singleton-20210927-complaint.pdf

[3] Granted by the General Services Administration (GSA) and the Federal IT Workforce Committee of the CIO Council.

My background and experience with redistricting began with McKibben Demographics from 2004-2012, when I provided expert demographic and analytic support in over 120 separate school redistricting projects. These engagements involved developing demographic profiles of small areas to assist in building fertility, mortality and migration models used to support long-range population forecasts and infrastructure analysis. Over this time, I informally consulted on districting projects with Dr. Peter Morrison. In 2012 I formally began performing redistricting analytics and continue my collaboration with Dr. Morrison to this day.

I have been involved with over 40 significant redistricting projects, serving roles of increasing responsibility from population and statistical analyses to report writing to directly advising and supervising redistricting initiatives. Many of these roles were served in the capacity of performing Gingles analyses, risk assessments and Federal and State Voting Rights Act (VRA) analyses in state and local areas.

In each of those cases, I have personally built, or supervised the building of, one or more databases combining demographic data, local geographic data and election data from sources including the 2000, the 2010 and now 2020 decennial Census. I also innovated the use of the US Census Bureau's statistical technique of "iterative proportional fitting" or "IPF" of the Census Bureau's American Community Survey (ACS) and the Census Bureau's Special Tabulation of Citizen Voting Age Population Data to enable the development of districting plans at the Census block level. This method has been presented and accepted in numerous cases I have developed or litigated. These data have also been developed and used in the broader context of case-specific traditional redistricting principles and often alongside other state and local demographic and political data.

In 2012 I began publicly presenting my work at professional conferences. I have developed and publicly presented on measuring effective voting strength, how to develop demographic accounting models, applications of using big data and statistical techniques for measuring minority voting strength – and have developed and led numerous tutorials on redistricting. With the delivery of the 2020 Census, I have presented on new technical challenges of using 2020 Census data and the impact of the Census Bureau's new differential privacy (DP) system. This work culminated with being invited to chair the "Assessing the Quality of the 2020 Census" session of the 2021 Population Association of America meeting, featuring Census Director Ron Jarmin.

I have written professionally and been published since 2004 in numerous peer-reviewed academic publications. I am the author of "Population Estimates" and "Internal and Short Distance Migration" in the definitive demographic reference "The Methods and Materials of Demography". In 2015 I joined a group of professional demographers serving as experts in the matter of *Evenwel, et al. v. Texas* case. In Evenwel I served in a leadership role in writing an Amicus Brief on the use of the American Community Survey (ACS) in measuring and assessing one-person, one vote. I also successfully drew a map for the State of Texas balancing both total population from the decennial census and citizen voting age population from the ACS (thereby proving that this was possible – a key tenet of the case). I believe this was the first and still only time this technical accomplishment has been achieved in the nation at a state level. In 2017 I co-authored "From Legal Theory to Practical Application: A How-To for Performing Vote Dilution Analyses." In 2019 I co-authored "Redistricting: A Manual for Analysts, Practitioners, and Citizens". In 2021 I authored an assessment of the impact of the U.S. Census Bureau's approach to ensuring respondent privacy and Title XIII compliance by using a disclosure avoidance system involving differential privacy and was certified as an expert by the US District Court of Alabama Eastern Division. In 2021 I also co-authored ""The Effect of the Differential Privacy Disclosure Avoidance System Proposed by the Census Bureau on 2020 Census Products: Four Case Studies of Census Blocks in Alaska".

I have been retained to develop, analyze and/or critique four state redistricting plans in 2021, including the state legislature for the Republican Texas House Committee on Redistricting, the state senate for Democratic Counsel for the State of Illinois, and state senate and legislature for Republican Counsel for the State of Wisconsin.

I have been deposed once in the last four years, in the matter of *Harding v. County of Dallas*.

I maintain membership in numerous professional affiliations, including:

- International Association of Applied Demographers (Member and Board of Directors)
- American Statistical Association (Member)
- Population Association of America (Member)
- Southern Demographic Association (Member)

My rate is $350 per hour for analysis, research and report writing, and $500 per hour for depositions and testimony.

In this report, I provide:

1) A demographer's perspective on the Alabama redistricting process and the *Singleton v. Merrill* case.
2) A summary and interpretation of traditional redistricting principles.
3) A discussion of "One Person One Vote" (OPOV) and its relevance to this case.
4) A discussion and analysis of the census and DOJ definitions of "Black" population.
5) An independent and factual analysis of plaintiffs' plan, the State of Alabama's enacted plan, and several other hypothetical plan options illustrating further alternative plan scenarios worthy of consideration.
6) A series of maps of alternative whole-county plans, as well as maps demonstrating features of Plaintiff's plan and the enacted plan.

Based on my knowledge and experience as a demographer, I conclude, among other points presented in this report, that:

1) the whole county plan suggested by plaintiffs has population deviation among the districts so that some persons votes are weighted more than others, and that deviation at the beginning of the decade is likely to result in far greater deviation by the end of the decade than a plan with zero deviation;

2) a map-drawer can racially gerrymander while keeping counties whole;

3) a requirement to keep counties whole does not necessarily result in the political result plaintiffs apparently desire, which is two congressional districts likely to elect a Democrat;

4) while counties were historically important communities of interest, before advances in communications and transportation, they have far less importance today; and

5) plaintiffs' whole county plan does not observe the important traditional districting criteria of preserving the core of existing districts.

It is my understanding that plaintiffs have also proposed modification to the whole county plan with county splits to result in less, or no, deviation. Because such alternatives are no longer whole county plans, and because the focus of this report is on the effect of a whole county requirement, this report focuses on the whole county plan proposed in plaintiffs' complaint.

I reserve the right to supplement this report.

1) A demographer's perspectives on the Alabama redistricting process and issues posed in *Singleton v. Merrill*.

The Alabama State Legislature is responsible for drawing both congressional and state senate and state house boundaries, as well State Board of Education districts. Both chambers of the state legislature must approve a single redistricting plan. The governor may veto the lines drawn by the state legislature[4] On May 5, 2021 the State of Alabama issued the "Reapportionment Committee Redistricting Guidelines", which stated among other things:

- "No district shall be drawn that subordinates race-neutral districting criteria to considerations of race, color, or membership in a language minority group (except…) to comply with Section 2";
- "Districts shall be composed of contiguous and reasonably compact geography";
- "Districts shall respect communities of interest…including but not limited to ethnic, racial, economic, tribal, social, geographic or historical identities"; and
- "The legislature shall try to preserve the cores of the existing districts"

Using population estimates from the Census Bureau, the Alabama legislature began to develop redistricting plans in May of 2021. Once the 2020 Census data were delivered in August of 2021, the Alabama legislature utilized that data to continue the redistricting process[5]. Plans were drawn in compliance with the published criteria for redistricting[6], which includes (among other guidance):

- IIa. Districts shall comply with the United States Constitution, including the requirement that they equalize total population; and
- IIb. Congressional districts shall have minimal population deviation.

On November 4, 2021 the proposed plans were signed into law[7] by Governor Kay Ivey.

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[4] https://ballotpedia.org/Redistricting_in_Alabama_after_the_2020_census

[5] https://www.census.gov/newsroom/press-releases/2021/population-changes-nations-diversity.html, https://www.census.gov/newsroom/press-releases/2021/2020-census-redistricting-data-easier-to-use-format.html

[6] http://www.legislature.state.al.us/aliswww/reapportionment/Reapportionment%20Guidelines%20for%20Redistricting.pdf

[7] Alabama enacted a congressional map on Nov. 4, 2021, after Gov. Kay Ivey (R) signed the proposal into law.[1] The Alabama House of Representatives voted 65-38 in favor of the map on Nov. 1 followed by the Alabama State Senate voting 22-7 on Nov. 3.[1][2] This map takes effect for Alabama's 2022 congressional elections.

Alabama enacted state legislative maps for the state Senate and House of Representatives on Nov. 4, 2021, after Gov. Kay Ivey (R) signed the proposals into law.[1] Senators approved the Senate map on Nov. 1 with a 25-7 vote.[3] Representatives approved the Senate map on Nov. 3 with a 76-26 vote.[1] For the House proposal, representatives

On September 27, 2021 (prior to the completion of the 2021 Alabama redistricting process) plaintiffs Bobby Singleton, Rodger Smitherman, Eddie Billingsley, Leonette W. Slay, Darryl Andrews, and Andrew Walker sued John H. Merrill in his official capacity as the Alabama Secretary of State stating:

> "Alabama's current Congressional redistricting plan, enacted in 2011, Ala. Act No. 2011-518, is malapportioned and racially gerrymandered, packing black voters in a single majority-black Congressional district and minimizing their influence in five majority-white districts. This action is brought to require the Alabama Legislature to enact a new plan with 2020 census data that remedies the existing unconstitutional gerrymander by restoring Alabama's traditional redistricting principle of drawing its Congressional districts with whole counties.[8]"

Plaintiffs in the case thereby claim (prior to the delivery of the actual plan) that: a) there is an existing racial gerrymander; and b) the only appropriate remedy is drawing a plan using whole counties, subordinating all other traditional redistricting principles. It is asserted that strict adherence to the county-line rule would remedy the racial gerrymanders in Alabama's current congressional redistricting plan, while affording Black voters two performing coalition districts instead of just the one majority-Black district, in which Black voters are now alleged to be excessively concentrated ("packed").Plaintiffs go on to propose a remedial districting plan complying with their proposed county "bright line" rule. That is – Alabama's congressional districts must exactly follow county boundaries – and in so doing must subordinate all other traditional redistricting criteria. Including achieving zero population deviation.

Plaintiffs state in their complaint (P.20) that

> "By returning to Alabama's traditional redistricting principle of aggregating whole counties, Alabama can remedy the existing racial gerrymander, restore a measure of rationality and fairness to Alabama's Congressional redistricting process, and afford African Americans an opportunity to elect candidates of their choice in at

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voted 68-35 in favor on Nov. 1 and senators followed on Nov. 3 with a 22-7 vote.[4] These maps take effect for Alabama's 2022 legislative elections.

Alabama's seven United States representatives and 140 state legislators are all elected from political divisions called districts. District lines are redrawn every 10 years following completion of the United States census. Federal law stipulates that districts must have nearly equal populations and must not discriminate on the basis of race or ethnicity.

Source: https://ballotpedia.org/Redistricting_in_Alabama_after_the_2020_census

[8] https://redistricting.lls.edu/wp-content/uploads/AL-singleton-20210927-complaint.pdf

> least two districts. Restoring the integrity of county boundaries will advance the representation of black citizens and, indeed, the fair representation of all Alabamians."

After the Alabama Legislature passed a congressional districting plan, Plaintiffs amended their complaint to challenge the new plan as an allege racial gerrymander. They continue to argue that the cure is to require Alabama to keep counties whole. Adjudicating the extent to which the Alabama enacted plan is or is not a racial gerrymander is not within the scope of this report or my expertise. However, in this report I shall examine evidence that supports a discussion of whether the Singleton remedy is a racial gerrymander or not.

It is unknown why plaintiffs attempt to revert Alabama congressional redistricting to comply with a county bright line rule as "the" remedy. As cited in the complaint – the use of county lines for redistricting is not without precedent. For a century and a half, Alabama drew its Congressional districts with whole counties[9] until the 1960 Census. Alabama has not kept all counties whole for the purposes of congressional redistricting since then. Further, while Alabama's state constitution (Art. IX, § 200) provides that state *senate* districts be contiguous and avoid county splits, the state constitution does not address counties in with respect to congressional districts.

All states must comply with the federal constitutional requirements related to population and anti-discrimination. For congressional redistricting, the Apportionment Clause of Article I, Section 2, of the U.S. Constitution requires that all districts be as nearly equal in population as practicable, which essentially means exactly equal[10]. Since the 1960 Census, the "one person, one vote" rule emerged from the Supreme Court's decision in Wesberry v. Sanders (1964) means that Congressional districts must have equal populations so that one person's vote counts as much as another's vote. However, it is my understanding that in *Tennant v. Jefferson County*, the Supreme Court of the United States reaffirmed that mathematical precision is not constitutionally required for Congressional districts and that minor deviations from population equality *can be justified* by sufficiently important state interests.

[9] See https://archives.alabama.gov/legislat/ala_maps/getstart.html State's exhibit 114-1 in *Chestnut v. Merrill*, CA No. 2:18-CV-00907-KOB (N.D. Ala.)

[10] https://www.ncsl.org/research/redistricting/redistricting-criteria.aspx

Plaintiffs also cite the New Jersey SCOTUS case of *Karcher v. Daggett*, which explains circumstances[11] under which states can deviate from absolutely perfectly balanced districts. In addition to the instructive outcomes of these cases, the Congressional Research Service has published history and guidance on the use of counties in the context of other criteria[12]:

> "…county boundaries, along with contiguity and compactness criteria, as the basis for the construction of congressional district boundaries have historically been state requirements. It appears that it is the fact that many states had such a requirement that makes Altman note that "most congressional districts were contiguous…; and, with the exception of districts in large urban areas, most congressional districts during this period [presumably, 1842-, 1963] were composed of whole counties." Courts have recognized that preserving political boundaries is a valid consideration for redistricting. The splitting of county and city boundaries has primarily occurred as a result of the political equality requirement in the post-*Baker v. Carr* era and as a result of the Voting Rights Act redistricting requirements. Nineteen states required that the preservation of political subdivision boundaries be a factor in congressional redistricting, and one state allowed it to be a factor in the 2000 redistricting cycle."

Therefore, while preserving county boundaries is a traditional districting principle, and was used more strictly before the "one person, one vote" rule was announced, it is unclear why county lines should be prioritized over other redistricting criteria or why doing so would result in a better plan. Therefore, it is this demographer's goal in this report to offer an independent, objective, and factual analysis of the performance of plaintiff's plan, the State of Alabama's enacted plan, and several independently generated plans that could be considered other options or scenarios not considered by either party.

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[11] In *Karcher v. Daggett*, another case that did not involve the more demanding racial gerrymandering standards, the Court suggested that acceptable population deviations for a Congressional redistricting plan can be determined by identifying those alternative plans which produce the lowest population deviations while respecting the state's policy of preserving political subdivisions (in that case municipalities). 462 U.S. at 739-40. "The showing required to justify population deviations is flexible, depending on the size of the deviations, the importance of the State's interests, the consistency with which the plan as a whole reflects those interests, and the availability of alternatives that might substantially vindicate those interests yet approximate population equality more closely. By necessity, whether deviations are justified requires case-by-case attention to these factors." Id. at 741.

[12] https://crsreports.congress.gov/product/pdf/R/R42831/3

2) Traditional Redistricting Principles

In addition to these mandatory standards set out by the U.S Constitution and the Voting Rights Act, states may adopt their own redistricting criteria, or principles, for drawing the plans. Those criteria appear in state constitutions or statutes, or may be adopted by a legislature, chamber, or committee, or by a court that is called upon to draw a plan when the legislative process fails. The Congressional Research Service explains[13]:

> "Many of the "rules" or criteria for drawing congressional boundaries are meant to enhance fairness and minimize the impact of gerrymandering. These rules, standards, or criteria include assuring population equality among districts within the same state; protecting racial and language minorities from vote dilution while at the same time not promoting racial segregation; promoting geographic compactness and contiguity when drawing districts; minimizing the number of split political subdivisions and "communities of interest" within congressional districts; and preserving historical stability in the cores of previous congressional districts."

The following districting principles (or criteria) have been adopted by many states:

- *Preservation of communities of interest:* District boundaries should respect geographic areas whose residents have shared interests, such as neighborhoods and historic areas.
- *Continuity of representation.* There is a benefit to continuing the political and geographic stability of districts. This can be measured with:
  - *Preservation of districts ("core retention"):* A redrawn district should include as much of the same residential population as the former district did, as allowed by the minimum population that needs to be rebalanced.
  - Incumbents: Districts should not be drawn to include pairs of incumbents.
- *Compactness*: Districts should be geographically compact and not irregular.
- *Contiguity*: All parts of a district should be connected at some point with the rest of the district. Simply put, contiguity means that a pedestrian could walk from any point within the district to any other point within it without needing to cross the district's boundaries; and
- *Preservation of counties and other political subdivisions*: District boundaries should not cross county, city, or town, boundaries to the extent practicable.

[13] https://crsreports.congress.gov/product/pdf/R/R42831/3

Plaintiffs' allegations fixate on the preservation of county boundaries, and it is in this regard that I now focus. More than a dozen states consider using counties as boundaries for redistricting a state or federal plan, including Alabama, Iowa, Idaho, Kentucky, Massachusetts, Michigan, Mississippi, Missouri, Nebraska, New Jersey, North Carolina Ohio, Texas, West Virginia and Wyoming. Iowa and West Virginia stand out as states that particularly emphasize the use of counties in drawing congressional districts.[14]

In Iowa, Section 37 of their constitution states "a congressional district is composed of two or more counties it shall not be entirely separated by a county belonging to another district and no county shall be divided in forming a congressional district." §42.4.b Redistricting Standards goes on to state:

> "Congressional districts shall each have a population as nearly equal as practicable to the ideal district population, derived as prescribed in paragraph "a" of this subsection. No congressional district shall have a population which varies by more than one percent from the applicable ideal district population, except as necessary to comply with Article III, section 37 of the Constitution of the State of Iowa."

I am aware of no such requirement under Alabama law. The Singleton complaint does not acknowledge Iowa as an example of using county boundaries for congressional redistricting but does refer to West Virginia. Article 1, Section 4 of the West Virginia Constitution states "Representatives to Congress. For the election of representatives to Congress, the state shall be divided into districts which shall be formed of contiguous counties and be compact. Each district shall contain, as nearly as may be, an equal number of population, to be determined according to the rule prescribed in the constitution of the United States." I am aware of no such requirement under Alabama law. It is also my understanding that West Virginia never split counties in a congressional map prior to 2010, when the map was challenged and ultimately addressed in *Tennant v. Jefferson County*. I am aware of no such history in Alabama; rather, it is my understanding that Alabama has routinely split one or more counties in its congressional map since the 1960s.

[14] https://www.ncsl.org/Portals/1/Documents/Redistricting/DistrictingPrinciplesFor2010andBeyond-9.pdf

Plaintiffs also refer to Georgia and the case of in *Abrams v. Johnson*. On pages 44 of their amended complaint, plaintiffs write:

> "the Supreme Court affirmed a court-ordered Congressional redistricting plan that honored "Georgia's 'strong historical preference' for not splitting counties outside the Atlanta area." Id. At 99 (citation omitted). The Court agreed that Georgia's 159 counties provide "ample building blocks for acceptable voting districts without chopping any of those blocks in half."

What plaintiffs did not mention in their complaint was the actual text in the decision that explained why counties were an acceptable form of geography specific to use in Georgia:

> "The court acknowledged that maintaining political subdivisions alone was not enough to justify less than perfect deviation in a court plan… ("[W]e do not find legally acceptable the argument that variances are justified if they necessarily result from a State's attempt to avoid fragmenting political subdivisions by drawing congressional district lines along existing county, municipal, or other political subdivision boundaries"). The District Court, in conformance with this standard, considered splitting counties outside the Atlanta area, but found other factors "unique to Georgia" weighed against it.

The court went on to state:

> "Georgia has an unusually high number of counties: 159, the greatest number of any State in the Union apart from the much-larger Texas. These small counties represent communities of interest to a much greater degree than is common, and we agree with the District Court that "such a proliferation" provides "ample building blocks for acceptable voting districts without chopping any of those blocks in half." 864 F. Supp., at 1377."

The court then went on to describe the remarkably small deviations that resulted from having so many pieces of geography from which to use. The inference in the plaintiff's complaint is that all of Georgia is drawn with intact counties (which it is not), that Georgia requires the use of counties statewide for congressional redistricting (which it does not) and that Georgia's matter is somehow representative and can be considered illustrative for other states (which the court expressly said it was not). In summary, while there are a number of unique instances where states can and do rely on counties for congressional redistricting – they are very limited and are not generalizable to Alabama in the way plaintiffs suggest.

3) Abiding by "One Person, One Vote"

The core purpose of the Census is to apportion political power, and to allow states and localities to draw political districts that equalize political power through "one person, one vote" or OPOV. The "one person, one vote" principle is meant to ensure that voters in each election district hold equally weighted ballots. Equalizing total population during redistricting, to the last person, accomplishes this end. Any difference from perfectly balanced population during redistricting will introduce what is formally known as "deviation". Using a simple example: let us say that:

- A state has 20,000 people and needs to be divided into 2 congressional districts.
- The state will redistrict using traditional redistricting principles.
- The state has gotten an exception to balancing their population perfectly. State leadership gives District 1 10,125 people (overpopulated by 1.25%), and District 2 9,875 (underpopulated by 1.25%).

In this scenario, the population deviation is 2.5%. The impact of this difference is beyond numeric though. District 1 does not enjoy the benefits of one person one vote. Since they are overpopulated, each resident's vote is diluted. One person = .9875 votes. Similarly, District 2 *more than enjoys the* benefits of one person one vote. Since they are underpopulated, each resident's vote is magnified. One person = 1.0125 votes.

The entire legal and political impact of OPOV and unbalanced population is beyond the scope of this paper, but the demographic impact is not. Conventionally, the concept of "deviation" is only measured at a point in time – when redistricting is done. In *Singleton v. Merrill* the court is being asked to accept what is characterized as a small amount of deviation to mitigate much more serious alleged ulterior motives. Since plaintiffs ask for leniency in allowing some population deviation as of 2020 in their plan, I contemplated the impact of that deviation not just in 2020 – but over the course of the decade from 2020 to 2030 (that is, the period of time that the districts are to be used). Other than as a thought exercise, I would not do this for a normal redistricting analysis because congressional districts usually start with the smallest deviation possible: 0 or 1 person. However, if we are being asked to allow for *some* deviation among districts now - then I argue that we should know the impact of this deviation over the decade of their anticipated use, not just the year they were developed. In Section 4 ("Deviations") I perform a demographic analysis where I produce a series of rigorous population forecasts, then assess what I *expect* the deviations to be over time from the plaintiff's plan, the State of Alabama's plan and a variety of other independently developed plans. I did not have any a priori knowledge or expectations whether the plaintiffs plan would perform better than, the same, or worse than a plan such as Alabama's starting with zero deviation.

4) Census Race Definitions

On page 29 of their amended complaint, plaintiffs state:

> "The Plaintiffs' proposed Whole County Plan uses the official 2020 census data released on August 12, 2021. With an overall maximum deviation of only 2.47%, it contains a Black Belt District 7 that is only 0.11% above ideal population and has 49.9% black registered voters…"

The text of their report refers to a percent of Black voters, without reference or citation. On the following pages of their complaint, plaintiffs present a map and an almost illegibly small table that appears to show "%BL 18 In this table, District 6 appears to have "40.55%", District 7 appears to have "45.81%" and the total appears to have "25.06% of "%BL 18+". It is unknown what this is because it is also presented without reference or citation.

In the field of demography, and indeed in redistricting cases, the definition of the population in question is critical. Since the foremost purpose of the census is to generate statistics for the purpose of apportionment and redistricting – it is unclear why here plaintiffs refer to undocumented voting strength statistics rather than census Black Voting Age Population. Before I proceed, I will here try to define and document the true "Black" population of the two Black districts in the plaintiff's remedial plan.

The 2010 Census allowed respondents to self-declare their ethnic and racial identification:

> "In order to facilitate enforcement of the Voting Rights Act, the Census Bureau asks each person counted to identify their race and whether they are of Hispanic or Latino origin. Beginning with the 2010 Census (and continuing in 2020) the racial categories available in the Census were: White, Black, American Indian, Asian, Native Hawaiians and other Pacific Islanders, and Some Other Race. Persons of Hispanic or Latino origin might be of any race. Persons were given the opportunity to select more than one race – and that race could be in combination with Hispanic or non-Hispanic origin."[15]

The result is that the Census Bureau reports 263 different population counts for each level of Census geography in the country. A "Black" in Alabama therefore can be Black alone, or perhaps in combination with other races or possibly even also Hispanic. Since 2010, the number and proportions of multi-race populations in the United States has grown markedly.[16] An examination of Appendix 1 "Census 2020 Alabama Black Population Total, non-Hispanic and

[15] "How to Draw Redistricting Plans That Will Stand Up In Court", National Conference of State Legislators (NCSL), January 22, 2011, p. 17.

[16] Experts own independent observations.

Hispanic Combinations" reveals numerous new and important findings on who Blacks are in Alabama.

In Appendix 1 the population is reported starting in total, then progressing by row through race alone and race in combination for Alabama's Black population. Column A shows the total population and Column B shows the % of the total population for that group. Column C shows the non-Hispanic population and Column D shows the % of the total population for that group. Column E shows the Hispanic population and Column F shows the % of the total population for that group. In Appendix 2, the same format follows for the Alabama Black Voting Age Population (VAP).

In Appendix 1 (P.43), Column A (Total Population) I show that the Black or African American alone population is 1,296,162 – or 25.8% of the population. At the bottom of the table, I show the incremental impact of Black alone or in combination. When all other race combinations are added, the Black population is 1,364,736 – or 27.2% of the population as shown in Table 4.1 (P.15). This represents an additional 68,574 Blacks, or 5.0% of the total Alabama Black population.

In Appendix 2, Column A (Voting Age Population) I see that the Black or African American alone population is 981,723 – or 25.1% of the population. At the bottom of the table, I show the incremental impact of Black alone or in combination. When all other race combinations are added, the Black population is 1,014,372 – or 25.9% of the VAP as shown in Table 4.2 (P.15). This represents an additional 68,574 Blacks, or 3.2% of the Alabama Black VAP.

The "%BLK 18+" population in the plaintiff's report appears to be Alabama's Black alone VAP from the 2020 Census. But in this matter precise definitions matter. This "alone" definition is the one most consistently used historically in VRA cases because a) a multi-race classification did not exist prior to 2000; and b) the "alone" definition has been most defensible from a political science / Gingles 2 voting behavior perspective. On September 1, 2021 the DOJ published "Guidance under Section 2 of the Voting Rights Act, 52 U.S.C. 10301, for redistricting and methods of electing government bodies"[17] which states:

> The Department's initial review will be based upon allocating any response that includes white and one of the five other race categories identified in the response. Thus, the total numbers for "Black/African American," "Asian," "American Indian/Alaska Native," "Native Hawaiian or Other Pacific Islander," and "Some other race" reflect the total of the single-race responses and the multiple

[17] https://www.justice.gov/opa/pr/justice-department-issues-guidance-federal-statutes-regarding-redistricting-and-methods

> responses in which an individual selected a minority race and white race. The Department will then move to the second step in its application of the census data by reviewing the other multiple-race category, which is comprised of all multiple-race responses consisting of more than one minority race. Where there are significant numbers of such responses, the Department will, as required by both the OMB guidance and judicial opinions, allocate these responses on an iterative basis to each of the component single-race categories for analysis. *Georgia v. Ashcroft,* 539 U.S. 461, 473, n.1 (2003).

In order to facilitate analysis that reflects current DOJ guidance, I will include analysis containing both Black alone (individuals who identify Black as their only race and are not Hispanic) or in combination (people who identify as Black plus one or more other categories, hereafter referred to as the "All Black" definition in this report) as appropriate.

Table 4.1 Singleton Plan Total Population by District

District	Total Pop	Black Alone Pop	All Black Pop	% Black Alone	% All Black
1	720,903	178,921	190,043	24.8%	26.4%
2	709,514	184,471	197,316	26.0%	27.8%
3	715,486	121,007	131,328	16.9%	18.4%
4	712,333	40,533	47,917	5.7%	6.7%
5	727,206	125,405	139,063	17.2%	19.1%
6	720,310	298,729	308,741	41.5%	42.9%
7	718,527	339,093	350,328	**47.2%**	**48.8%**
Grand Total	**5,024,279**	**1,288,159**	**1,364,736**	25.6%	27.2%

Table 4.2 Singleton Plan Voting Age Population by District

District	Total Pop	Black Alone Pop	All Black Pop	% Black Alone	% All Black
1	559,860	131,988	137,385	23.6%	24.5%
2	553,805	139,700	145,697	25.2%	26.3%
3	556,784	92,167	96,652	16.6%	17.4%
4	550,055	31,122	33,882	5.7%	6.2%
5	569,546	96,864	103,325	17.0%	18.1%
6	562,843	227,389	233,260	40.4%	41.4%
7	564,273	257,502	264,171	**45.6%**	**46.8%**
Grand Total	**3,917,166**	**976,732**	**1,014,372**	24.9%	25.9%

Table 4.3 HB1 Plan Total Population by District

District	Total Pop	Black Alone Pop	All Black Pop	% Black Alone	% All Black
1	717,754	185,771	196,827	25.9%	27.4%
2	717,755	216,019	228,648	30.1%	31.9%
3	717,754	175,783	187,284	24.5%	26.1%
4	717,754	51,314	59,655	7.1%	8.3%
5	717,754	123,355	136,782	17.2%	19.1%
6	717,754	137,209	145,897	19.1%	20.3%
7	717,754	398,708	409,643	**55.5%**	**57.1%**
Grand Total	**5,024,279**	**1,288,159**	**1,364,736**	25.6%	27.2%

Table 4.4 HB1 Plan Voting Age Population by District

District	Total Pop	Black Alone Pop	All Black Pop	% Black Alone	% All Black
1	557,535	137,354	142,777	24.6%	25.6%
2	557,677	161,893	167,971	29.0%	30.1%
3	564,281	135,659	141,011	24.0%	25.0%
4	556,133	39,507	42,819	7.1%	7.7%
5	561,187	95,014	101,339	16.9%	18.1%
6	552,286	100,385	104,551	18.2%	18.9%
7	568,067	306,920	313,904	**54.0%**	**55.3%**
Grand Total	**3,917,166**	**976,732**	**1,014,372**	**24.9%**	**25.9%**

Table 4.5 Existing 2011 Plan Total Population by District (Replicates in part Plaintiff Figure 10)

District	Total Pop	Black Alone Pop	All Black Pop	% Black Alone	% All Black
1	726,276	188,431	199,586	25.9%	27.5%
2	693,466	211,862	224,221	30.6%	32.3%
3	735,132	186,438	198,228	25.4%	27.0%
4	702,982	46,919	54,662	6.7%	7.8%
5	761,102	130,351	144,648	17.1%	19.0%
6	740,710	120,130	128,681	16.2%	17.4%
7	664,611	404,028	414,710	**60.8%**	**62.4%**
Grand Total	**5,024,279**	**1,288,159**	**1,364,736**	**25.6%**	**27.2%**

Table 4.6 Existing 2011 Plan Voting Age Population by District

District	Total Pop	Black Alone Pop	All Black Pop	% Black Alone	% All Black
1	564,302	139,380	144,863	24.7%	25.7%
2	539,812	159,212	165,202	29.5%	30.6%
3	576,455	143,415	148,910	24.9%	25.8%
4	543,423	36,006	39,038	6.6%	7.2%
5	595,873	100,325	107,050	16.8%	18.0%
6	572,838	89,754	93,787	15.7%	16.4%
7	524,463	308,640	315,522	**58.8%**	**60.2%**
Grand Total	**3,917,166**	**976,732**	**1,014,372**	**24.9%**	**25.9%**

5) Analysis and Evaluation of Plans

Next, I analyze and evaluate the enacted Alabama plan and plaintiffs' proposed plan using the following measures traditional redistricting criteria:

A. communities of interest, including:
B. core retention analysis;
C. incumbency; and
D. compactness.

For the purposes of independent comparison and context, I attempted to develop additional Alabama redistricting plans using plaintiff's method of whole counties[18] (consistent with our understanding of the Plaintiff's plan that no other traditional redistricting criteria were considered). In their complaint, plaintiffs go to great lengths discussing the history of redistricting in Alabama and enacted and contested congressional plans. But plaintiffs only offer one remedial plan, with no discussion of whether alternate plan scenarios (and their associated political and demographic outcomes) using their county bright line rule are even possible, nor the long-term consequences of the population deviation they propose. Plaintiffs also do not discuss whether keeping counties whole will always necessarily result in a plan with two Black minority influence districts. It does not.

In the vacuum created by that omission, our goal was to determine whether the plaintiffs plan was the *only way* to develop Alabama congressional districts using whole counties (with their unique demographic and political outcomes and unavoidable population deviation). Was the omission of alternative county-based plans an oversight, or by necessity? Are there *less* favorable political or demographic outcomes plaintiffs chose to overlook? Perhaps there are better outcomes the plaintiffs were unaware of? Without alternate scenarios or analysis, I cannot know. The only way of knowing whether their exact use of whole counties is the best remedy to a questionable harm, I need to know the breadth of outcomes possible with plaintiff's proposed remedy. Is it the strategy and methodology of using whole counties that provides the needed potential relief, or is it the exact combination of counties they propose? If no other combinations of counties provide viable relief, then I must ask why the inflexibility and consequences of one exact county-based plan proposed by the plaintiffs best serves the needs of all the people of Alabama.

[18] Since these plans are developed using counties, the preservation of political subdivisions is given. The contiguity of counties in these alternate plans was enforced.

A. Communities of Interest

The concept of "communities of interest" (COIs) is frequently used, but not always easy to apply to redistricting. The U.S. Supreme Court has specified districts should contain "communities defined by actual shared interests."[19] The concept of COI can be difficult to define, and, consequently, making use of such an intangible concept in the actual constructing of boundaries may be difficult and arbitrary.[20] A broad, commonly used definition is "a group of people who share similar social, cultural, and economic interests, and who live in a geographically defined area". Others have gone to greater lengths. The University of Michigan Center for Urban, State and Local Policy (CLOSUP) defined communities of interest as:

> "While there is no set definition of COIs, we think of a COI as a group of people in a specific geographic area who share common interests (such as economic, historic, cultural, or other bonds) that are linked to public policy issues that may be affected by legislation. CLOSUP's research suggests that COIs can consist of religious, ethnic, or immigrant communities, neighborhoods, people in tourism areas, regional media markets, outdoor recreation or natural resource areas, economic zones, and much more. Examples of COIs include: historical communities; economic communities; racial communities; ethnic communities; cultural communities; religious communities; immigrant communities; language communities; geographic communities; neighborhoods; economic opportunity zones; tourism areas; school districts; outdoor recreation areas; communities defined by natural features; creative arts communities; media markets, etc.

Notably, CLOSUP's definition does *not* include administrative geography such as counties. Thus COIs can have an infinite array of interpretations and applications in redistricting. In a statewide plan such as in Alabama, meaningful COIs may exist at various geographic scales; not all of them can be preserved simultaneously. Even if one were to consider them all, it would not be possible to preserve them all. In preserving any one or more of them, it would necessarily divide other communities. And those COIs in one part of the state may not prevail in others. Do statewide COIs trump local ones? So then, which COIs should Alabama seek to preserve? Should Alabama rank those in any given area, and if so, on what basis? According to how many members they have? But how can that even be ascertained?

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[19] *Miller v. Johnson*, 515 U.S. 900, 919–20 (1995).

[20] Matthew J. Streb, Rethinking American Electoral Democracy, 2nd ed. (New York: Routledge, 2011), p. 111; Brunell, Redistricting and Representation, p. 66; Brickner, "Reading Between the Lines…," p. 16.

Plaintiffs in this case have sought to elevate just one COI above all others: county geography. Before I proceeded, I investigated county geography and its uses in Alabama's history further to better understand and possibly defend the use of counties for redistricting. In the United States, counties are administrative units of geography and can be thought of as communities of interest. There are over 3,000 of them nationwide (and 67 in Alabama). As administrative units of geography they serve a wide variety of purposes, from finance to infrastructure to services and planning and more. While counties are unquestionably "geographically defined areas" from our first COI definition above, they are rarely uniquely and decisively bound historical communities; economic communities; racial communities; ethnic communities and so forth (from CLOSUP's definition). And this is true in Alabama.

In states such as Alabama, county boundaries preceded the introduction of the automobile. Drawing on the work of Stephan[21] (1977), a county can be described as a community representing the spatial distribution of a population resulting from its interaction with a governmental unit in accordance with time-minimization theory. Prior to the widespread adoption of long-distance communication devices, transportation technology was the determining factor in this interaction. Thus, county boundaries resulted from the necessity for people to travel between dispersed residences and a county seat under limiting conditions of time and the average velocity of the means of transportation. If country boundaries were too large, portions of the population would not have been able to interact with a center; if too small, then the cost of maintaining the centers would have been unnecessarily high, assuming there were enough local resources to maintain them at all. Ergo, counties are communities of interest historically formed under the constraints of time minimization. They do not have the same importance today that they held before modern communications and transportation.

Alabama is a state rich in history and diversity. With over 5 million residents, the yellowhammer state spans from the mountainous Tennessee Valley to the south by Mobile Bay covering over 52,000 square miles. It contains some of the richest farming country in the nation, alongside tech corridors and growing urban areas. The communities of interest shared by people dependent on a local economy is not defined by county boundaries, when citizens often live in suburbs and bedroom communities in neighboring counties. It could be argued that few Alabamians perceptively regard the administrative county they live in as the foremost, let alone singular definition of their "community of interest". Indeed, it would be difficult to imagine any resident arguing their administrative geography topping their college football allegiances.

[21] Stephan, G. (1977). Territorial Division: The least-time constraint behind the formation of subnational boundaries. Science 1996 (April): 522-523.

Today, much of the historic development and utility of counties as transportation hubs has changed. We no longer need to consider how long it takes on horseback to get from one county seat to another. Their current characteristics and utility are based on residuals of this history. Thus the historic utility of counties and their relevance as communities of interest is changing. If a redistricter were to argue for their prevailing use in designing a plan, they would need to do so for them as individual units as well as for why certain counties in aggregate represent a unifying geography. To the very degree that one argues administrative geographies are important as unique and defining COIs, one argues *against* their collective use and value as homogeneous and representative units of political geography. As with any COI, the aggregation of counties as communities of interest does not somehow a priori create a greater COI. In fact – the voice of any individual county may be eroded when it is aggregated into election districts with other counties. In the *Singleton v. Merrill* complaint – there are no arguments for why counties should prevail not only as a community of interest, but *the* community of interest. In the absence of such a justification, I argue that other COIs capturing regional characteristics, cultural differences and more in Alabama can only be considered and captured using sub-county granularity.

I will go on to show in this section that not only are numerous other configurations of congressional districts possible using counties in Alabama, but that:

a) there are significant and negative continuity of representation impacts of a county-based redistricting plan on Alabama's Black residents, as demonstrated with a core retention analysis and incumbency analysis;
b) the use of counties does not remedy gerrymandering, as shown with a compactness analysis; and
c) the introduction of a deviation from perfectly balancing the size of congressional districts today has long-term and far reaching implications for One Person One Vote in Alabama, as shown with a series of population forecasts.

I conclude by discussing the political performance, the racial outcomes and impact to incumbents of the Plaintiff's plan and more.

B. Core Retention Analysis

Courts have recognized the need to preserve the core of a prior established district as a legitimate redistricting criterion,[22] as well as the avoidance of contests between incumbents.[23] Core retention fosters the continuity of political representation. A C*ore Retention Analysis* (CRA) is simply a demographic accounting of the addition, subtraction, and substitution of persons that would be brought about by a proposed realignment of a district's existing boundaries. A CRA is a way of quantifying precisely how a proposed realignment would affect the continuity of political representation among a district's current residents and eligible voters.

Here, a CRA can be especially useful in exposing differential effects on specific groups of residents that amount to the denial or abridgement of the right to vote. To illustrate: suppose that 1,000 people now reside in a district in which Blacks constitute 480 (48%) of all the district's eligible voters (a Black "influence" district). Since this district now has too many residents (based upon the 2020 Census), a proposed boundary change retains 800 of its current residents and resituate 200 others in an adjacent district with too few people, thereby satisfying the newly-established requirement that every newly-drawn district be properly apportioned with 800 residents. Here, the "core" of the former district has fully retained numerically: all 800 residents of the newly-drawn district were part of the former district, maintaining the continuity of political representation among the proposed new district's current residents and eligible voters. That district would have a Core Retention percentage of 100%.

The CRA might also show that 150 of all 200 proposed resituated residents are Black. By this measure, "core retention" differs markedly for Blacks, because only 330 (480 minus 150) of the original 480 Black "core" of the former district has been retained. In short, the proposed new district would retain only 69% of the original Black core, thereby depriving 31% of Blacks of continuity of political representation.

Core Retention Analysis has usually only considered only the total populations of districts in comparisons across plans. As illustrated above, that limitation obscures other potentially problematic aspects of redistricting. In this case, I have broadened this standard demographic accounting model, using standard methodology, to present a full evaluation of various alternative redistricting plans, focusing on the right to vote by a protected group.

[22] *Abrams v. Johnson*, 521 U.S. 74, 84 (1997).

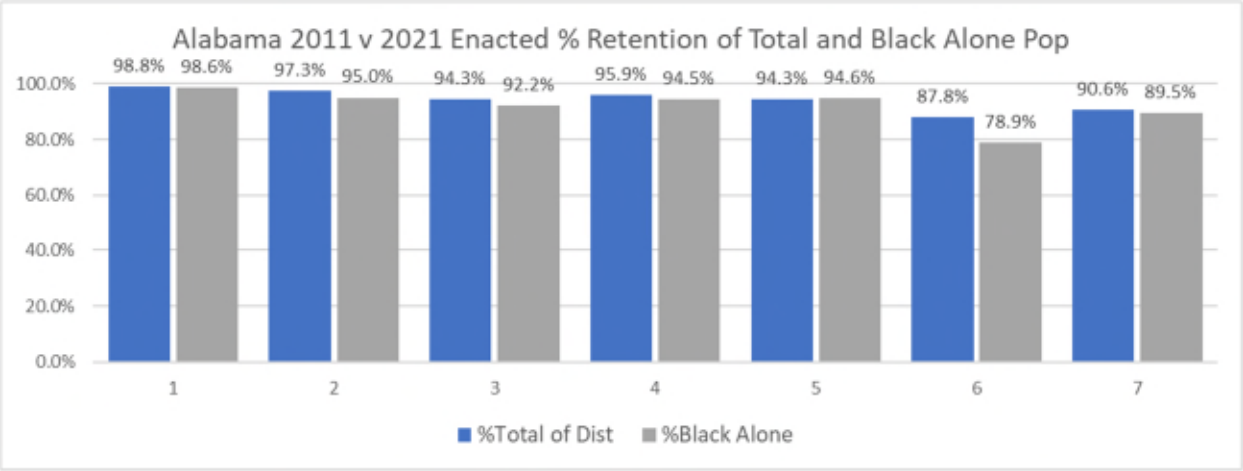
[23] *Bush v. Vera*, 517 U.S. 952 (1996).

Three core retention analyses follow:

1) Alabama 2011 v Alabama 2021 enacted
2) Alabama 2011 v Singleton
3) Alabama 2021 v Singleton

In Figure 5.1 it can plainly be seen that core retention of the total population and the Black population by the State of Alabama 2021 enacted plan compared to the 2011 existing Alabama plan is significant, consistent and comparable, which should have been expected given the least change approach of the 2021 plan.

Figure 5.1 Core Retention of Total and Black Population: 2011 Existing v 2011 Enacted Plans



In Tabl1 5.1 (below) the 2011 existing plan is shown in column 1, and the 2021 enacted plan is shown in column 2. The total population in column 3 is the number of total persons, and the Black population in column 4 is the number of Black persons who were retained and displaced in the 2021 enacted plan. For example, in the first row (1, 1) the total population of 717,754. This is intuitive. The existing 2011 D1 was reduced by exactly the number of persons necessary to balance – leaving 739 persons displaced to D2 and 7,783 persons displaced to D7. Concurrently, 185,771 Black persons are retained in D1, while 158 are displaced to D2 and 2,502 are displaced to D7.

At the bottom of Table 5.1(P.23) is a row named "Number Retained" which is the population in Alabama that did not change districts in the 2021 plan. The next row is "Percent Retained" which is the percent of the population that did not change districts in the 2021 plan. Alabama kept a remarkable 94.1% of the total population and 91.8% of the Black population intact with their 2021 enacted plan. The remainder is "Number Displaced" that were moved to some other district.

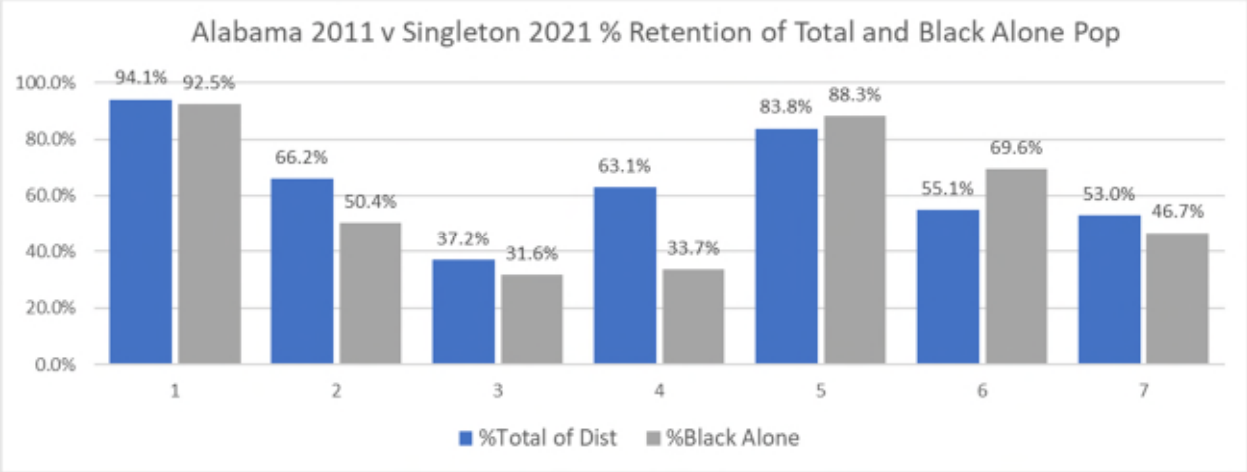
Table 5.1 Core Retention of 2011 Existing and 2021 Enacted Plan

Current 2011 Base District	New 2021 Enacted District	Total Population	Black Alone Population
1	1	717,754	185,771
	2	739	158
	7	7,783	2,502
1 Total		726,276	188,431
2	2	674,947	201,201
	7	18,519	10,661
2 Total		693,466	211,862
3	2	41,867	14,534
	3	693,265	171,904
3 Total		735,132	186,438
4	3	1,697	2
	4	674,218	44,318
	5	185	0
	6	5,012	18
	7	21,870	2,581
4 Total		702,982	46,919
5	4	43,533	6,996
	5	717,569	123,355
5 Total		761,102	130,351
6	3	22,792	3,877
	6	650,382	94,806
	7	67,536	21,447
6 Total		740,710	120,130
7	2	202	126
	4	3	0
	6	62,360	42,385
	7	602,046	361,517
7 Total		664,611	404,028
Number Retained		4,730,181	1,182,872
Percent Retained		94.1%	91.8%
Number Displaced		294,098	105,287
Grand Total		5,024,279	1,288,159

Figure 5.2 presents a core retention analysis of total population and Black population for the Singleton plan compared to the 2011 existing Alabama plan. Here I show two significant effects. First, the Singleton plan has significantly lower core retention, due to the large movements of population necessary to support their plan objective. To that end, I can see that the core retention of the Black population relative to total is:

- comparable in D1;
- much poorer in D2, D3 and D4;
- slightly better in D5 (in a part of Alabama distant from the Black influence discussion);
- slightly better in D6 (due to significant *non*-Black population being disgorged to other districts as part of the apparent attempt to improve the Black racial performance of D6); and
- worse in D7 (where Black population was disproportionately disgorged to D6 in an apparent attempt to balance the Black populations between the two districts).

Figure 5.2 Core Retention of Total and Black Population: State of Alabama 2011 v Singleton



Clearly, the State of Alabama's newly enacted 2021 plan registers consistently and significantly higher levels of core retention for both total and Black population than the Singleton plan - a result that should have been anticipated by the plaintiffs.

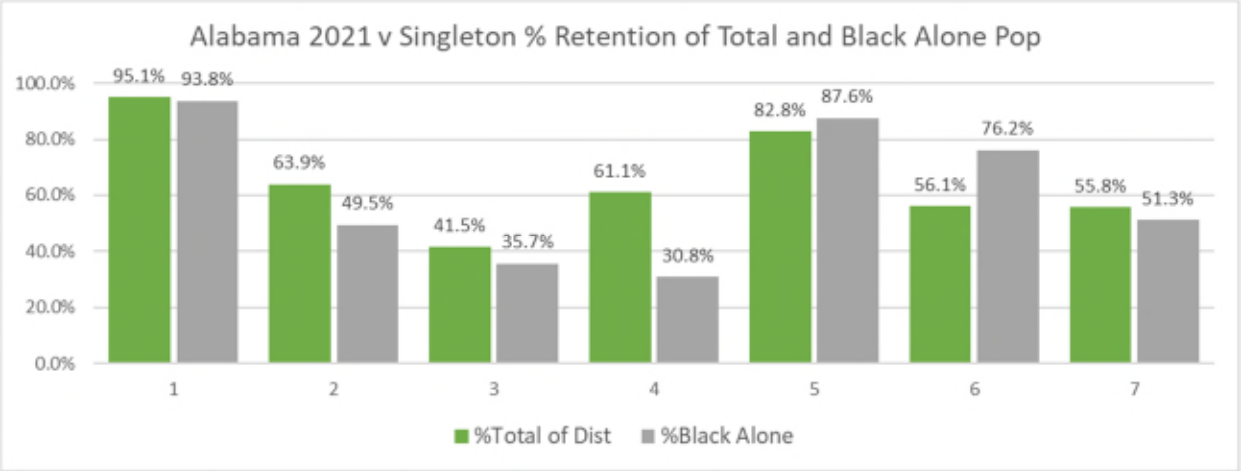
Table 5.2 (P.25) is consistent with Table 5.1 (P.23) except that is compares the Singleton plan with the 2011 existing plan. The significant difference shown in Figures 5.1 and 5.2 are reflected numerically here. The total population and Black population retained is significantly lower than Alabama's CRA shows, and the number displaced is significantly higher. At the bottom of Table 5.2 is the total retained population: 3,257,263 and Black retained population: 743,381. The Singleton plan displaces 1,472,918 more total and 439,491 more Black Alabamians than the enacted 2021 enacted Alabama plan.

Table 5.2 Core Retention of 2011 Existing and Singleton Proposed Plan

Current 2011 Base District	Proposed 2021 Singleton District	Total Population	Black Alone Population
1	1	683,333	174,358
	7	42,943	14,073
1 Total		726,276	188,431
2	1	37,570	4,563
	2	458,812	106,834
	7	197,084	100,465
2 Total		693,466	211,862
3	2	309,507	88,989
	3	273,123	58,903
	4	91,103	8,617
	7	61,399	29,929
3 Total		735,132	186,438
4	3	105,133	15,001
	4	443,687	15,801
	5	89,525	10,361
	7	64,637	5,756
4 Total		702,982	46,919
5	4	123,421	15,307
	5	637,681	115,044
5 Total		761,102	130,351
6	3	278,425	35,751
	4	54,122	808
	6	408,163	83,571
6 Total		740,710	120,130
7	6	312,147	215,158
	7	352,464	188,870
7 Total		664,611	404,028
Grand Total		5,024,279	1,288,159
Number Retained		3,257,263	743,381
Percent Retained		64.8%	57.7%
Number Displaced		1,767,016	544,778
Grand Total		5,024,279	1,288,159

This analysis is followed by a core retention analysis of the Singleton plan compared to the State of Alabama 2021 enacted plan. Since the Alabama 2021 enacted plan is similar to the original 2011 plan – it is no surprise that the pattern of retention by district, by total and Black population is consistent – but just slightly different.

Figure 5.3 Core Retention of Total and Black Population: State of Alabama 2021 v Singleton



This superior record for the State's Plan reflects the advantage of a least change approach: simply adjusting existing boundaries where necessary, instead of completely redrawing all districts, as plaintiffs did. Overall, the differences in core retention shows the significant incremental loss of the continuity of representation borne disproportionally by Alabama's Black population.

It is also worth noting that in the process of reapportioning the state population after Census 2020, the state effectively unpacked District 7 in an effort to balance each districts population. In examining Table 4.5 (P.16) I show that the existing (that is, pre-apportionment) plan had 664,611 total and 404,028 Black alone population. I show in Table 4.3 (P.16) that the new HB1 plan has 717,754 total and 398,708 Black alone population. That is, D7 added (717,754-664,611) or 53,143 total persons, while disgorging (404,028 – 398,708) or 5,320 Black alone persons to adjacent districts. It is difficult to argue that the State of Alabama deliberately packed Black population when their plan demonstrates that they in fact *unpacked* District 7 (resulting in a reduction in Black alone population from 60.8% to 55.5%) of the total population to the degree practicable while holding other traditional redistricting criteria.

C. Incumbency Analysis

The current residential address of congressional incumbents were geocoded on 11-14-2021. Alabama's enacted plan respects incumbents. While not stated explicitly in their report, the plaintiff plan *does not* respect incumbents. Plaintiffs' plan (Figure 5.4) pairs Palmer and Rogers in proposed District 3 and leaves District 7 unrepresented.

In our subsequent analysis, I consider 13 alternate plans built from counties. Among these - two plans: Plan 2 (S2) Figure 5.5 and Plan 3 (1) Figure 5.6 avoid pairing incumbents - demonstrating that other combinations of counties are possible that respect traditional redistricting principles.

Figure 5.4 Hatcher Plan

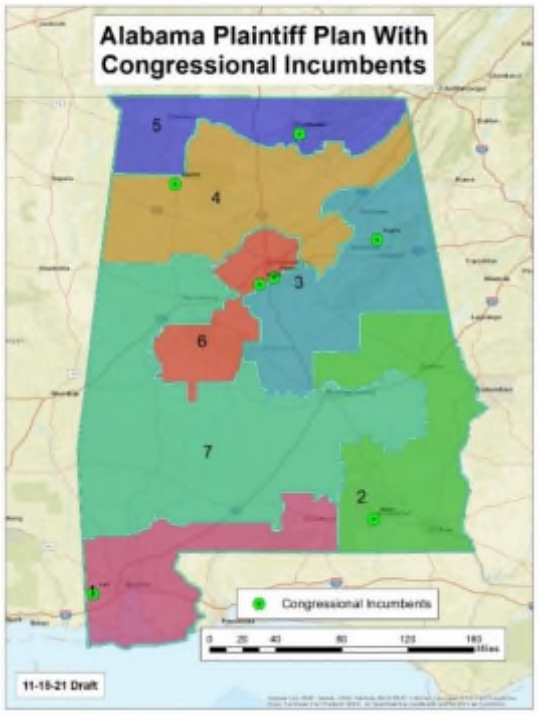


Figure 5.5 Alternate Plan 2 (S2)

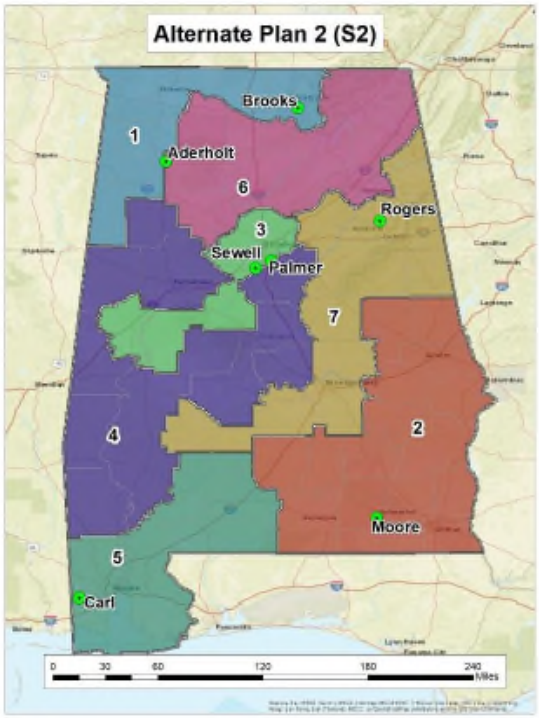
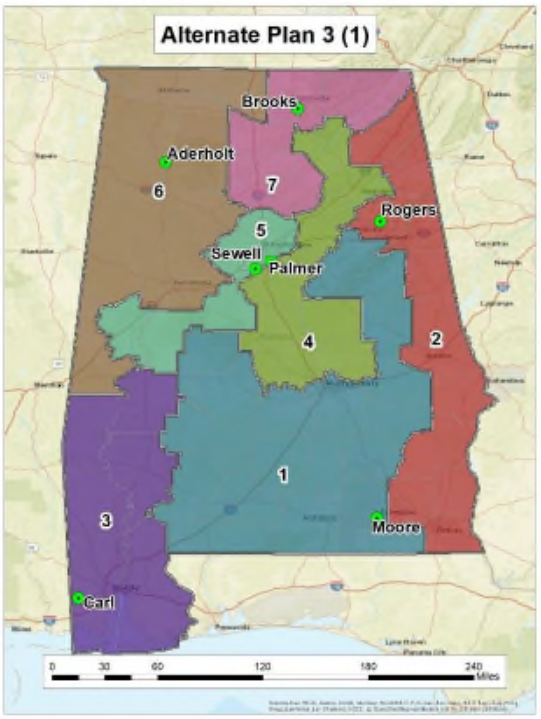


Figure 5.6 Alternate Plan 3 (1)



D. Compactness

Compactness of districts is a measure to ensure that districts do not excessively deviate from being "reasonably shaped" that is intended to deter gerrymandering. This of course is an enormously ambiguous and arbitrary description of what compactness actually is. Compactness was relatively easy to attain before "One Person One Vote". However, with the development of both technology[24] and redistricting law (especially Baker v. Carr, which lead to splitting of geography as population deviations were driven lower) compactness became less and less possible. Today, while most compactness measures are absolute, they can still effectively serve as a tool compare one plan against another and to determine which is superior (even if multiple plans have poor compactness).[25] But what measure does an expert use? "To deter gerrymandering, many state constitutions require legislative districts to be "compact." Yet, the law offers few precise definitions other than "you know it when you see it," which effectively implies a common understanding of the concept. In contrast, academics have shown that compactness has multiple dimensions and have generated many conflicting measures". [26] There is no professional consensus on a "right" measure, and every widely used measure works differently. A district that is "most compact" by one measure can easily and frequently be less compact by another. For this reason, I pick the four most common compactness measures (Polsby-Popper, Schwartzberg, Reock and Convex Hull) - each of which has unique features, and strengths and weaknesses.[27] I then compare the compactness of each district of each plan individually and in aggregate.

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[24] The 1971 and 1981 Reapportionments used limited computer mapping for the used limited computer mapping for the first time. 1991 added significant geographic technology— Census Tiger Files— Geographic Information Systems.

[25] https://www.ncsl.org/Documents/legismgt/Compactness-Hofeller.pdf

[26] "How to Measure Legislative District Compactness If You Only Know it When You See it" https://gking.harvard.edu/presentations/how-measure-legislative-district-compactness-if-you-only-know-it-when-you-see-it-7

[27] The Polsby-Popper and Schwartzberg ratios place high importance on district perimeter. Thus, they are highly susceptible to bias due to shoreline complexity. Therefore, districts that are trimmed around shorelines may end up with a low compactness score through no fault of the district's authors and may not necessarily be a true indicator of gerrymandering. This is precisely why it's important to use multiple compactness scores (in this case the Polsby-Popper, Schwartzberg, Reock and Convex Hull measures) and let the reader judge which one is a better fit based on the geography of the district and method of calculation each score uses. A higher score means more compact, but the scores using different measures cannot be directly compared to each other. Source: https://cdn.azavea.com/com.redistrictingthenation/pdfs/Redistricting_The_Nation_Addendum.pdf

In Table 5.3 below I assess the State of Alabama compactness by district, by method. Within each method, the higher the score the better. Using District 5 as an example, it scores highest in Polsby-Popper, Schwartzberg and Convex Hull, but in fact performs the worst in Reock. This table enables us to assess the performance of individual districts across methods. This illustrates exactly why it is beneficial to look at multiple, highly regarded methods when performing compactness analysis. Since the values within each method are similar (but are in fact mathematically different) it is not possible to summarize accurately across plans. In order to compare the Alabama enacted plan with the plaintiff plan, I summarize the compactness scores by method.

Going into this analysis, I gave the plaintiff plan the benefit of the doubt. Alabama's plan was built from the lowest level of Census geography: census blocks, which is exactly the geography and methodology alleged by the plaintiffs to create the gerrymandering problem they seek to remedy. I assumed that because the plaintiff plan was alleged to remedy gerrymandering and was built from whole, geometrically simple counties, it would score decisively better in a compactness analysis over a plan such as Alabama's. I was wrong.

In Table 5.3 below I show the existing scores by district, by compactness measure. The scores shaded in green are the "best" in each measure, that is: most compact. The scores shaded in red are the poorest, that is: least compact. Not all districts are ranked the same in each measure, which is why I use multiple measures and examine each individually as well as in aggregate. The last column "Total" is simply a sum of the scores across plans for that district and is designed to provide a final summary ranking of the compactness of each district. The last row "Sum" is simply a sum of the scores for all districts in the plan for that measure. This is calculated to enable a summary comparison of metrics from one plan to another. A higher score in "Sum" means that by that measure, that plan is more compact. For this exercise, I interpret whichever plan has the majority of high scores to be the "more compact" plan. Table 5.3 is the compactness scores for the existing Alabama 116th congressional plan and serves as a basis for comparison.

Table 5.3 Alabama Existing (2011) 116th Plan Compactness Scores

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.16	0.40	0.42	0.71	1.70
2	0.22	0.47	0.49	0.74	1.93
3	0.22	0.47	0.36	0.73	1.79
4	0.18	0.43	0.36	0.62	1.59
5	0.29	0.53	0.22	0.77	1.82
6	0.14	0.37	0.43	0.69	1.63
7	0.13	0.36	0.38	0.62	1.49
Sum	1.34	3.04	2.66	4.90	

In Table 5.4 below the results pass the "eyeball test" that is: you can just look at District 2 and see that it has simple geometry. It has numerous straight segments and is compact in the sense it fits nicely in its circumscribing circle. But some details in the table are not intuitive. The districts with significant lengths of riparian boundaries tend to score poorly (and are hard to see from a statewide map). Smaller river segments have greater sinuosity, thus greater lengths. Districts 1, 4, 6, and 7 have long lengths of river boundaries. District 5 has a lot of straight segments but suffers from being elongated (fits poorly in a circle).

Table 5.4 Alabama 2021 Enacted Plan Compactness Scores

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.20	0.44	0.40	0.71	1.75
2	0.26	0.51	0.50	0.76	2.02
3	0.25	0.50	0.36	0.77	1.88
4	0.19	0.44	0.36	0.61	1.60
5	0.32	0.56	0.30	0.80	1.98
6	0.15	0.39	0.31	0.68	1.55
7	0.19	0.44	0.43	0.68	1.74
Sum	1.55	3.28	2.67	5.01	

In Table 5.4, I first note that by looking at the "Sum" row at the bottom - compactness scores are higher in each measure than the 2011 congressional plan. As expected, each method ranks each district differently. Polsby-Popper and Schwartzberg and Convex-Hull ranks D5 as being the best, while Reock ranks D2 highest. In looking at the last column "Total" I show that D2 actually prevails as the most compact district. My interpretation is that the highest ranking districts are comparable, but that D4, D6 and D7 are least compact – due in part to a significant amount of border being waterways at the Bankhead Lake intersection in western Jefferson County.

In Table 5.5 I show the compactness scores by district for the Singleton proposed plan. The Polsby-Popper and Schwartzberg scores join the Alabama enacted plan in outperforming the existing congressional plan. However, by the Reock and Convex Hull measures, the plaintiff plan trails not only the existing (2011) plan but also the enacted Alabama plan.

Table 5.5 Singleton Plan Compactness Scores

District	Polsby-Popper	Schwartzberg	Reock	Convex_Hull	Total
1	0.23	0.48	0.29	0.65	1.67
2	0.22	0.46	0.41	0.70	1.79
3	0.24	0.49	0.31	0.73	1.77
4	0.22	0.47	0.32	0.67	1.69
5	0.27	0.52	0.25	0.75	1.79
6	0.19	0.44	0.30	0.68	1.61
7	0.18	0.42	0.45	0.70	1.74
Sum	1.56	3.29	2.33	4.88	

Alternate Plans

In their complaint, plaintiffs propose one remedial plan using whole counties. Plaintiffs do not acknowledge let alone propose any alternative plans or strategies or address whether any other configuration of counties is even possible. Plaintiffs do not mention protecting incumbents, and in fact pair two incumbents in District 3 (Alabama's existing plan and proposed plan protect incumbents). So. Alternative plans were explored and drawn with whole counties to demonstrate that options exist under the plaintiff's premise. Many in fact. The alternative plans are presented to make points about expanded deviations and possible political outcomes of drawing other whole county maps. I do not express an opinion about the legality of any deviation in the alternative plans.

2018 Election Gov # and % D Districts

In order to characterize the plans and compare them with the performance of the plaintiff's plan, I collected the results of the 2018 election[28] which were reported for each of Alabama's 1,992 voting precincts. I aggregated these precincts to the county level for assessing the plaintiff's plan and alternate plans 1-13, and I approximated the geography of the 7 whole districts of the enacted Alabama plan. I then measured the voting performance for governor as:

> G18GOVRIVE (# of Republican governor votes) /
>
> G18GOVRIVE (# of Republican governor votes) + G18GOVDMAD (# of Democratic governor votes) + G18GOVOWRI (# of other / write in governor votes).

Percentages shown are the resulting % voting for the Republican governor in each plan.

In order to create a uniform and accurate measure of the number and percent Black majority or influence districts, I calculated the number of Black alone or in combination first for counties, then for Census blocks. The number of Black districts reported in Table 5.6 (P.32) refers to the number that are over 40% "All Black" in the plan, and the percent refers to the exact percent "All Black" in those districts. I reinforce: no effort has been made in this analysis to create "alternative" plans to complement the Alabama plan using sub-county geography. As I am sure both parties in this case would concede – the number of "alternative" plans using subcounty geography such as voting precincts or even Census blocks is immeasurable.

[28] https://redistrictingdatahub.org/state/alabama/

Table 5.6 Alternate Plan Characteristics

Plan	Deviation	Incumbents Safe?	2018 Election Gov # and % D Districts	# and % Black Districts > 40%
Plaintiff	2.5%	N	Two, 41.4% and 44.0%	Two, 42.9% and 48.8%
1 (S1)	0.6%	N	One, 41.3%	One, 43.0%
2 (S2)	1.0%	Y	One, 41.3%	One, 43.0%
3 (1)	2.1%	Y	One, 41.3%	One, 43.9%
4 (2)	2.1%	N	One, 41.4%	One, 42.9%
5 (3)	1.2%	N	One, 41.4%	One, 42.9%
6 (4)	1.5%	N	One, 41.3%	Two, 42.4% and 43.0%
7 (5)	0.7%	N	One, 41.3%	One, 43.0%
8 (1B)	2.5%	N	Two, 41.3% and 44.1%	Two, 43.0% and 48.7%
9 (2B)	6.2%	N	One, 44.2%	None
10 (3B)	4.9%	N	One, 41.3%	Two, 42.6% and 43.0%
11 (4B)	4.3%	N	One, 44.2%	One, 41.1%
12 (5B)	6.0%	N	Two, 41.3% and 45.4%	Two, 43.0% and 46.2%
13 (6B)	3.1%	N	One, 41.4%	Two, 42.5% and 42.9%
Alabama	0.0%	Y	31.9%	57.1%

The plaintiffs plan, alternate plans and the Alabama enacted plan are shown in the Map Appendices 1-16. Detailed maps of the Alabama and plaintiff plans are as follows:

The Alabama Enacted Plan:

- Percent Black Alone Voting Age Population by county is presented in Map Appendix 17.
- Voting Age Population by County is presented in Map Appendix 18.
- Percent Black Alone Voting Age Population by VTD[29] is presented in Map Appendix 19.
- Voting Age Population by VTD is presented in Map Appendix 20.

The Singleton Proposed Plan:

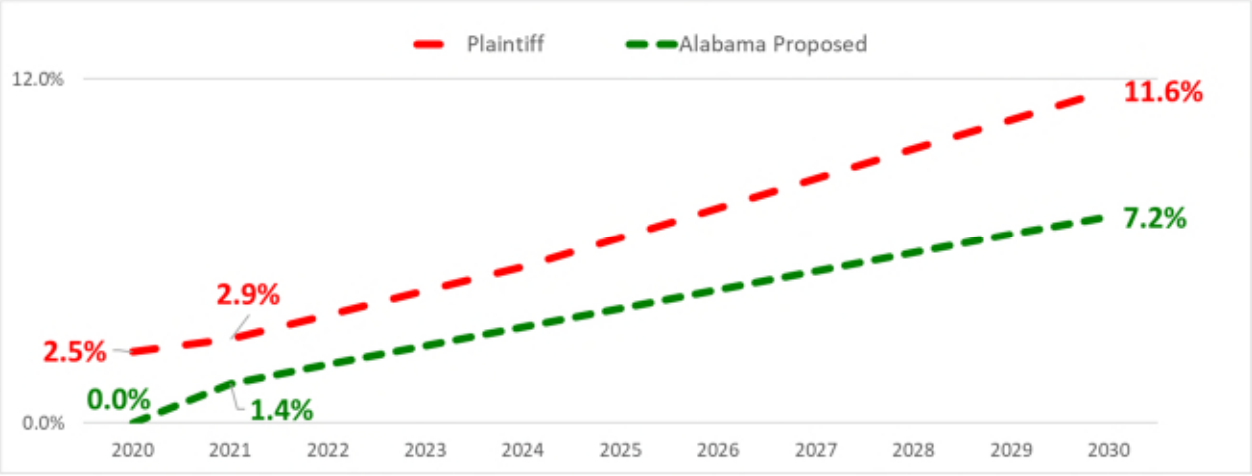
- Percent Black Alone Voting Age Population by county is presented in Map Appendix 21.
- Voting Age Population by County is presented in Map Appendix 22.
- Percent Black Alone Voting Age Population by VTD is presented in Map Appendix 23.
- Age Population by VTD is presented in Map Appendix 24.
- District 6 Percent Black Alone Voting Age Population by VTD is presented in Map Appendix 25.

[29] VTDs are Voting Districts. "VTD" is a census term for a geographic area, such as an election precinct, where election information and data are collected; boundaries are provided to the Census Bureau by the states. Since boundaries must coincide with census blocks, VTD boundaries may not be the same as the election precinct and may include more than one precinct. Source: https://www.ncsl.org/research/redistricting/the-redistricting-lexicon-glossary.aspx

Deviation

The Plaintiff's plan results in a 2020 population deviation of 2.5%, well beyond the one person/one vote conventional deviation of +/- 1 person for congressional districts. Compare this to the State of Alabama's enacted plan, which *is* actually +/- one person. However, neither of these two deviations are likely to remain static until redistricting again can be effected using the 2030 census. That is, these deviations are likely to change over the coming decade. As such, I have developed an approach using conventional demographic methods to estimate the population deviation of the plans over the course of the decade to 2030. The premise is that if we are going to consider opening the door to *some* deviation in 2020 to meet other redistricting requirements - we should make an informed decision based on the expected deviation over the course of the decade that will follow. As a demographic expert, I propose under this circumstance that it is beneficial to assess the impact and utility of a districting plan *over the course of the decade that it is expected to perform*. Not just the base redistricting year that it begins. Using professionally developed small-area population projection methods (see Appendix 4) I am able to forecast the annual population by congressional district of: 1) the plaintiff's plan; 2) the State of Alabama enacted plan; and 3) other draft plans I have developed for 2020-2030. This approach allows one to see the expected annual deviation over the period of time that a given plan is likely to be in effect, which is from 2020 to 2030, when the next decennial census will be taken.

Figure 5.7: Population Deviations 2020-2030: Plaintiff Proposed and Alabama Enacted Plans – Projected 2020-2030



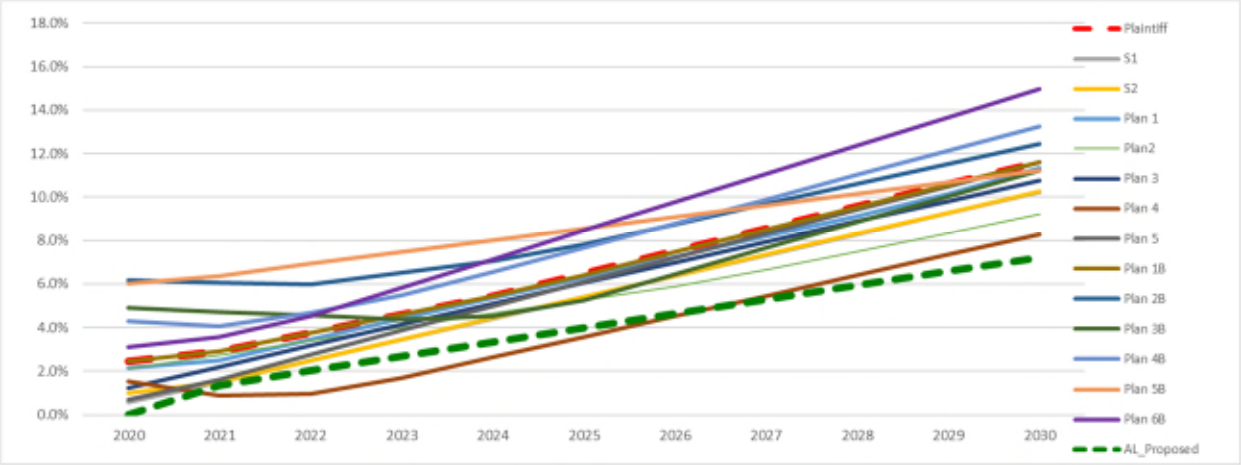
In Figure 5.7, the red dotted line is the plaintiff's plan, and the green dotted line is the enacted Alabama plan. The plaintiff's plan begins in 2020 with a deviation of 2.5%. Based on the forecast population growth over the decade from 2020-2030, the deviation of the plaintiff plan is expected to grow to 11.6%.

By comparison, the Alabama enacted plan begins in 2020 with a deviation of 0.0%. Based on the forecast population growth over the decade from 2020-2030, the deviation of the Alabama enacted plan is expected to grow to 7.2%. The change is already underway, impacting both plans. In 2021, I estimate the 2.5% deviation in the plaintiff's plan for 2020 is currently actually 2.9%, and the deviation in the Alabama enacted plan is already actually 1.4% because of likely population shifts between the date of the census and today.

In Figure 5.8 the plaintiff plan and Alabama enacted plan are compared with 13 alternative county-based plans that I independently and personally developed using whole counties. As with Figure 5.8, the deviation trends for these alternate plans range anywhere from 0.7% to 6.2% in 2020 and grow to between 8.3% and 15% by 2030. One plan, Plan 4 actually shows a short-term decline in deviation, before increasing modestly throughout the decade.

In examining these trends, I have two observations. First – where the deviation is throughout the decade and where it ends in 2030 is strongly driven by where they start in 2020. The plans that start with the lowest deviation tend to end with the lowest deviations. This is critical to understanding their utility throughout the decade. Deviations in congressional plans are conventionally zero, to support the concept of "one-person, one vote". Here, plaintiffs argue that *some* deviation is palatable for their benefit of realizing two Democrat performing districts. But plaintiffs do not argue how much deviation is palatable, nor do they address the long-term consequences of opening this door. I argue that if some deviation in the base year is tolerable, that in order to make an informed decision whether the trade-off is worth it, one must consider the expected impact of the introduced deviation for the lifespan of the plan – not just for the year it was based.

Figure 5.8: Population Deviations 2020-2030: Plaintiff Proposed and Alabama Enacted Plans – Projected 2020-2030



The second observation is that difference in the trends and their outcomes are also driven by unique combinations of geography across the state – some of which are going to have continued population decline over the decade, while some will remain relatively stable, while others will grow dramatically. So. Not only does the starting point matter, but the combination of shrinking, stable and growing geographies that comprise the districts matters as well. This is not to argue that population forecasts should now become a traditional redistricting criteria. Rather, population forecasts should be created, studied and considered as I have done here for their unique ability to the show long-term impacts and utility of redistricting plans.

Index of Misallocation

In addition to the obvious insights on long-term utility of a redistricting plan provided by population forecasts, I have gone on to link these forecasts to a measure that shows how many people would need to be "re-allocated" in order to meet the one person one vote +/- 1 person standard over time. This measure, known as the Index of Misallocation (IOM), was introduced by Swanson[30] to examine the effect of population estimation errors. Comparing the misallocation under the Plaintiff's plan to that under the State's plan, as shown in Figure 5.9 (P.36):

In 2020:

- The IOM under the State's enacted plan is 0.08295%. Multiplying 0.008295 by the total 2020 population of 5,024,279 yields **4,168**, the number of people that would have to be re-distributed to meet the one person/one vote requirement in 2020 by reducing the IOM (and total deviation) to zero.
- The IOM under the Singleton proposed 2020 plan is 0.317056%. Multiplying 0.00317056 by the total 2020 population of 5,024,279 yields **15,929**, the number of people that would have to be re-distributed to meet the one person/one vote requirement in 2020 by reducing the IOM (and total deviation) to zero.

In 2020 the State's plan requires 11,761 fewer people to be re-distributed in order to have an IOM of zero in 2020 than does the Plaintiff's plan.

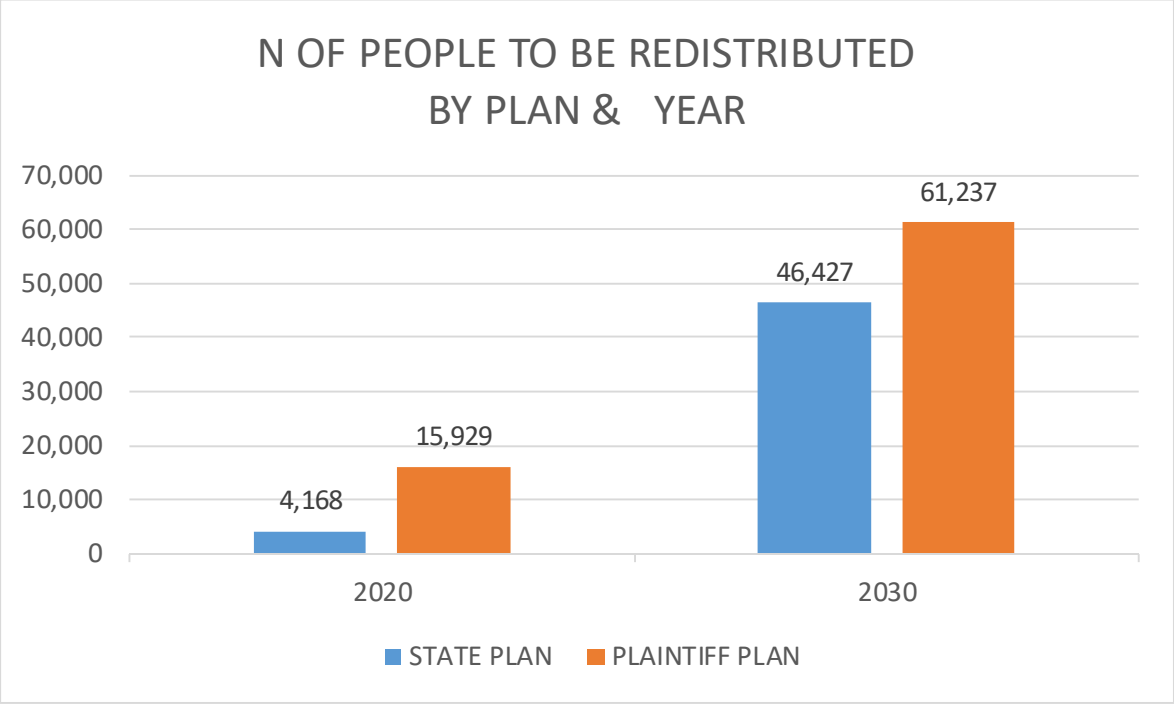
[30] Swanson, D. A. (1981) Allocation Accuracy in Population Estimates: An Overlooked Criterion with Fiscal Implications. pp. 13-21 in Small Area Population Estimates, Methods and Their Accuracy and New Metropolitan Areas Definitions and Their Impact on the Private and Public Sector, Series GE-41 No.7, U.S. Bureau of the Census.

In 2030:

- The IOM under the State's enacted plan is 0.88012%. Multiplying 0.0088012 by 5,275,078, the expected total 2030 population under the State's Plan, yields **46,427**, the number of people that would have to be re-distributed to meet the one person/one vote requirement in 2020 by reducing the IOM (and total deviation) to zero.
- The IOM under the Singleton plan is 1.15424%. Multiplying 0.0115424 by 5,305,364, the expected total 2030 population under the Plaintiff's plan, yields **61,237**, the number of people that would have to be re-distributed to meet the one person/one vote requirement by reducing the 2030 IOM (and the total deviation) to zero.

By 2030, the State's plan requires 14,810 fewer people to be re-distributed in order to have an IOM of zero than does the Plaintiff's plan.

Figure 5.9: Index of Misallocation by Plan and by Year

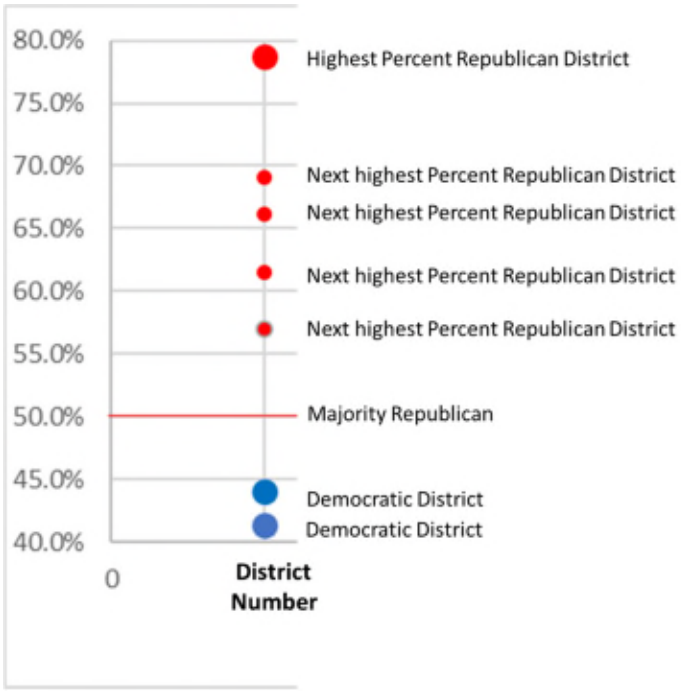


Political Performance

In order to characterize the plans and compare them with the performance of the plaintiff's plan, I collected the results of the 2018 election[31] which were reported for each of Alabama's 1,992 voting precincts. I aggregated these precincts to the county level for assessing the plaintiff's plan and alternate plans 1-13, and I approximated the geography of the 7 whole districts of the enacted Alabama plan. Percentages shown in this analysis are the resulting % voting for the Republican governor in each plan.

As shown in Figure 5.10 below - for ease of explanation, the percent voting Republican in the 2018 governor's race is shown as points on a vertical axis for each plan. The lower numbers, *below* the 50% mark, represent districts that did (or would) have voted for the Democratic candidate. Those points *above* the 50% mark, represent districts that did (or would) have voted for the Republican governor.

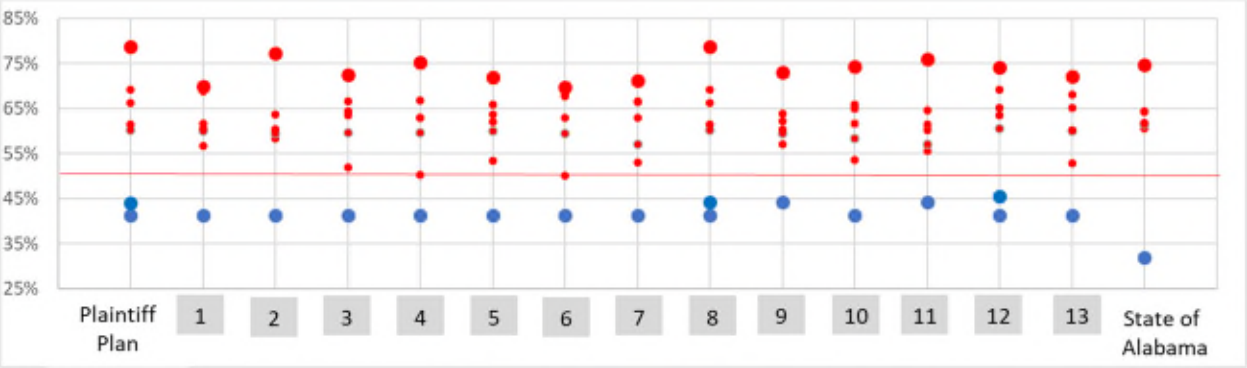
Figure 5.10 Political Performance Data Visualization Explanation



[31] https://redistrictingdatahub.org/state/alabama/

Figure 5.11 shows the variety of outcomes by plan for the 2018 Alabama governor's race. To the left, I show the plaintiff's plan. Note the two blue dots at the bottom, representing the two districts that would have voted democratic in the 2018 election – consistent with the election performance proffered in the plaintiff's complaint. Moving from left to right, I work through 13 alternate plans. Plans 8 and Plan 12 are distinctive in that they both offer a political remedy of two democratic voting districts, consistent with the plaintiff's plan. These two plans are also notable because they are options that also afford strong Black voting strength options. Plan 9 in particular is notable because it creates one "super-majority" district near 80% 2018 Republican voting strength – consistent with the plaintiff plan. Other plans, including 1-7, 9-11 and 13 show a variety of distributions of Republican and Democratic voting strength for the seven congressional districts. To the right, I show the State of Alabama's enacted plan.

Figure 5.11 Political Performance of Alabama Plans: % Republican Votes in 2018 Governor's Race



Racial Composition

Next, I measured the % Black alone or in combination (including with Hispanic) under different scenarios, demonstrating that there are numerous districting scenarios that can afford a variety of Black influence districts.

As shown in Figure 5.12 (P.39) - for ease of explanation, the percent All Black (that is – percent Black alone or in combination) is shown on a vertical axis, with a point representing the value for each of the 7 Congressional districts. The lower numbers, *below* the red 40% mark, are values for districts lower than the threshold presented in the plaintiff's complaint. The two values *above* the red line are the two districts presented as viable Black influence districts in the plaintiff's complaint.

Figure 5.12 Racial and Ethnic Performance of Alabama Plans Data Visualization Explanation

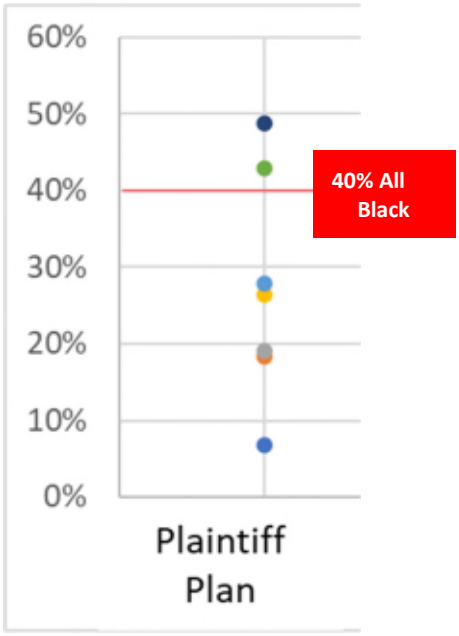
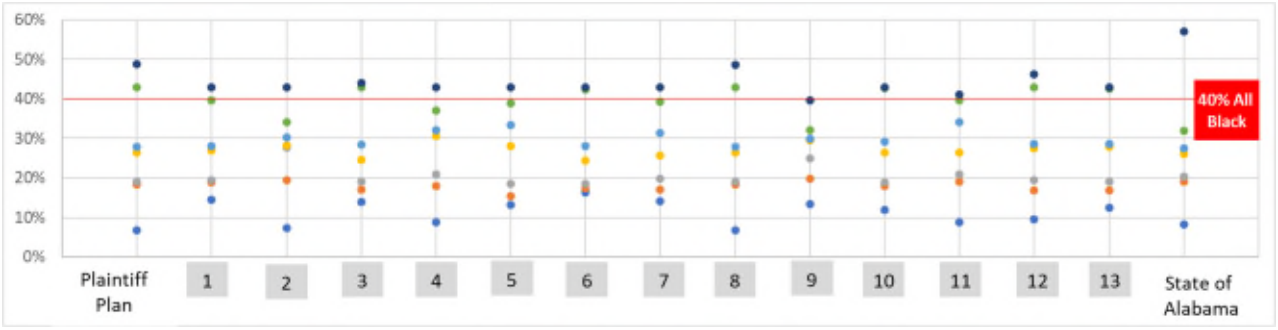


Figure 5.13 shows the variety of race outcomes by plan. To the left, I show the plaintiff's plan. Note the two dots at the top, above the red line representing the two districts that are Black influence. Moving from left to right, I work through 13 alternate plans. As with our findings for political performance, Plans 8 and Plan 12 are distinctive in that they both offer two Black influence districts. Other plans, including 1-7, 9-11 and 13 show a variety of distributions "All Black" strength representation. To the right, the State of Alabama's enacted plan is shown with one Black majority district.

Figure 5.13 Racial and Ethnic Performance of Alabama Plans: % All Black



It is here that I pause to reflect on the possibility that the Singleton plan, not the State of Alabama plan represents a racial gerrymander.

First, I performed a simple examination of the area that was produced as District 6 in the Singleton plan. As shown in Map 25, District 6 is anchored in Birmingham and extends southwest. A visual examination suggests that if an analyst were to begin with a district in Birmingham with the objective of creating a Black minority influence district – the only *possible* direction they could have gone was southwest – into the northern black belt portion of District 7. As shown the area encircled on Map 25 in the Map Appendix, an analyst would by necessity need to exclude as much *non-Black* possible along the way to do so. And that is in fact what the Singleton plan shows. There is a significant "choke point" in the middle of the district where the plaintiffs appear to have avoided as much non-Black population as possible – then they appear to have expanded the district just as much as possible to capture as much Black population as possible to raise District 6 to a point of semi-equitability in terms of race and political performance as District 7. There is no other direction or way District 6 could be extended beyond Birmingham except to achieve this goal. As a results, in Table 5.5 (P.30) "Singleton Plan Compactness Scores" District 6 is shown as having the lowest compactness scores in the Singleton plan – by far.

Plaintiffs may say that the combination of counties they chose for District 6 was driven by a desire to come as close to perfect deviation as possible while using whole counties. Even if that were true, the fact remains that a map drawer can still racially gerrymander while using whole counties if race predominates in his choice of which counties to include in a district. In examining the numerous possible combinations of counties that could possibly comprise a remedial plan, I observe that alternate plans 3, 6, 8, 10, 12 and 13 offer county-based solutions that yield two Black influence districts that are above 40%. Conversely, alternate plans 1, 2, 4, 5, 7, 9, and 11 offer county-based solutions that yield only one Black influence district. It can hardly be argued that the simple use of counties, and the one remedial plan based on them is a unique solution to remedy alleged racial gerrymandering. With the use of counties removed as a unique, exclusive solution – the only remaining argument defending the plaintiff's plan is that of political performance in their favor. That is, the argument that is made that Black registered voters have the opportunity to elect the candidates of their choice while remaining a minority influence in Districts 6 and 7. Without counties as the determining factor for this, I could argue that there are innumerable geographic combinations besides those constrained by counties that could potentially meet – and even exceed the performance touted by plaintiffs if that was their objective.

Conclusion

In summarizing this analysis, I reach several conclusions:

1) The introduction of population deviation in 2020 has long-standing and far reaching implications for OPOV. The whole county plan suggested by plaintiffs has population deviation among the districts so that some persons votes are weighted more than others. The introduction of *any amount* of deviation should be defended in terms of why that is an optimal amount (in the context of other plan deviations) weighing all of the other pros and cons of other viable scenarios using Alabama counties as the plaintiffs propose. Further, the long-term consequences of the 2020 deviation in the plaintiff's plan should be considered. A decision to accept the Singleton plan does not only have consequences for the present, but for many years in the future.

2) The use of counties to create congressional districts in Alabama does not prevent racial gerrymandering – and may in fact create it in the plaintiff's plan. The plaintiffs do not appear to have proven why the Alabama enacted plan is a racial gerrymander, and in the process have paid bare a process by which a map-drawer can racially gerrymander while keeping counties whole. There are numerous possible combinations of counties that can create Congressional district scenarios with low deviations. Some of these result in one Black minority influence district, some results in two.

3) A requirement to keep counties whole does not necessarily result in the political result plaintiffs apparently desire either, which is two congressional districts likely to elect a Democrat. In much the same way I have illustrated that different viable combinations of counties can results in one or two Black minority districts – so too can the use of counties yield one or two Democratic performing districts.

4) While counties were historically important communities of interest, before advances in communications and transportation, they have far less importance as communities of interest today; and

5) Plaintiffs' whole county plan does not observe the important traditional districting criteria of preserving the core of existing districts. Continuity of representation is a significant and prevailing factor and represents a well-established community of interest. The plaintiff plan introduces significant disruptions to continuity of representation. The plaintiff plan not only is vastly inferior to the State of Alabama enacted plan for the total population – but it is also demonstrably and significantly biased against the Black population of Alabama.

DECLARATION

* * * * *

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and correct.

/s Thomas Bryan
Thomas Bryan

December 10, 2021
Date

Appendix 1: Census 2020 Alabama Black Population Total, non-Hispanic and Hispanic Combinations (through 3 races, excluding 4-, 5- and 6-race Black combinations)

Race	Total (A)	% of Total (B)	AL non-Hisp (C)	% of Total (D)	AL Hispanic (E)	% of Total (F)
Total, Hispanic or Latino:	5,024,279		4,760,232		264,047	
Population of one race:	**4,767,326**	**94.89%**	**4,575,614**	**91.07%**	**191,712**	**3.82%**
Black or African American alone	1,296,162	25.80%	1,288,159	25.64%	8,003	0.16%
Population of two races:	**243,473**	**4.85%**	**175,750**	**3.50%**	**67,723**	**1.35%**
White; Black or African American	45,429	0.90%	43,911	0.87%	1,518	0.03%
Black or African American; American Indian and Alaska Native	6,301	0.13%	6,012	0.12%	289	0.01%
Black or African American; Asian	2,049	0.04%	1,939	0.04%	110	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander	492	0.01%	456	0.01%	36	0.00%
Black or African American; Some Other Race	5,421	0.11%	2,983	0.06%	2,438	0.05%
Population of three races:	**12,093**	**0.24%**	**8,085**	**0.16%**	**4,008**	**0.08%**
White; Black or African American; American Indian and Alaska Native	4,493	0.09%	3,986	0.08%	507	0.01%
White; Black or African American; Asian	972	0.02%	899	0.02%	73	0.00%
White; Black or African American; Native Hawaiian and Other Pacific Islander	172	0.00%	165	0.00%	7	0.00%
White; Black or African American; Some Other Race	1,441	0.03%	573	0.01%	868	0.02%
Black or African American; American Indian and Alaska Native; Asian	124	0.00%	115	0.00%	9	0.00%
Black or African American; American Indian and Alaska Native; Native Hawaiian and Other Pacific Islander	13	0.00%	13	0.00%	0	0.00%
Black or African American; American Indian and Alaska Native; Some Other Race	146	0.00%	72	0.00%	74	0.00%
Black or African American; Asian; Native Hawaiian and Other Pacific Islander	145	0.00%	129	0.00%	16	0.00%
Black or African American; Asian; Some Other Race	86	0.00%	43	0.00%	43	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander; Some Other Race	27	0.00%	20	0.00%	7	0.00%
Total "All Black"	1,364,736	27.2%	1,350,192	26.9%	14,544	0.3%

Appendix 2: Census 2020 Alabama Black Voting Age Population, non-Hispanic and Hispanic Combinations (through 3 races, excluding 4-, 5- and 6-race Black combinations)

Race	VAP (A)	% of VAP (B)	AL non-Hisp (C)	% of Total (D)	AL Hispanic (E)	% of Total (F)
Total:	3,917,166		3,750,310		166,856	
Population of one race:	3,751,169	**95.76%**	3,630,366	**92.68%**	120,803	**3.08%**
Black or African American alone	981,723	25.06%	976,732	24.93%	4,991	0.13%
Population of two races:	**158,371**	**4.04%**	**114,790**	**2.93%**	**43,581**	**1.11%**
White; Black or African American	18,106	0.46%	17,569	0.45%	537	0.01%
Black or African American; American Indian and Alaska Native	4,692	0.12%	4,530	0.12%	162	0.00%
Black or African American; Asian	1,130	0.03%	1,075	0.03%	55	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander	262	0.01%	250	0.01%	12	0.00%
Black or African American; Some Other Race	3,470	0.09%	2,024	0.05%	1,446	0.04%
Population of three races:	**6,741**	**0.17%**	**4,620**	**0.12%**	**2,121**	**0.05%**
White; Black or African American; American Indian and Alaska Native	2,714	0.07%	2,452	0.06%	262	0.01%
White; Black or African American; Asian	325	0.01%	295	0.01%	30	0.00%
White; Black or African American; Native Hawaiian and Other Pacific Islander	75	0.00%	69	0.00%	6	0.00%
White; Black or African American; Some Other Race	721	0.02%	344	0.01%	377	0.01%
Black or African American; American Indian and Alaska Native; Asian	80	0.00%	73	0.00%	7	0.00%
Black or African American; American Indian and Alaska Native; Native Hawaiian and Other Pacific Islander	12	0.00%	12	0.00%	0	0.00%
Black or African American; American Indian and Alaska Native; Some Other Race	103	0.00%	55	0.00%	48	0.00%
Black or African American; Asian; Native Hawaiian and Other Pacific Islander	82	0.00%	76	0.00%	6	0.00%
Black or African American; Asian; Some Other Race	51	0.00%	31	0.00%	20	0.00%
Black or African American; Native Hawaiian and Other Pacific Islander; Some Other Race	14	0.00%	11	0.00%	3	0.00%
	1,014,372	25.9%	1,006,083	25.7%	8,289	0.2%

Appendix 3 Compactness Measures

Polsby-Popper

The Polsby-Popper (PP) measure (polsby & Popper, 1991) is the ratio of the area of the district (A_D) to the area of a circle whose circumference is equal to the perimeter of the district (P_D). A district's Polsby-Popper score falls with the range of $[0, 1]$ and a score closer to 1 indicates a more compact district.

$$PP = 4\pi \times \frac{A_D}{P_D^2}$$

Circumference Equal to District Perimeter

Schwartzberg

The Schwartzberg score (S) compactness score is the ratio of the perimeter of the district (P_D) to the circumference of a circle whose area is equal to the area of the district. A district's Schwartzberg score as calculated below falls with the range of [0,1] and a score closer to 1 indicates a more compact district.

$$S = \frac{1}{P_D/C} = \frac{1}{P_D/(2\pi\sqrt{A_D/\pi})}$$

Circle with Area Equivalent to the District

Source: https://fisherzachary.github.io/public/r-output.html

Appendix 3 Compactness Measures (continued)

Reock Score

The Reock Score (R) is the ratio of the area of the district A_D to the area of a minimum bounding circle (A_{MBC}) that encloses the district's geometry. A district's Reock score falls within the range of [0,1] and a score closer to 1 indicates a more compact district.

$$R = \frac{A_D}{A_{MBC}}$$

Minimum Bounding Circle of Original Gerrymander

Convex Hull

The Convex Hull score is a ratio of the area of the district to the area of the minimum convex polygon that can encloses the district's geometry. A district's Convex Hull score falls within the range of [0,1] and a score closer to 1 indicates a more compact district.

$$CH \quad \frac{A_D}{A_{MCP}}$$

Convex Hull of Original Gerrymander

Appendix 4 Forecasting Methodology

The population forecasting methodology found in this report is based on two concepts known as face validity (Smith, Tayman, and Swanson, 2013: 304) and Plausibility (Smith, Tayman, and Swanson, 2013: 307-308)1. Face validity is the extent to which a forecast uses the best methods for a particular purpose, is based on reliable data, and uses reasonable assumptions. Plausibility is the extent to which a forecast is consistent with historical trends, with the assumptions inherent in the model, and with projections for other areas.

Using these concepts as a foundation, the population forecasts found in this report are developed from three standard methods, linear extrapolation and geometric extrapolation, each of which is used separately and also in conjunction with the third, a "ratio" method known as "shift-share," creating four separate projections: (1) linear (2) geometric; (3) linear shift-share; and (4) geometric shift-share. As will be discussed along with the descriptions of these methods, the four projections are then averaged to produce a single forecast. Geometric, linear and "ratio" extrapolative projection methods are particularly useful when data series are limited temporally, which is the case with the data used to redistrict Alabama, where I have only limited 2010 and 2020 data that are both in the form of 2020 census geography per PL 94-171.

What are trend extrapolation methods? Trend extrapolation involves fitting mathematical models to historical data and using these models to project future population values. Although there are many different methods by which historical values can be modeled, it is convenient to organize these methods into three categories (Smith, Tayman, and Swanson, 2013: 185-213): (1) Simple extrapolation methods, which require data from only two points in time and of which there are three major approaches, linear change, geometric change, and exponential change; (2) Complex extrapolation methods, which require data from a number of points in time and of which there are different approaches, including linear trends, curve fitting and ARIMA time series; and (3) Ratio extrapolation methods, in which the population of a smaller area is expressed as a proportion of the population of a larger area in which the smaller area is located and of which there are three major approaches, constant-share, shift-share, and share-of-growth.

Both simple and complex trend extrapolation methods suffer from several shortcomings. They do not account for differences in demographic composition or for differences in the components of growth. That is, they are not fundamentally based on the fundamental demographic equation and are unable to incorporate information specific to trends in births, deaths, and migration. As such, they can provide little if any information on the projected demographic characteristics of the population. Because they have no theoretical content beyond the structure of a given model itself, they cannot be related to behavioral or socioeconomic theories of population growth.

Consequently, they have limited usefulness for analyzing the determinants of population growth or for simulating the effects of changes in particular variables or assumptions. In addition, they can lead to unrealistic or even absurd results if carried too far into the future. In spite of their shortcomings, trend extrapolation methods have a number of advantages over other projection methods. They do not need large amounts of data, can be readily applied and are easy to describe.

In spite of their simplicity and lack of theoretical content and demographic detail, applications of the Trend Extrapolation Method (TEM) often produced reasonably accurate projections of total population, even for projection horizons extending far into the future (Smith, Tayman, and Swanson 2013: 185). Small data requirements make these methods particularly useful for small geographic area population projections. In fact, a TEM is used to create the official sub-county population projections for Arizona (Office of the State Demographer 2016). Despite their simplicity and lack of demographic dynamics, TEMs can produce total population projections with a similar degree of accuracy as total population projections from more complex models (Smith, Tayman, and Swanson 2013: 331-337). On this note, it is important to keep in mind that there is a certain irreducible level of uncertainty regarding the future and no projection method–no matter how complex or sophisticated–can consistently improve projection accuracy beyond that level. Based on evidence to date, the relatively small amount contained in TEMs provide as much guidance about the future as does the much larger amount of information contained in more complex models.

So, I employ three of the extrapolative models described earlier (linear, geometric, and shift-share) for four major reasons. First, in this redistricting exercise, only a total population number is needed, not age-sex and other characteristics of Alabama's population. As already noted, simple extrapolative models are well suited for this task because they can generate projected total populations from low input requirements with minimal computational and assumption burdens. Second, there is no need to "borrow" data from other sources, which means there are data transfers and computations that are at higher risk of containing transcription, computing, and assumption errors than are the extrapolative models. Third, the extrapolative methods I employ are highly transparent and can be replicated and described easily. Fourth, also as noted earlier, there is no evidence that complex models provide more accurate forecasts of the total population than those produced by simple methods (Green and Armstrong, 2015). To the specific point of using extrapolative methods, Tayman, Swanson, and Baker (2021) observe that "the preponderance of evidence suggests that these methods can produce total population forecasts of comparable accuracy to those produced by more complicated forecasting techniques."

Because a geometric model moves a population through time in accordance with a constant ratio, the population will increase faster than would be the case if a linear model was used, which will only increase the population by a constant difference. This means that the geometric model will produce higher population projections at a given point in the future than will a linear model using the same data. As such, these two approaches can be viewed, respectively, as providing high and low scenarios from the same input data, which can be viewed as providing an indication of the uncertainty inherent in the forecasting process by giving high and low boundaries for each annual forecast from 2021 to 2030. Combining these two methods with the shift-share method will produce somewhat more nuanced views and by averaging all four of the projections, I obtain a "medium" scenario, which serves as the projection I expect to be the most accurate per Smith, Tayman, and Swanson (2013: 364). That is, the average becomes our forecast.

In spite of the uncertainty involving the future, the key question to ask is does a forecast provide a stronger basis for decision-making than the alternative, which is to not make a forecast, a decision that basically states that there will be no change from the present? I believe that a forecast provides a stronger basis when looking at alternative redistricting plans for Alabama because if there is one point upon which all parties can agree, there will be change as the state moves through the decade to 2030.

Linear Extrapolation (LINE)

The linear extrapolation method (LINE) assumes that the population will change by the same number of persons in the future as it did in the past. Past and future time periods are measured by years in this application. Using years as the time period, average annual absolute change (r) during the base period is computed as:

$$r = (Pl - Pb) / y$$

where r is the average annual absolute change during the base period; Pl is the population in the launch year (2020) ; Pb is the population in the base year (2010); and y is the number of years in the base period (i.e., 10). Population projections using the linear extrapolation method are computed as:

$$Pt = Pl + (t \times r)$$

where Pt is the population in the target year and t is the number of years from the launch year, Pl, which is 2020.

Geometric Extrapolation (GEO)

The average annual absolute "multiplier" during the base period is computed as:

$$R = (Pl / Pb)(1/y)$$

where R is the average annual multiplier during the base period, Pl is the population in the launch year (2020); Pb is the population in the base year (2010); and y is the number of years in the base period (i.e., 10). Population projections using the geometric extrapolation model are computed as

$$Pt = Pl \times Rt$$

where Pt = the total population in the target year and t is the number of years from the launch year, Pl, which is 2020.

Shift-Share (SHIFT)

The shift-share (SHIFT) method accounts for changes in population shares over the base period and this application assumes a linear trend in shares over the projection horizon (the number of years into the future that the target year is from the launch year) . It can be used in conjunction with either the LINE or the GEO method.

$$Pit = (Pt)[(Pil / Pl) + ((t/y)\{(Pil / Pl) – (Pib / Pb)\})]$$

where i denotes the smaller unit (i.e., county); P is the larger unit (State of Alabama); t is the number of years in the projection horizon; y is the number of years in the base period (2020-2010); and b, l, and t refer to the base, launch, and target years. The t/y term implements the linear trend and relates the length of the base period to the length of the projection horizon.

Endnote

1. A population estimate provides information about a present or past population (Swanson and Stephan, 2004: 770). Demographers typically refer to information about the future as either a projection or a forecast (Smith, Tayman, and Swanson, 2013: 2-4). Although these two terms are often used interchangeably, they can be differentiated according to the expected likelihood of their outcomes. A projection may be defined as the numerical outcome of a particular set of assumptions regarding the future population. It is a conditional calculation showing what the future population would be if a particular set of assumptions were to hold true. Because a projection does not attempt to predict whether those assumptions actually will hold true, it can be incorrect only if a mathematical error is made in its calculation. A projection can never be proven right or wrong by future events. A forecast may be defined as the projection that is most likely to provide an accurate prediction of the future population. As such, it represents a specific viewpoint regarding the validity of the underlying data and assumptions. A forecast reflects a level of judgment beyond that found in a projection, and it can be proven right or wrong by future

events (or, more realistically, it can be found to have a relatively small or large error). Projection is a more inclusive term than forecast: All forecasts are projections but not all projections are forecasts.

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Smith, S., Tayman, J., & Swanson, D. (2013). A practitioner's guide to state and local population projections. Dordrecht, The Netherlands: Springer.

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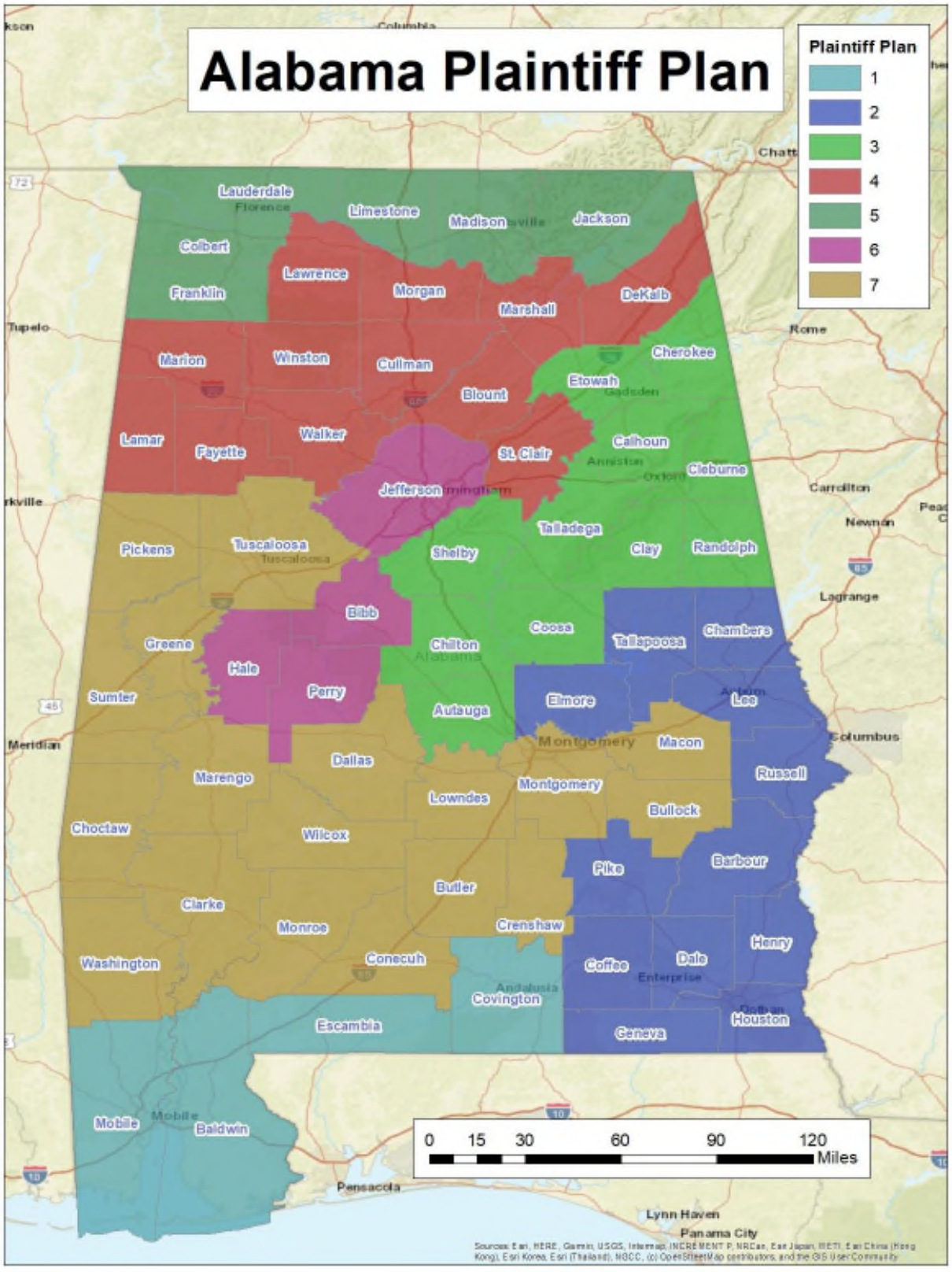
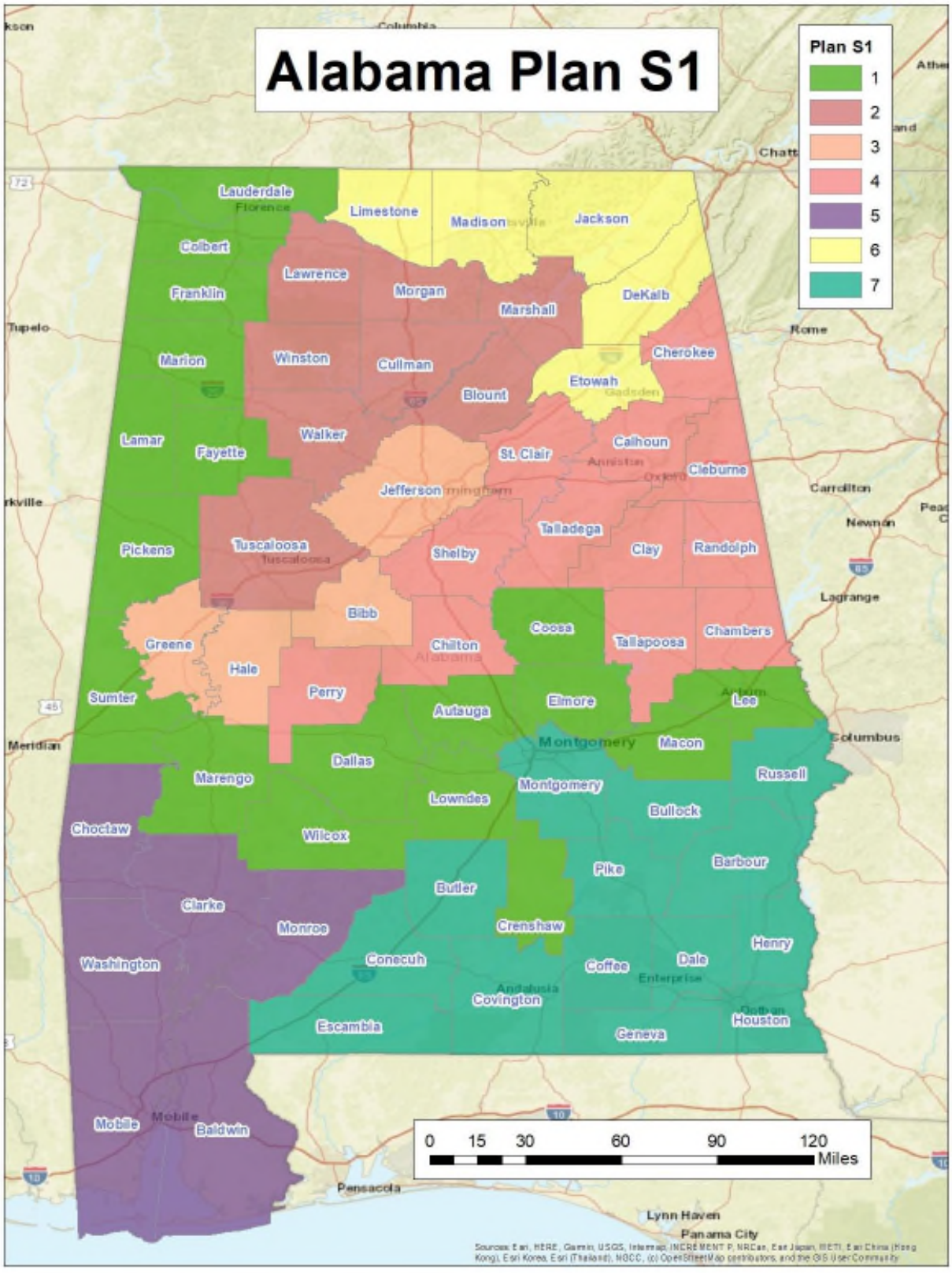
Tayman, J., D. A. Swanson, and J. Baker. (2021). Using Synthetic Adjustments and Controlling to Improve County Population Forecasts from the Hamilton–Perry Method. Population Research and Policy Review 40 (6): 1355-1383.

Map Appendices

Map Appendix 1 (Plaintiff Plan)



Map Appendix 2 (Plan S1)



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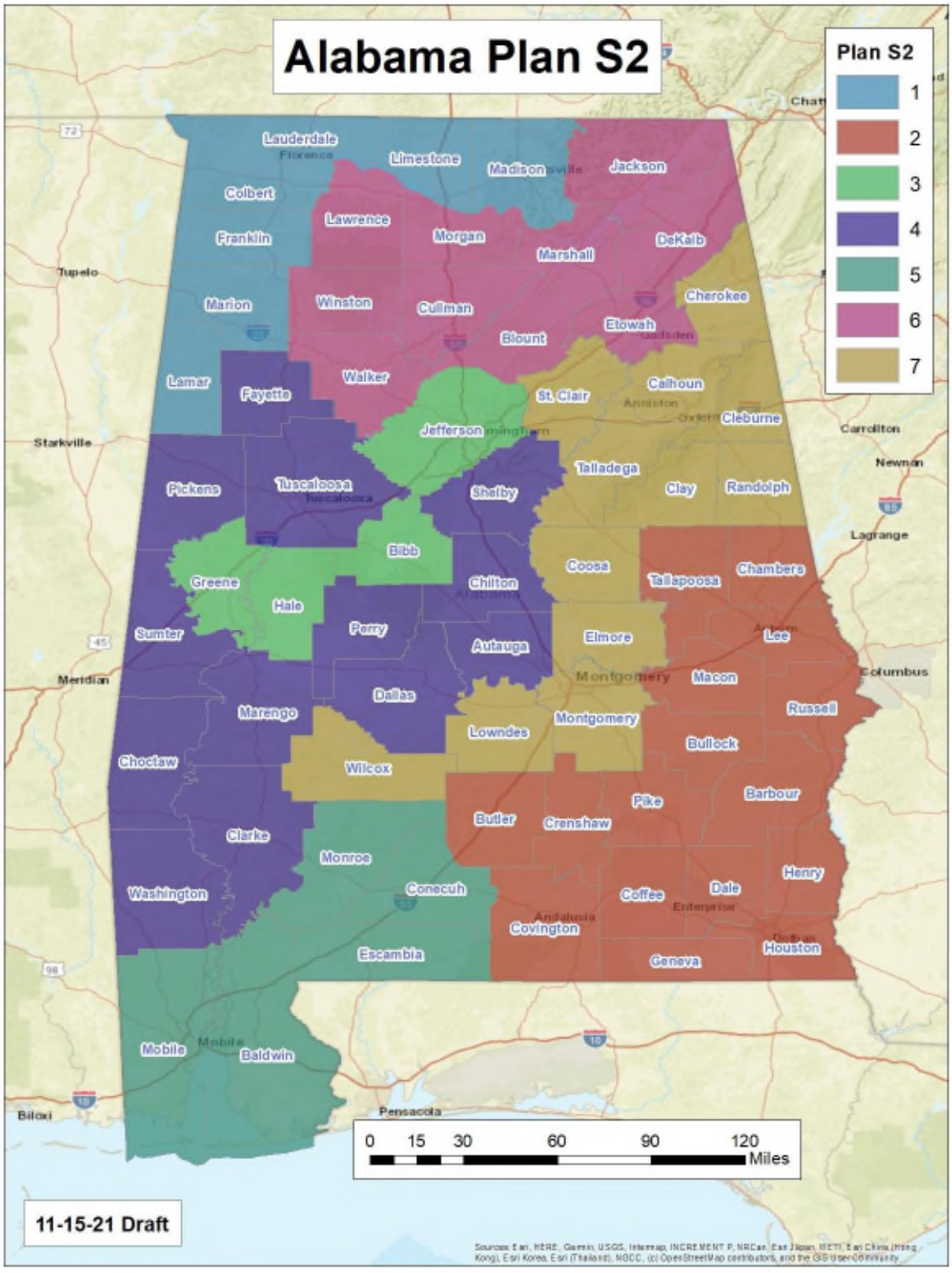
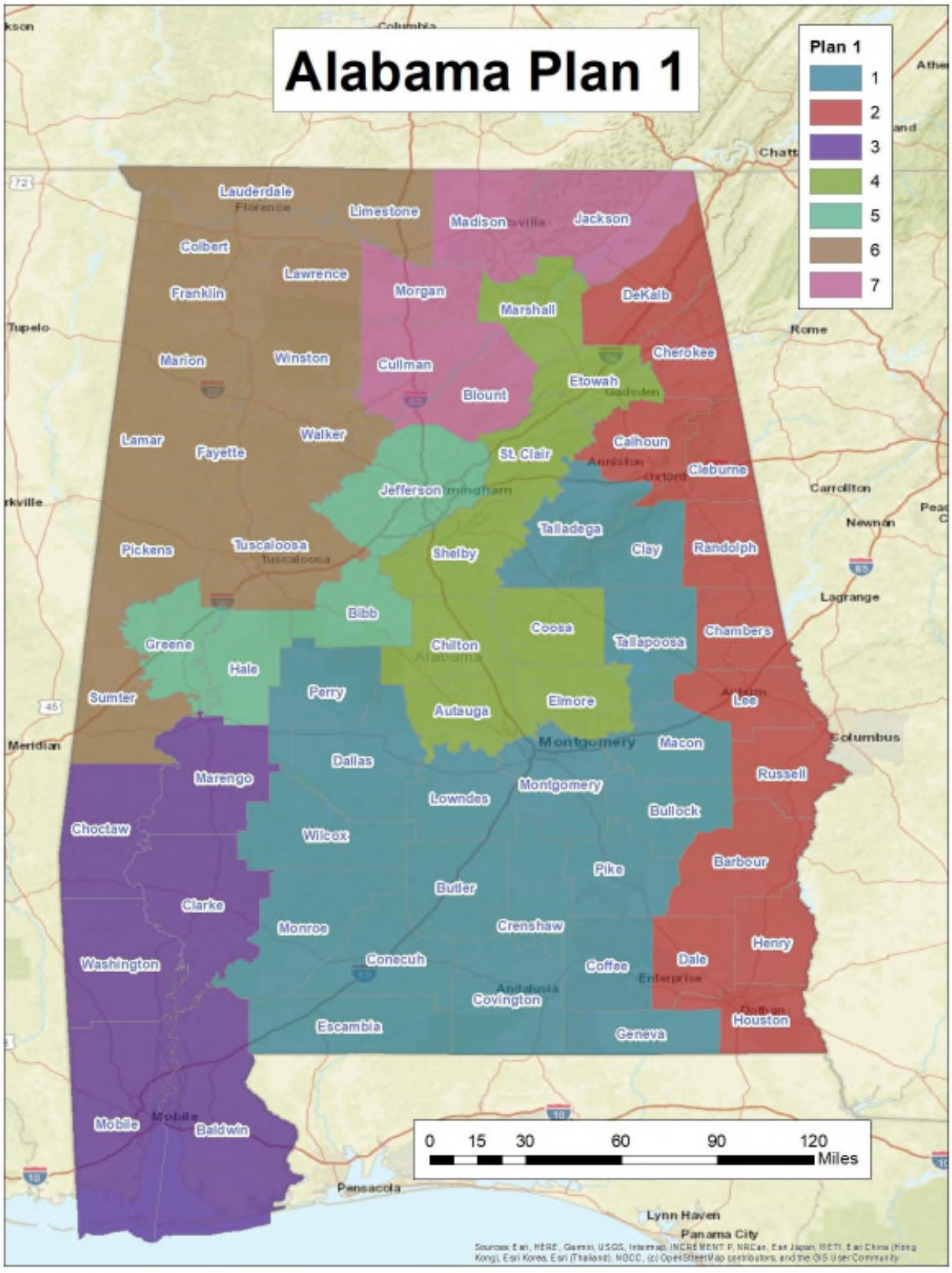
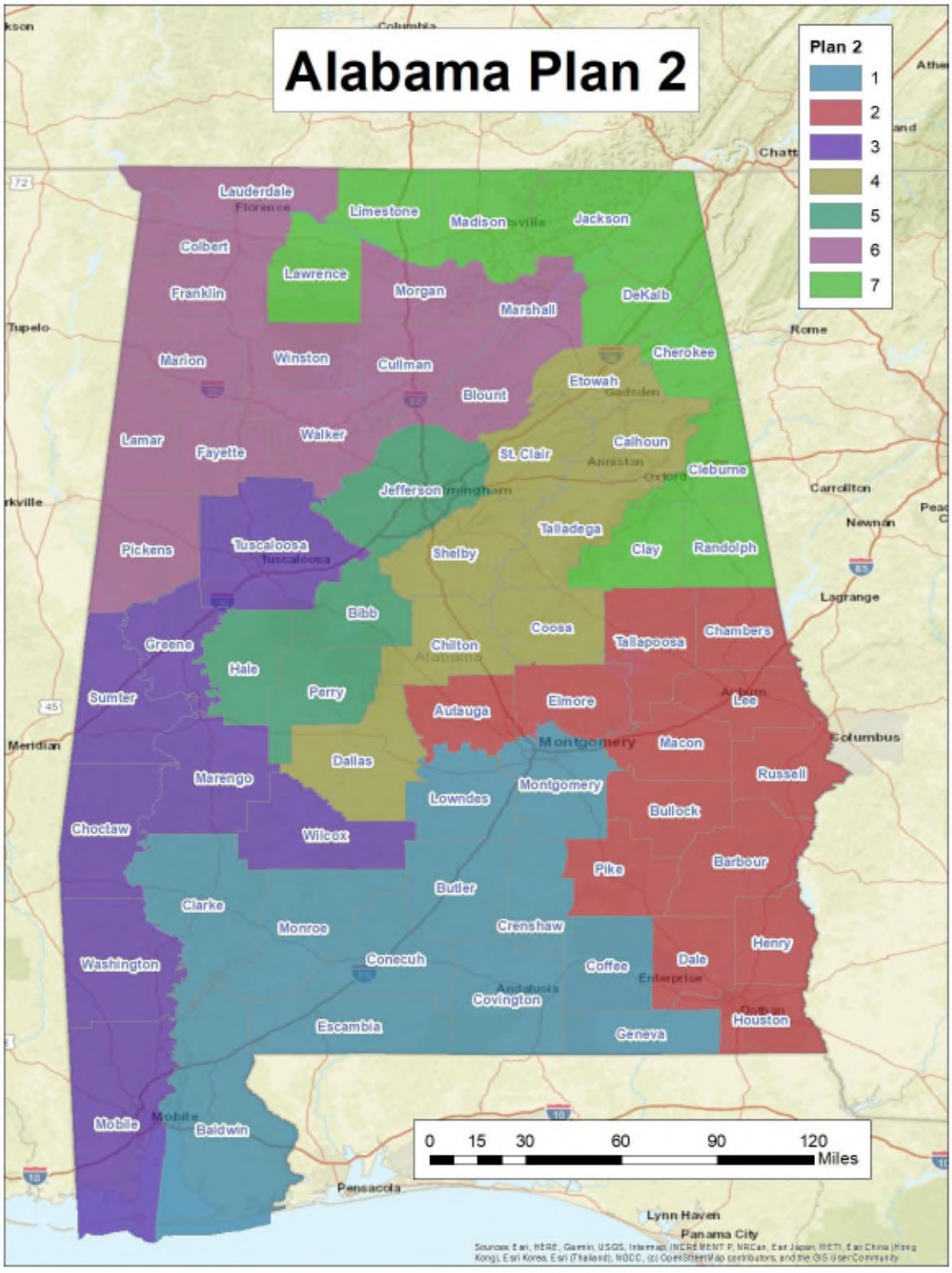


Map Appendix 4 (Plan 1)



Map Appendix 5 (Plan 2)



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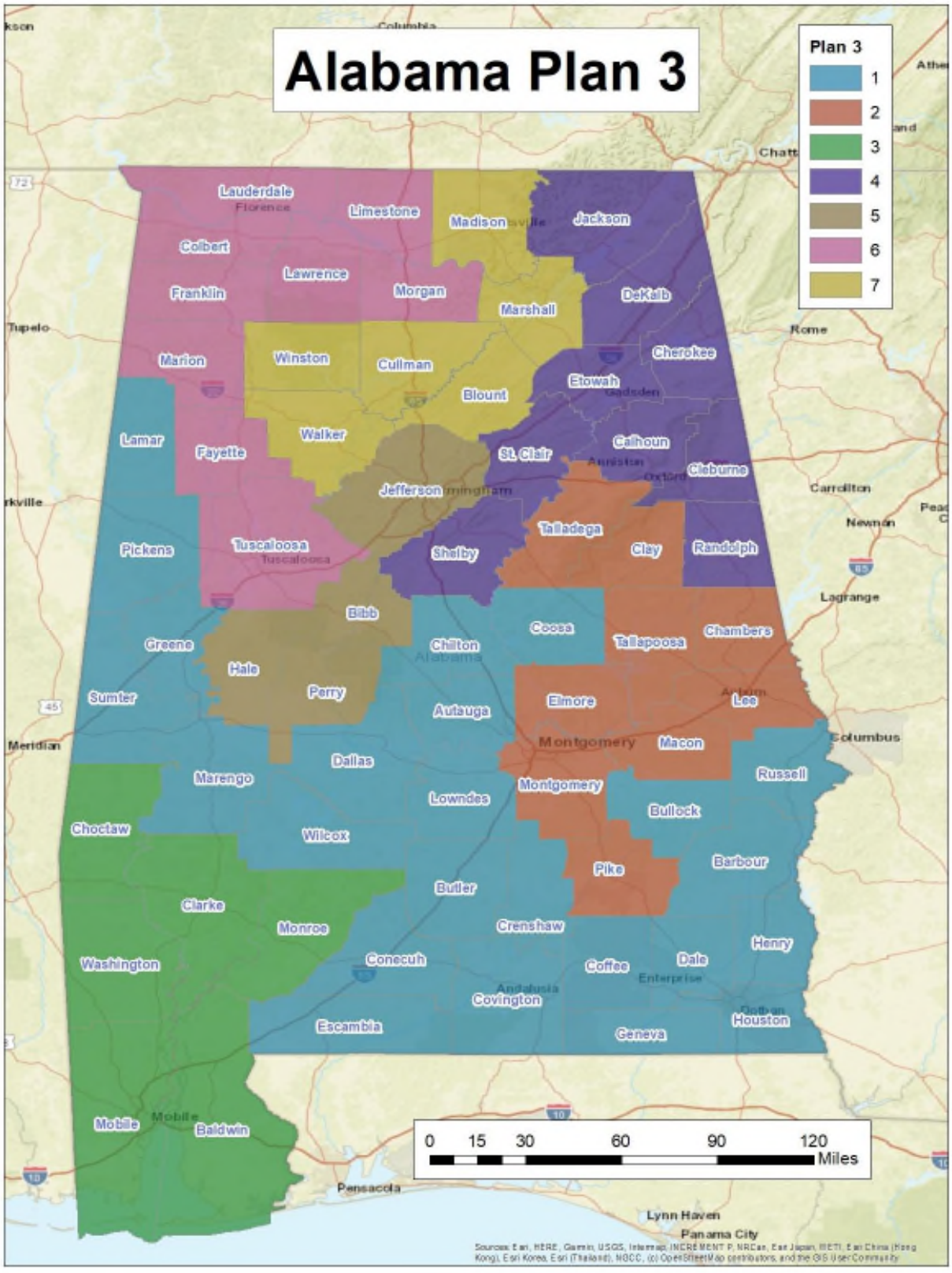
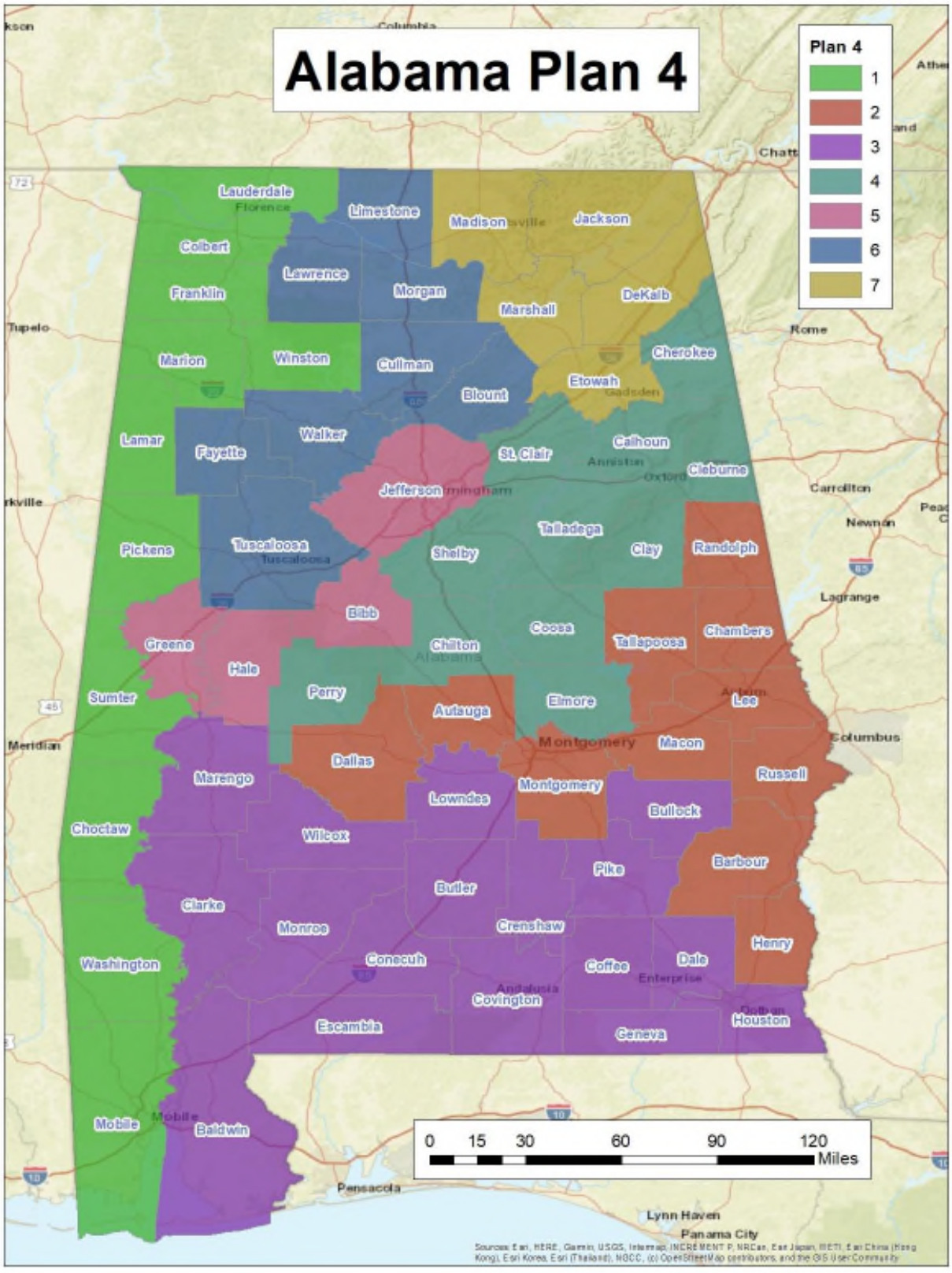
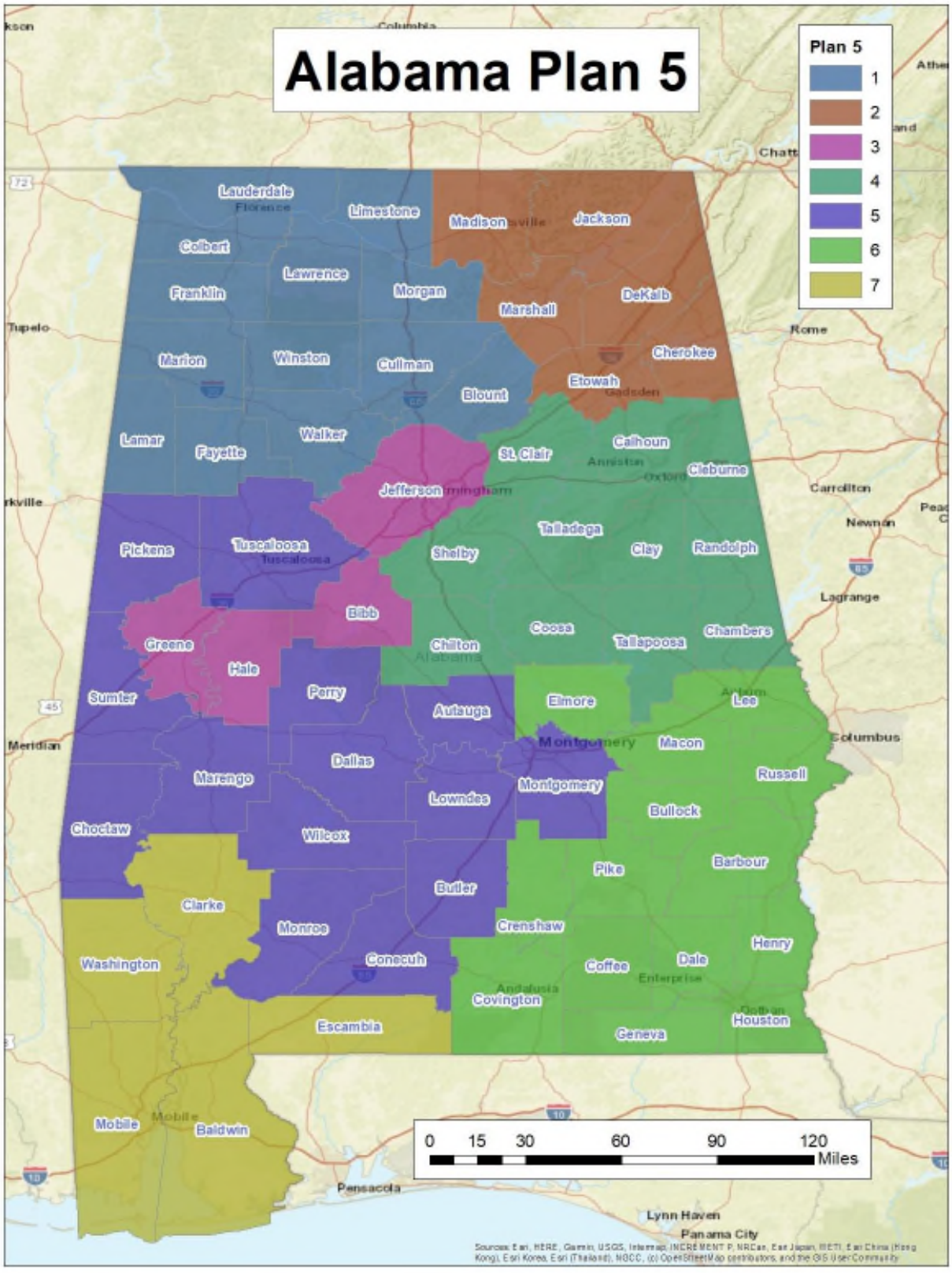


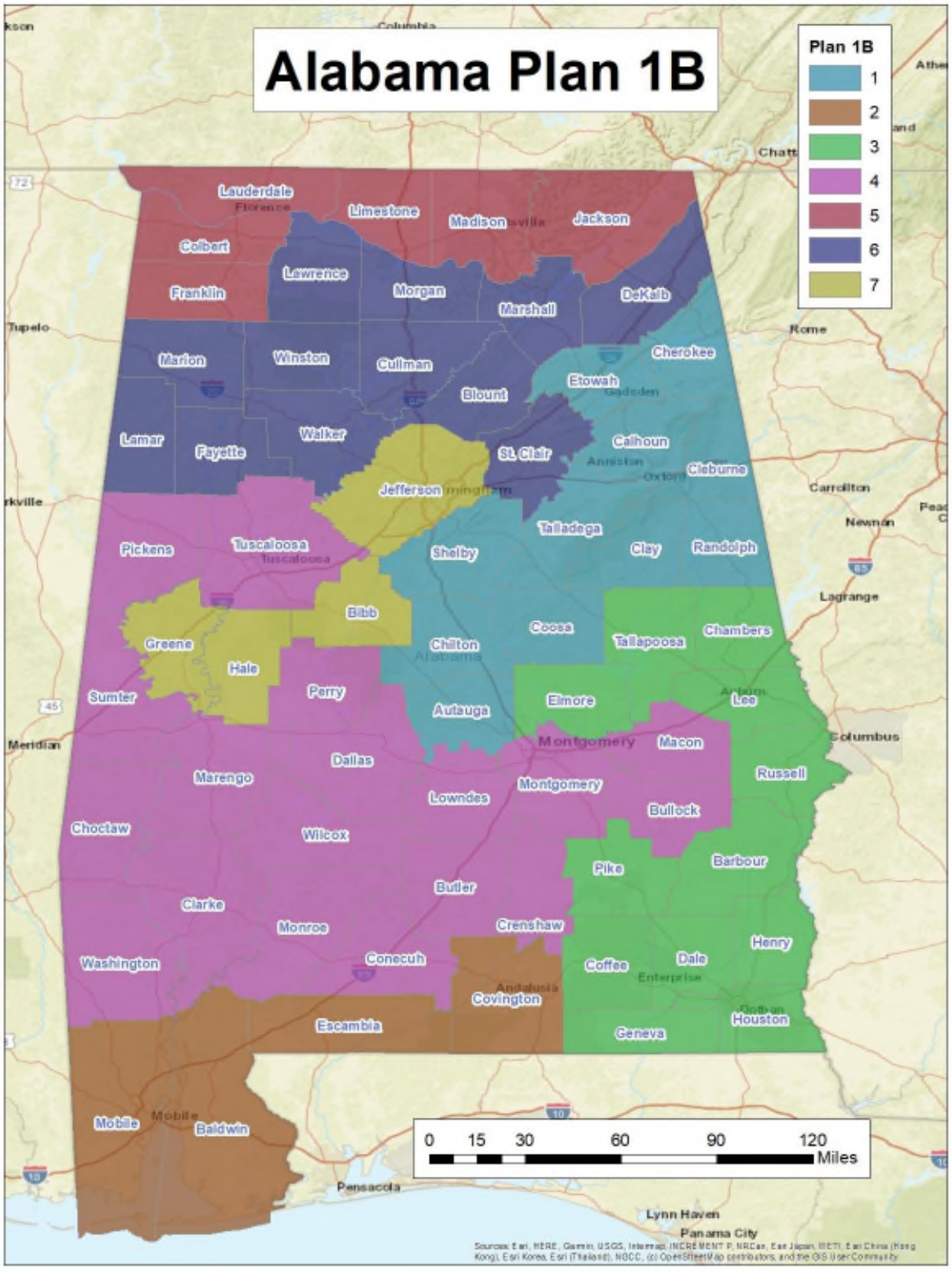
Map Appendix 7 (Plan 4)



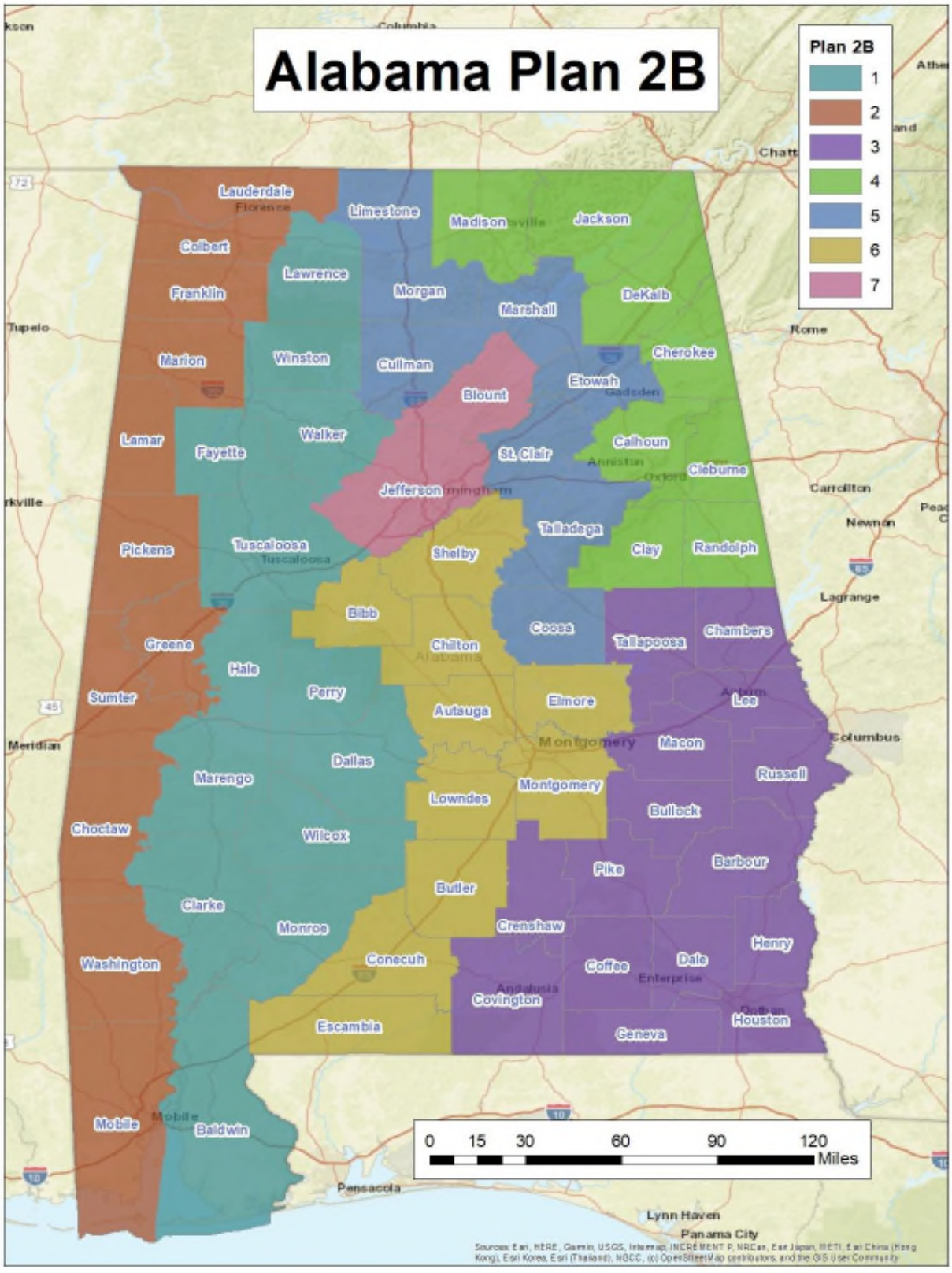
Map Appendix 8 (Plan 5)



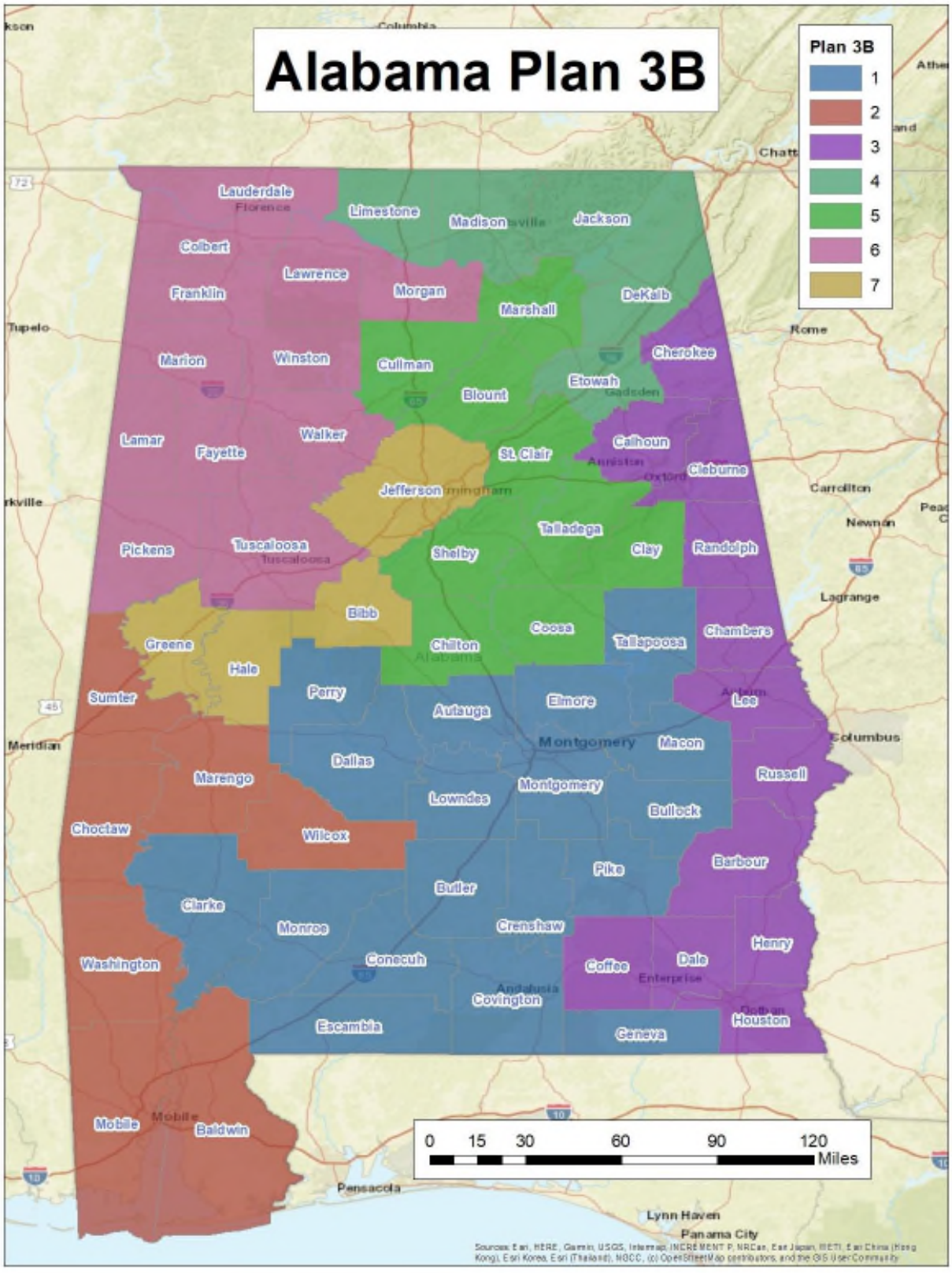
Map Appendix 9 (Plan 1B)



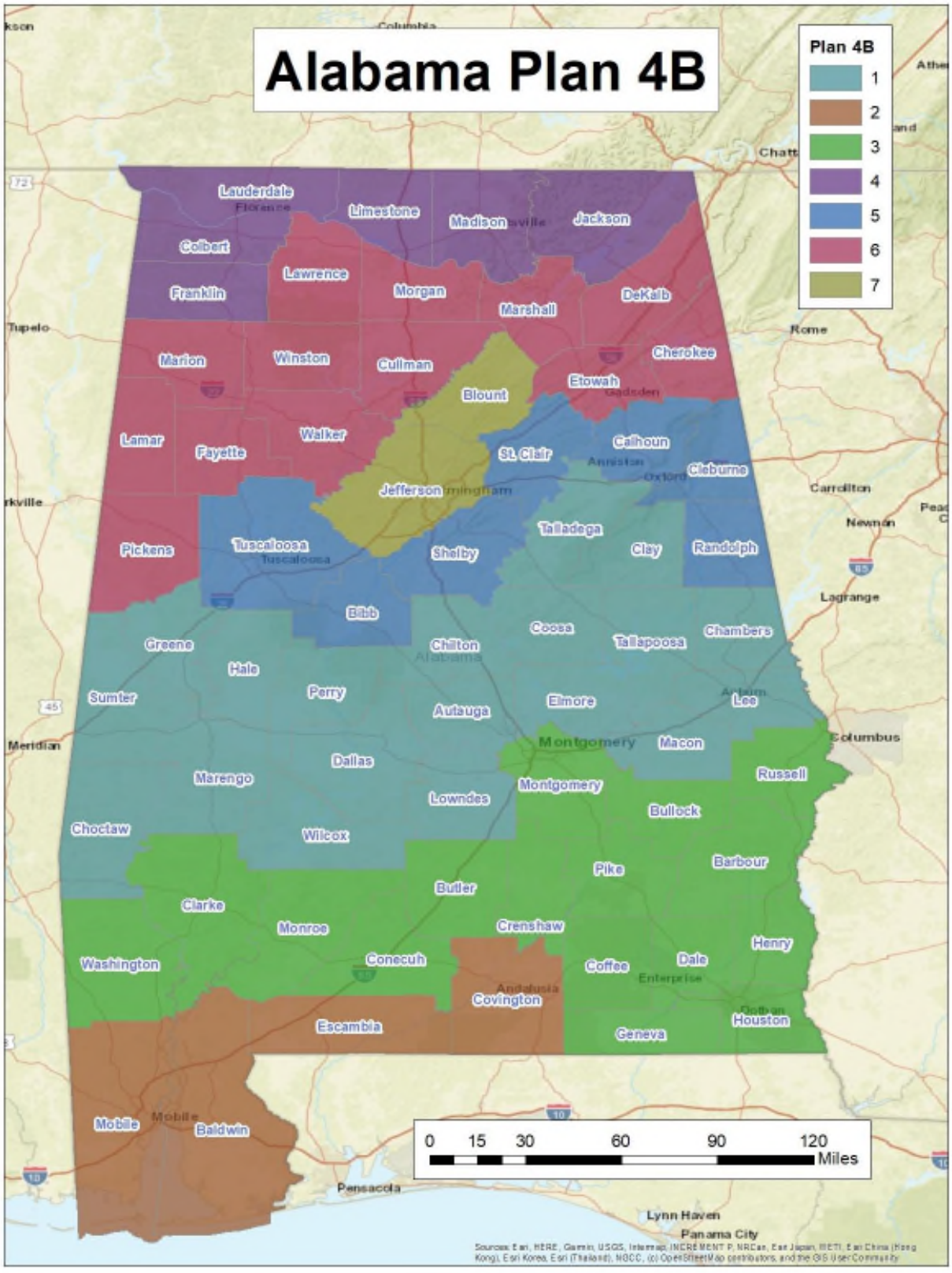
Map Appendix 10 (Plan 2B)



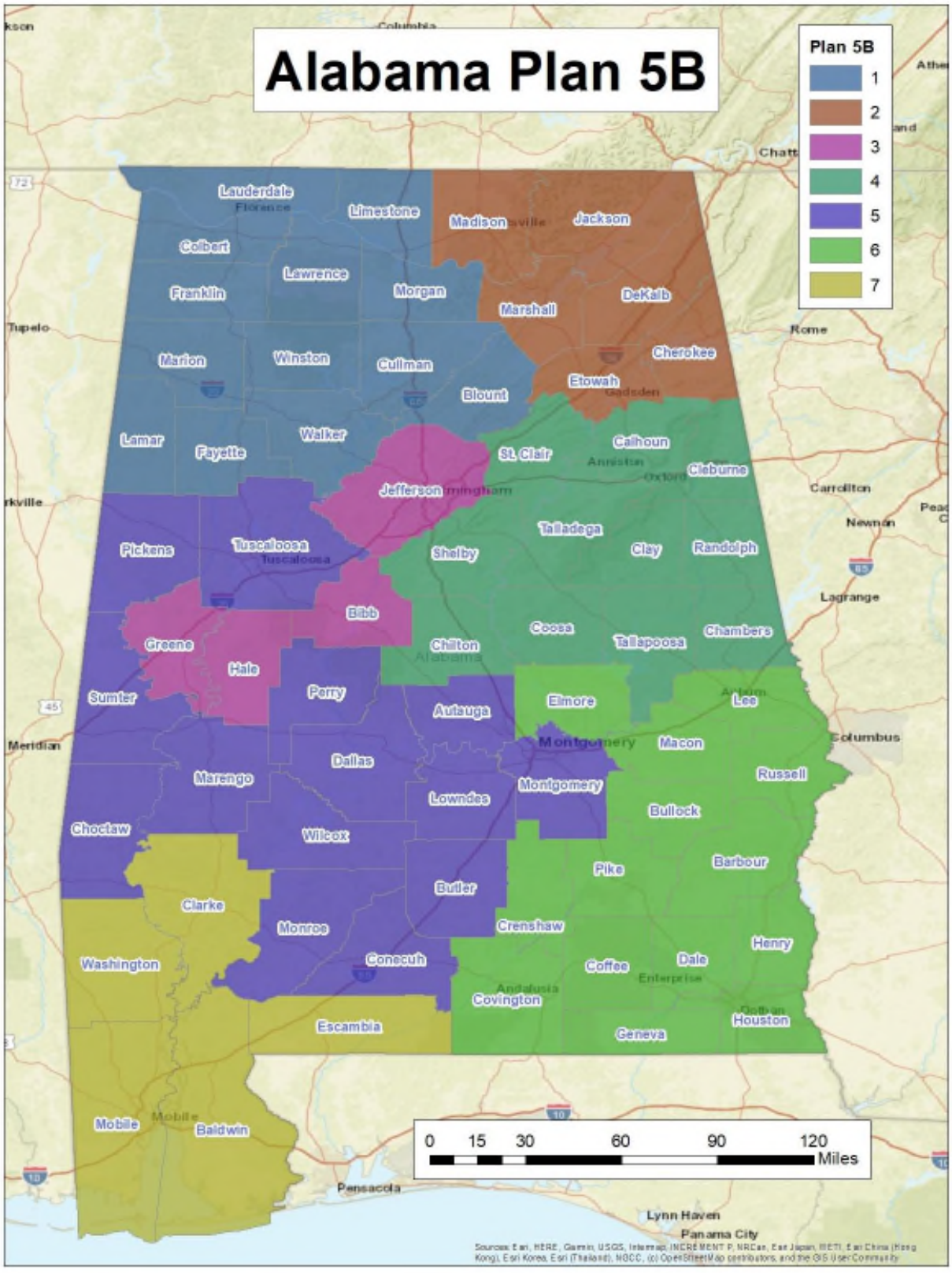
Map Appendix 11 (Plan 3B)



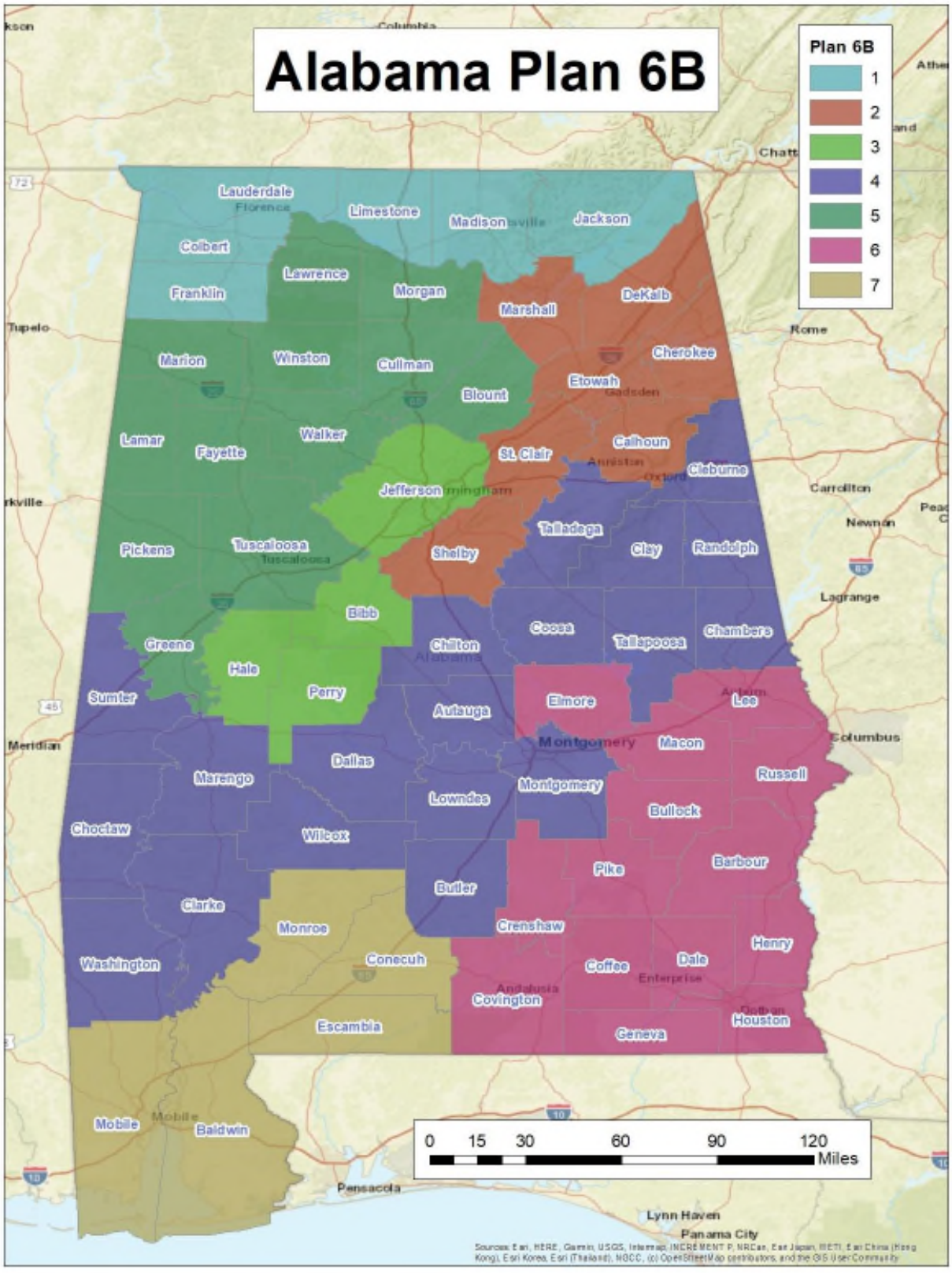
Map Appendix 12 (Plan 4B)



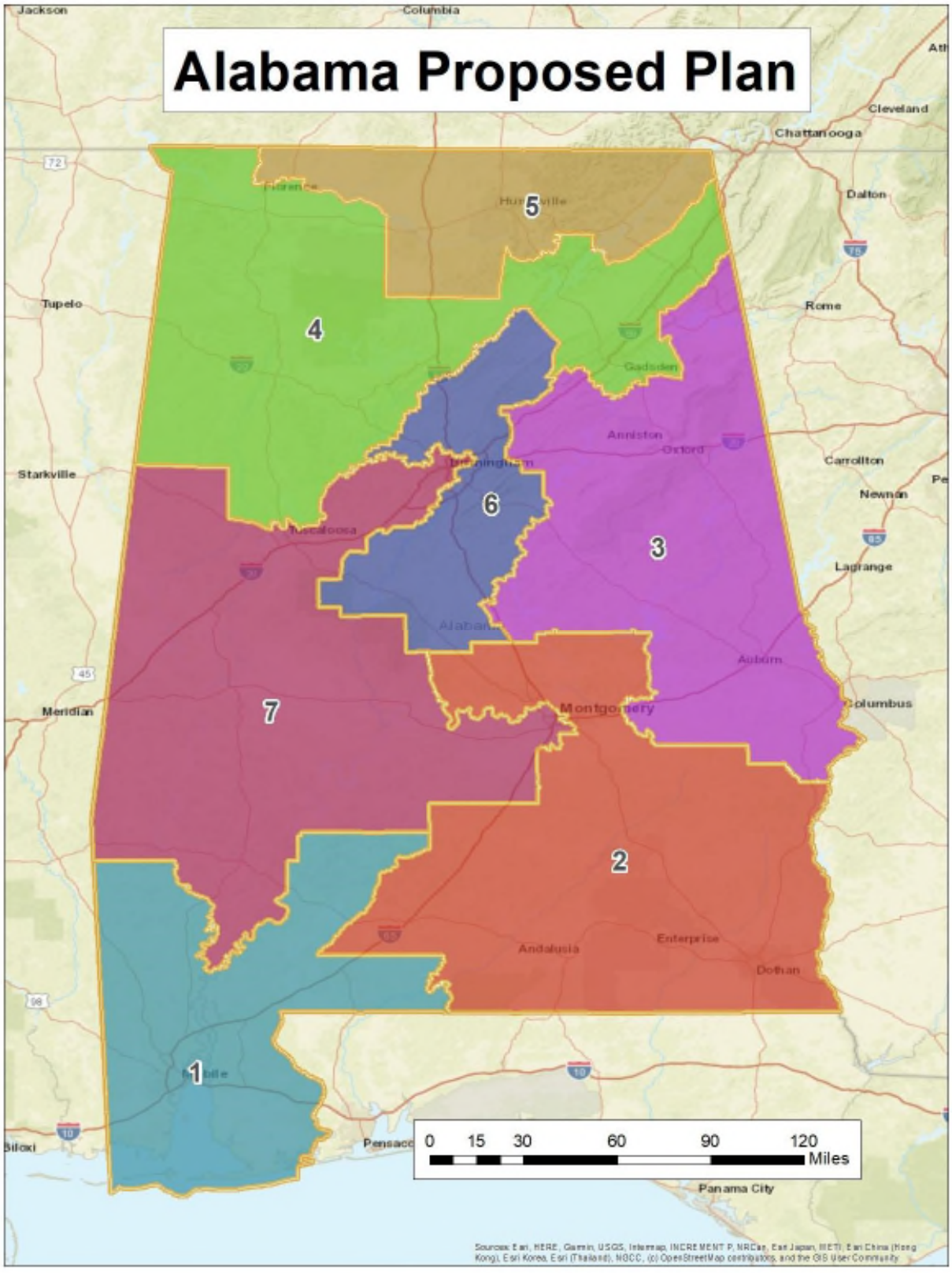
Map Appendix 13 (Plan 5B)



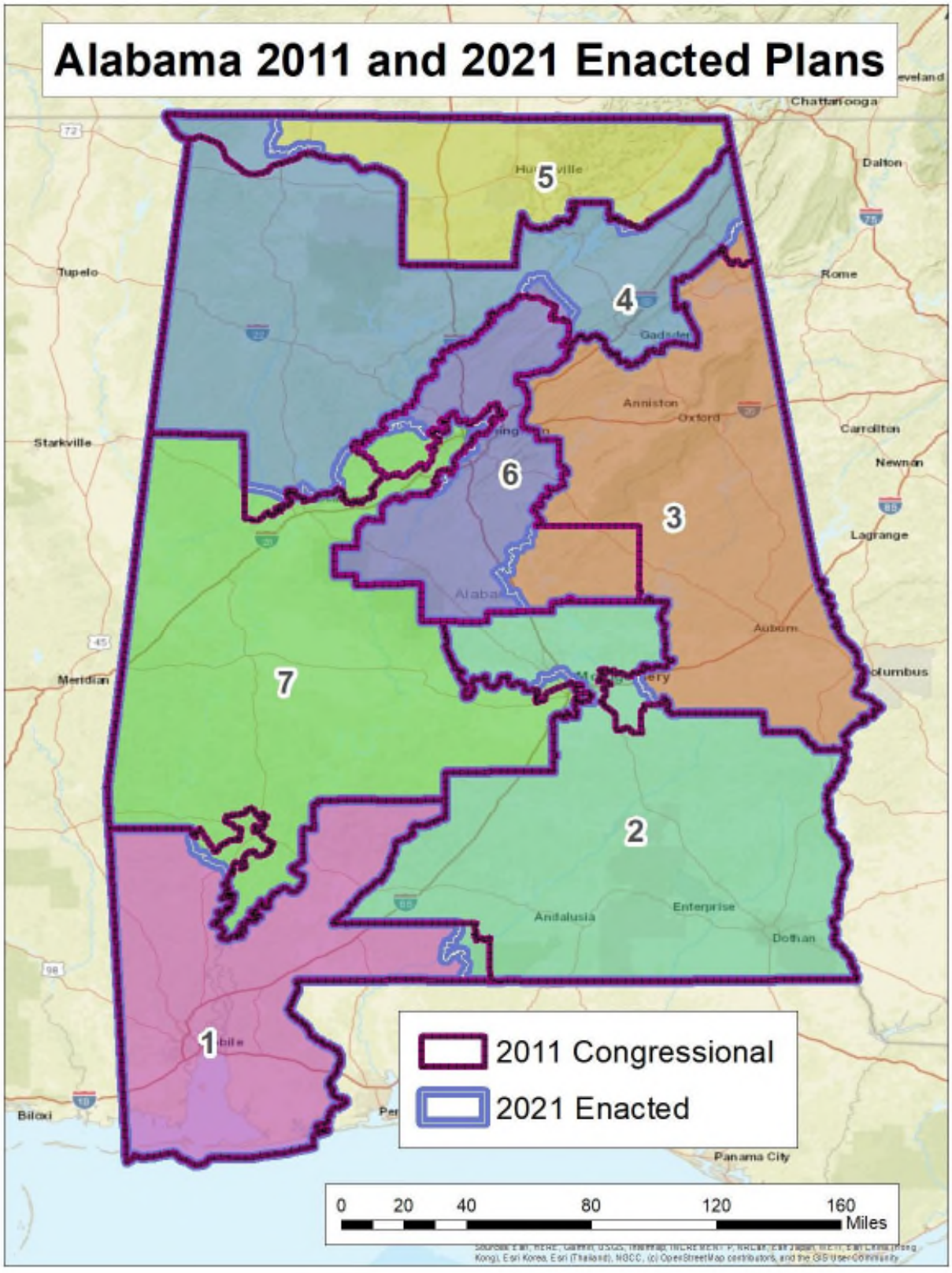
Map Appendix 14 (Plan 6B)



Map Appendix 15(State of Alabama Proposed Plan)

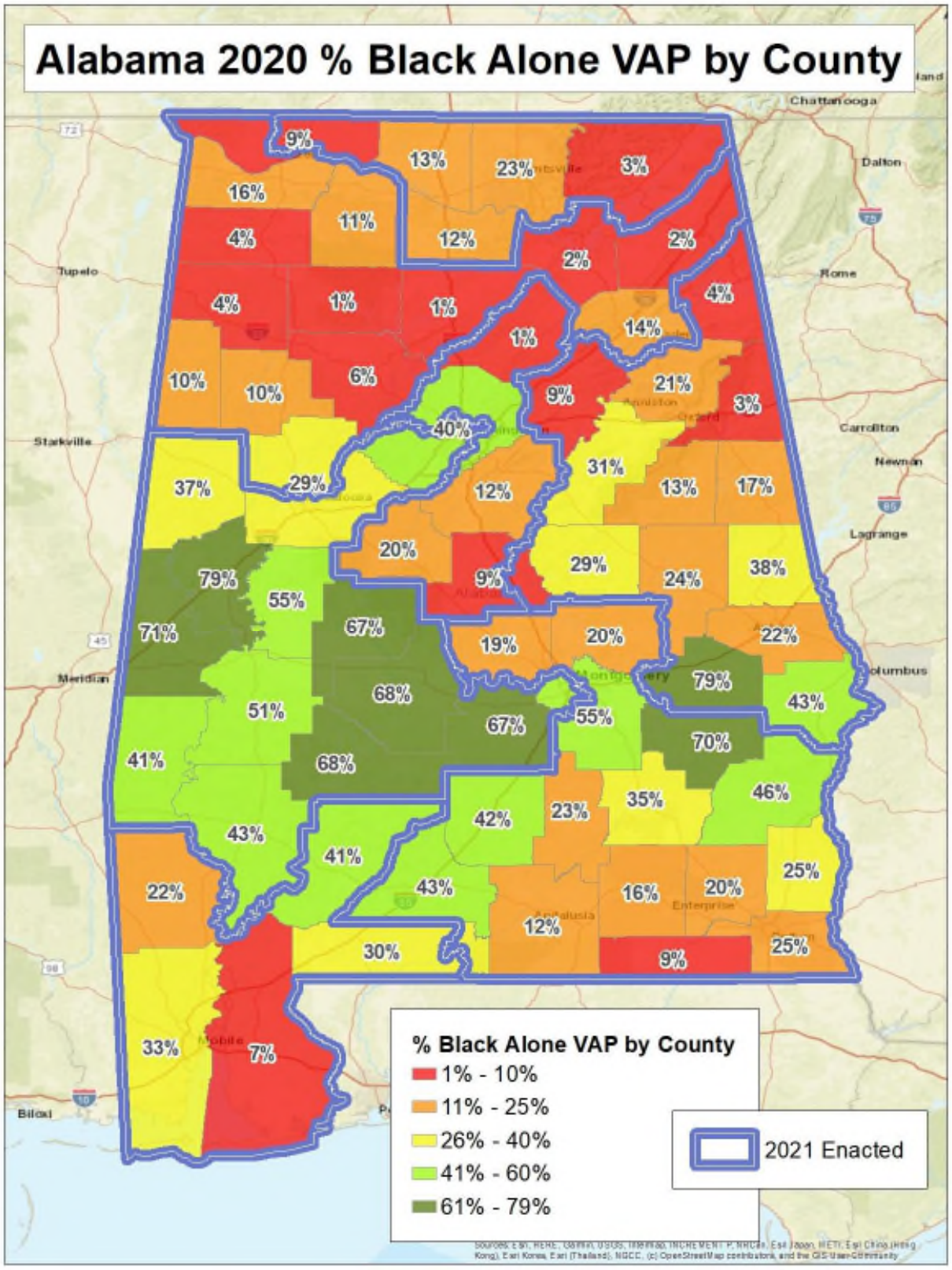


Map Appendix 16 (State of Alabama 2011 and 2021 Enacted Plans)

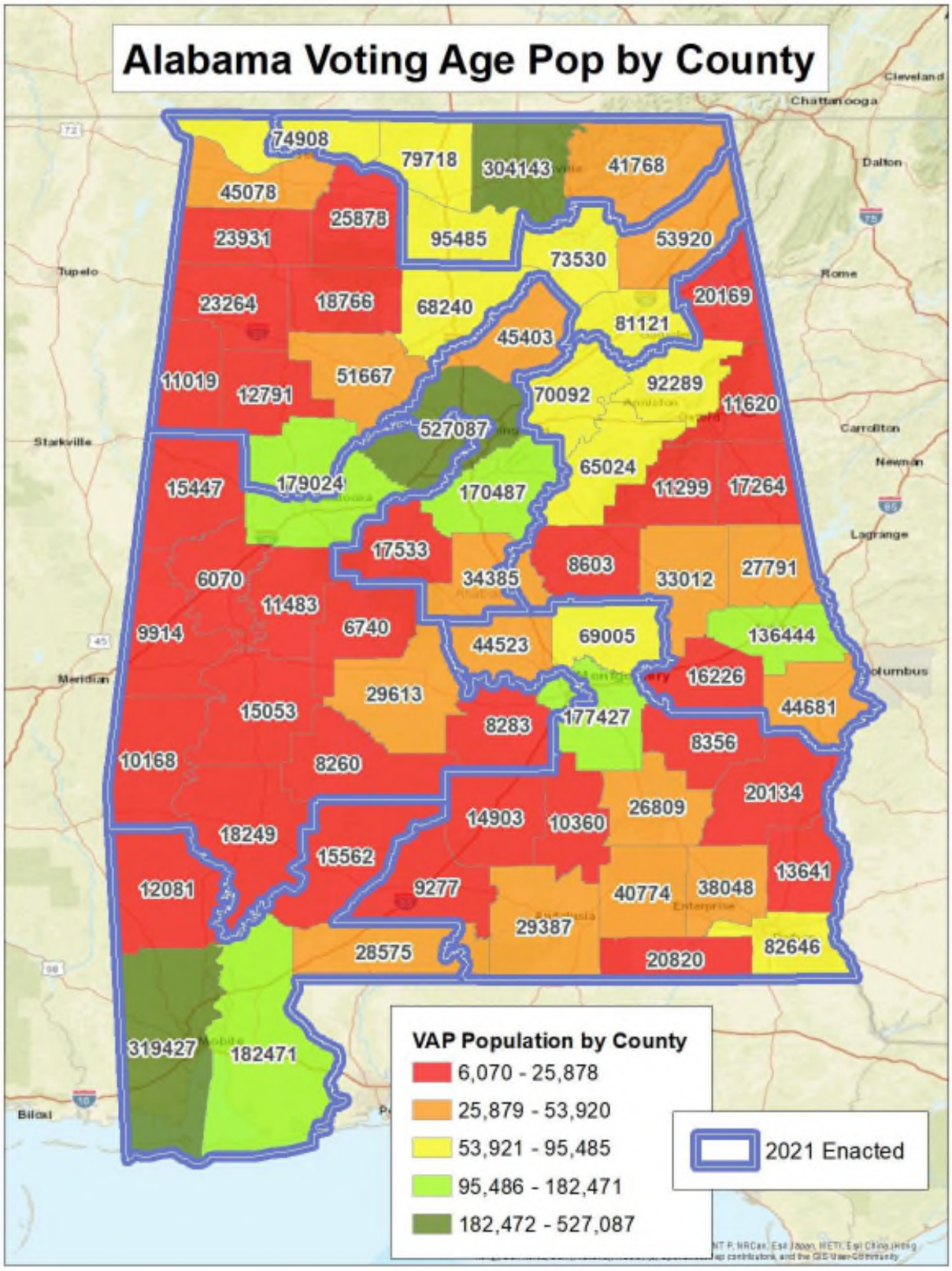


Alabama Enacted Plan
Map Appendices
% Black Alone and VAP
By County and VTD

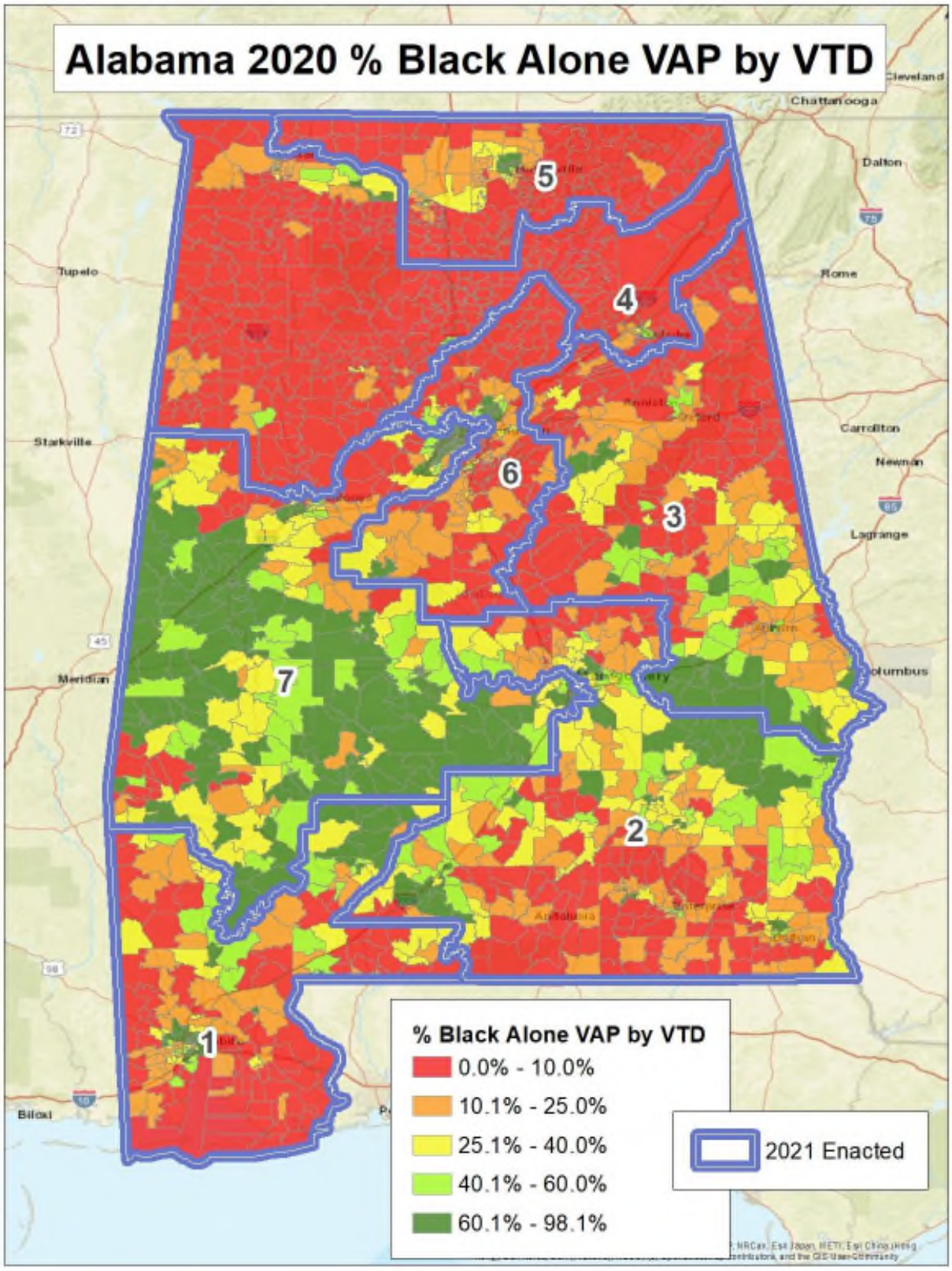
Map Appendix 17 (State of Alabama Percent Black Alone VAP by County)



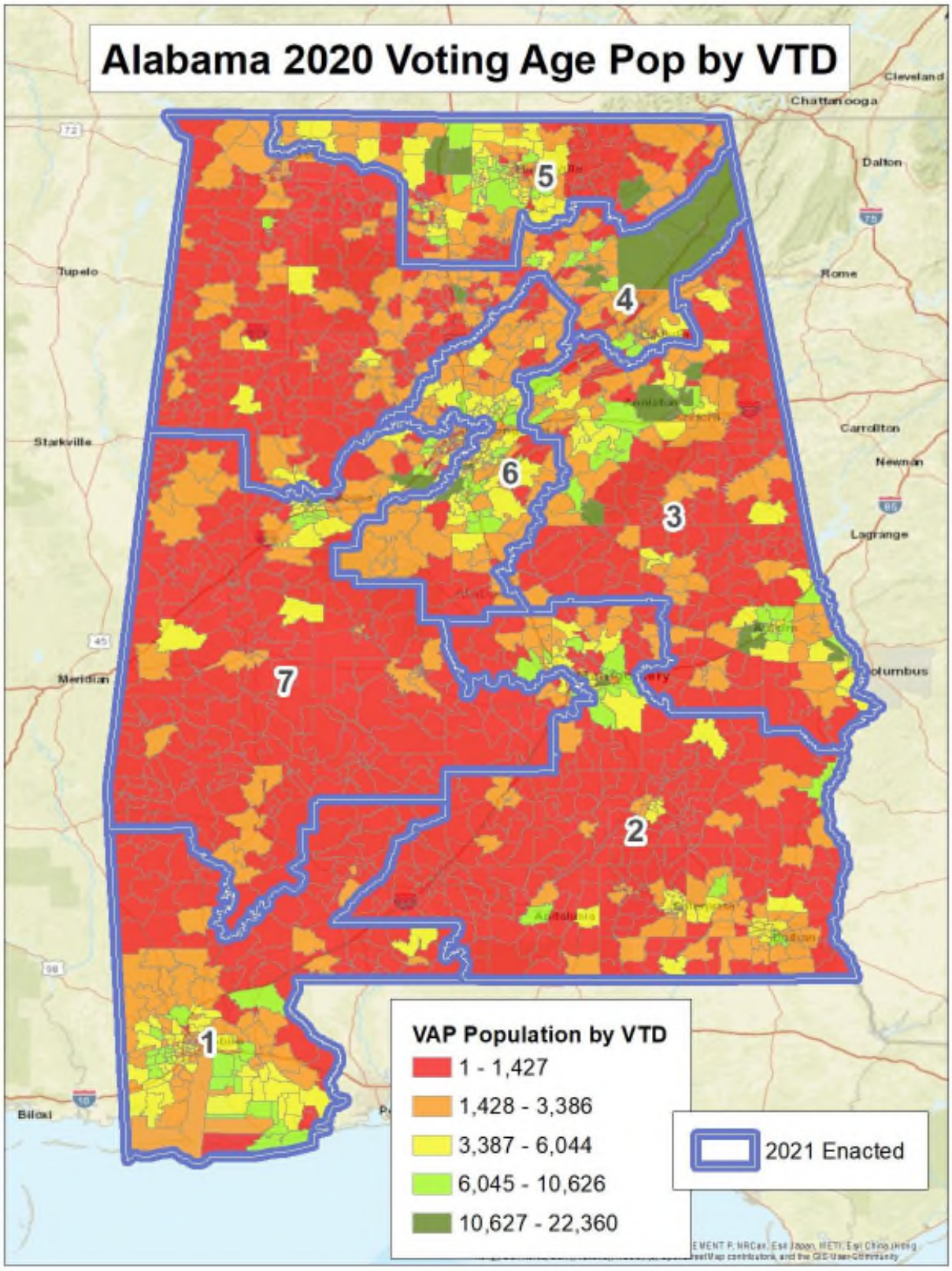
Map Appendix 18 (State of Alabama Voting Age Population by County)



Map Appendix 19 (State of Alabama Percent Black Alone VAP by VTD)

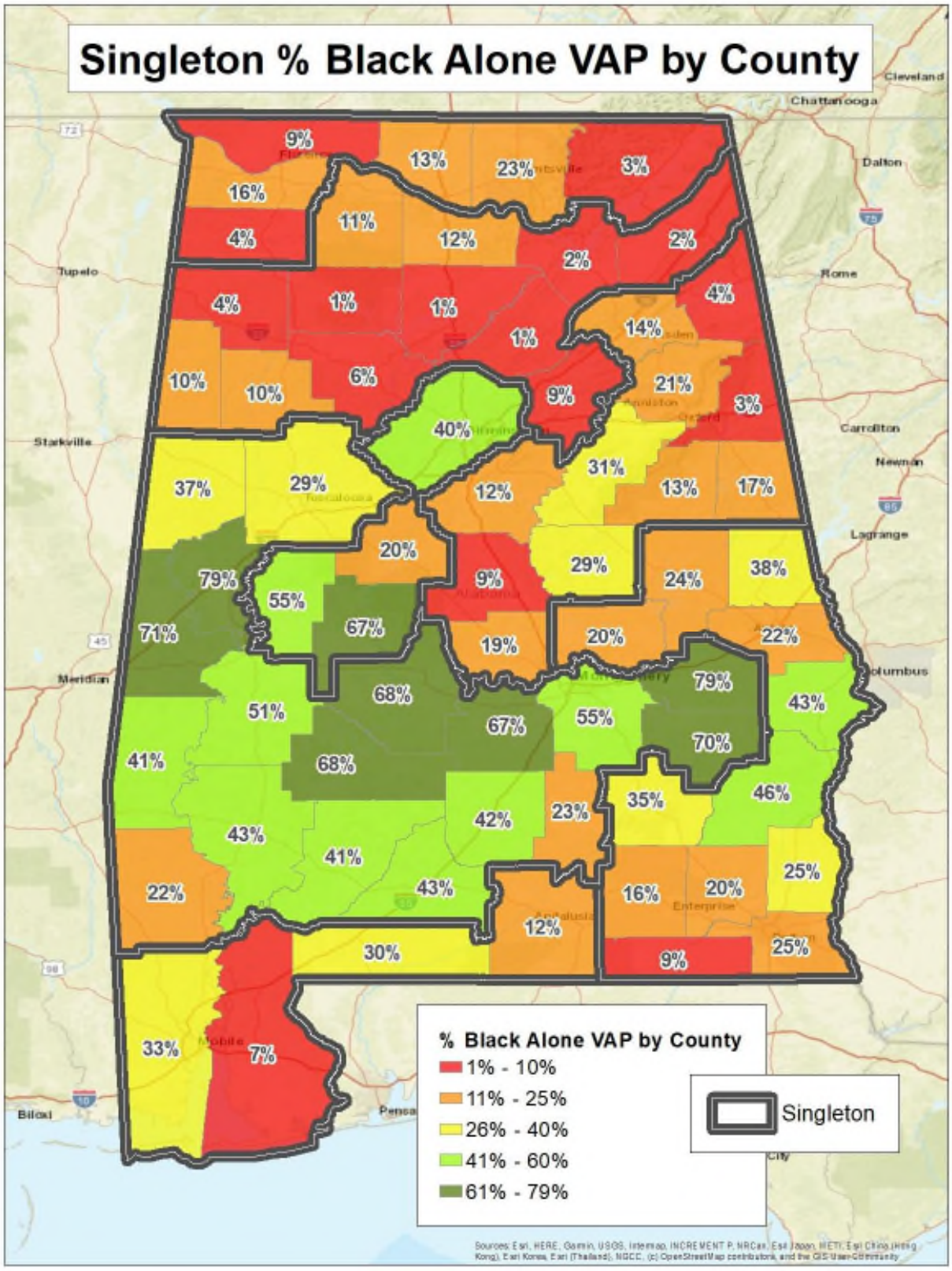


Map Appendix 20 (State of Alabama Voting Age Population by VTD)

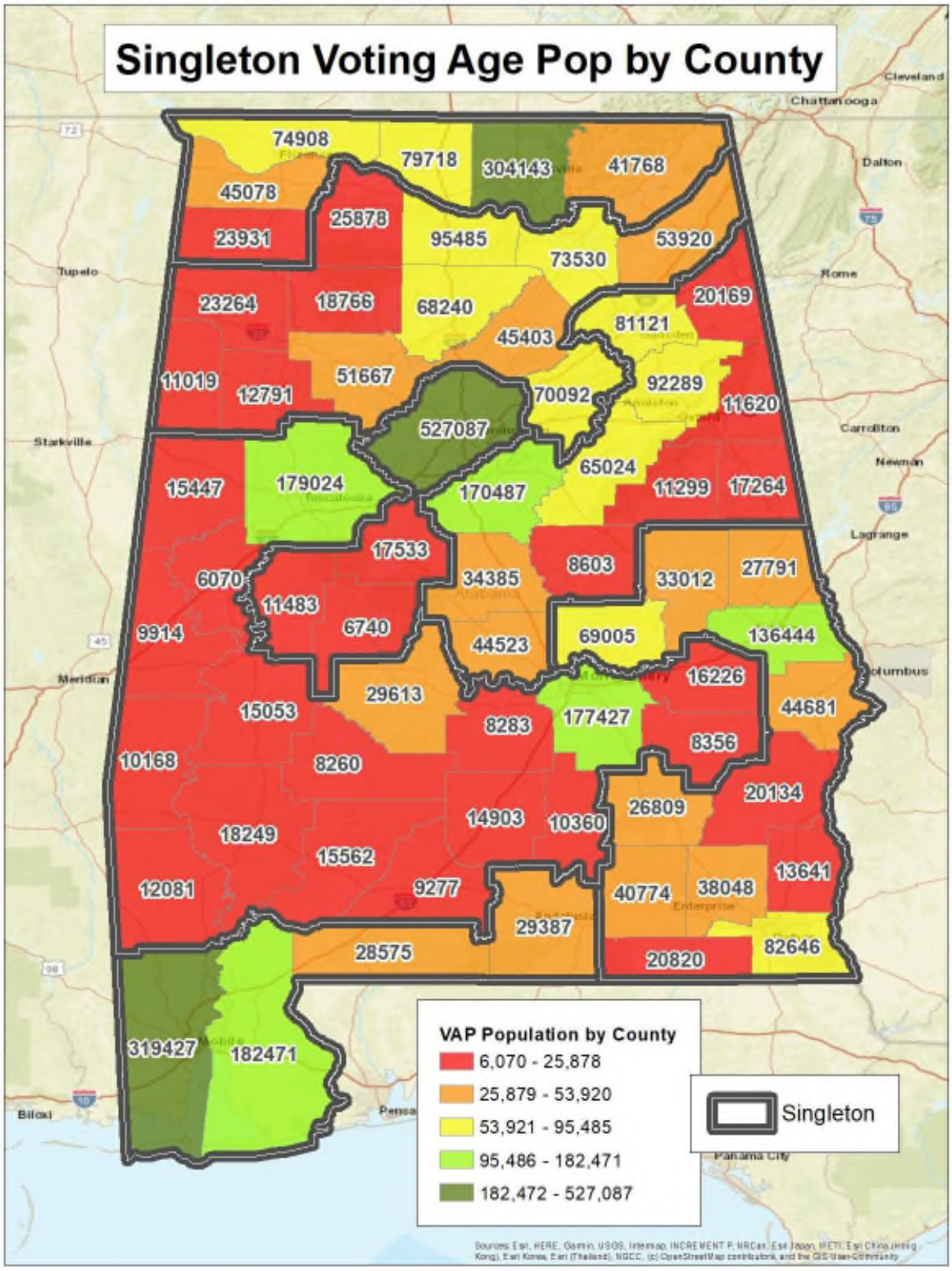


Singleton Plan
Map Appendices
% Black Alone and VAP
By County and VTD

Map Appendix 21 (Singleton Percent Black Alone VAP by County)



Map Appendix 22 (Singleton Voting Age Population by County)



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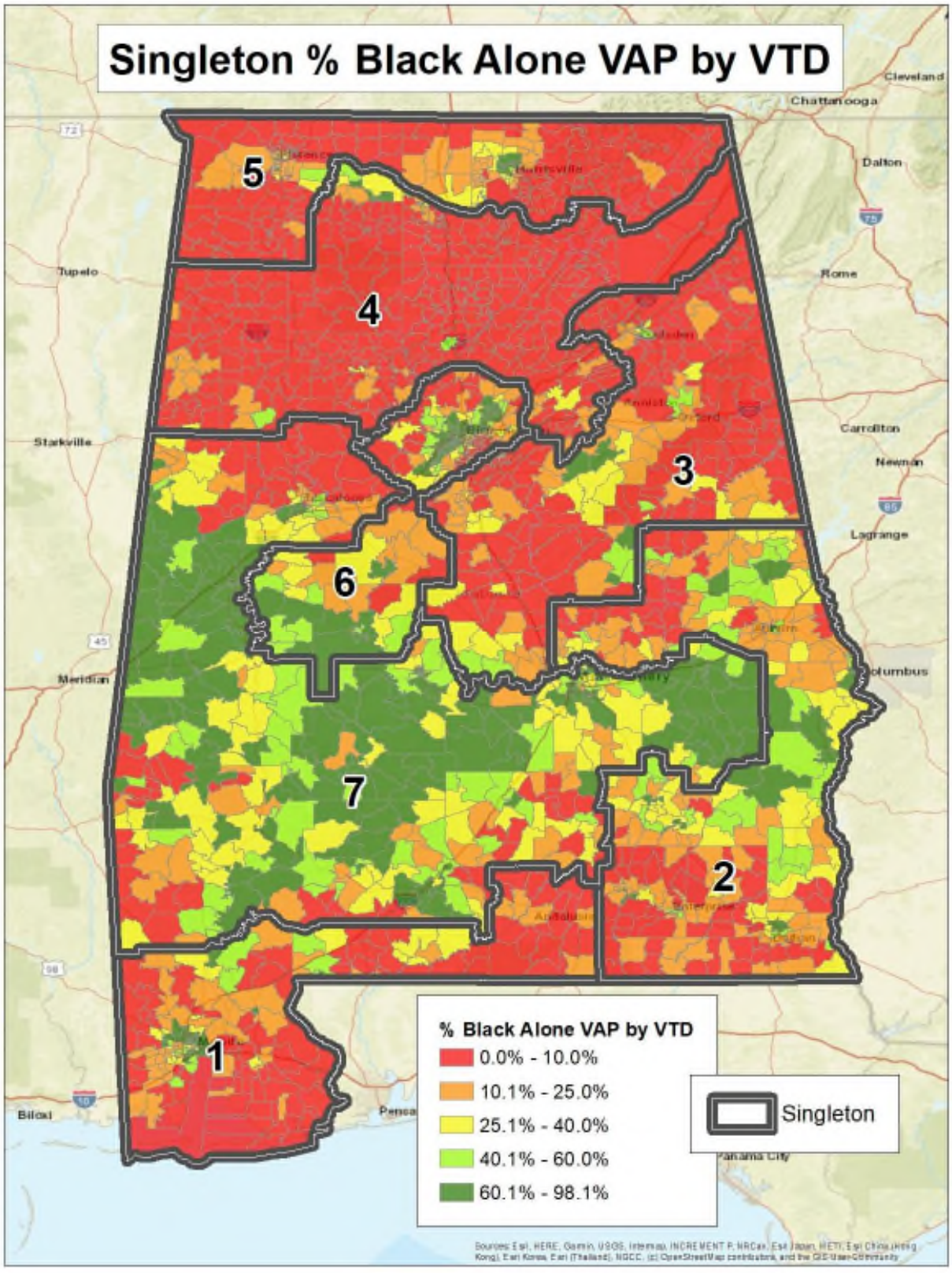
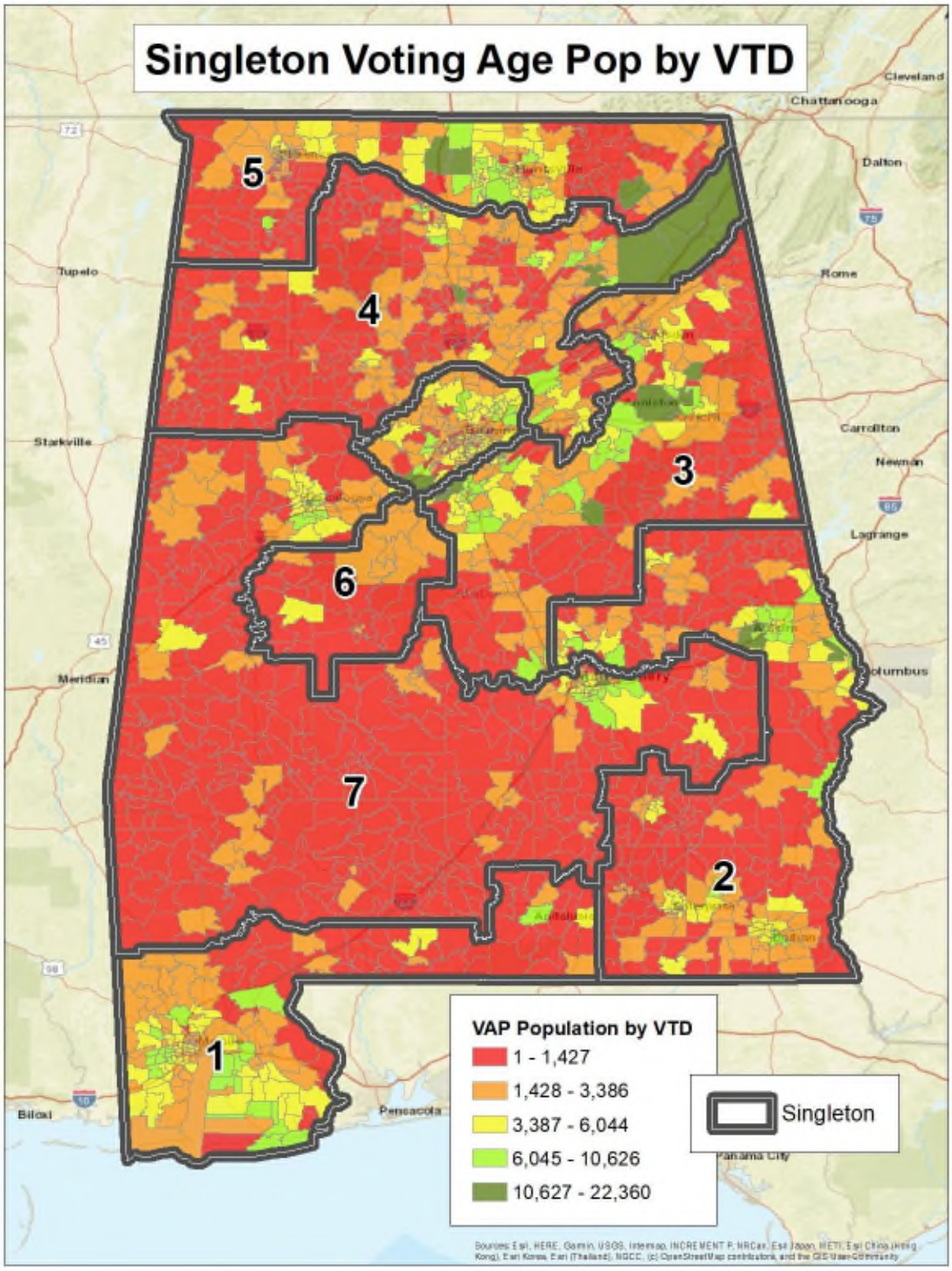


Map Appendix 24 (Singleton Voting Age Population by VTD)



Map Appendix 25 (Singleton Percent Black Alone VAP by VTD)