

No. 18-281

In the
Supreme Court of the United States

VIRGINIA HOUSE OF DELEGATES, M. KIRKLAND COX,
Appellants,
v.
GOLDEN BETHUNE-HILL, et al.,
Appellees.

**On Appeal from the United States District
Court for the Eastern District of Virginia**

**JOINT APPENDIX
Volume IV of IX**

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IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF VIRGINIA
(RICHMOND DIVISION)

Civil Action No. 3:14-cv-00852-REP-GBL-BMK

GOLDEN BETHUNE-HILL, *et al.*,
Plaintiffs,

v.

VIRGINIA STATE BOARD OF ELECTIONS, *et al.*,
Defendants.

DECLARATION OF THOMAS
BROOKS HOFELLER, Ph.D.

1. I am a recognized expert in the fields of districting and reapportionment in the United States. I have been retained, as an independent consultant, through counsel by Intervenor-Defendants House Speaker William Howell and the Virginia House of Delegates to provide expert testimony in this case. My hourly rate is \$300 per hour.

OBJECTIVES OF DECLARATION

2. I have been asked to determine whether H.B. 5005, the legislation enacted in 2011 by the Virginia General Assembly to redistrict Virginia's House of Delegates following the 2010 U.S. Census, is compact and contiguous.

3. Based on my review of the map and data reflecting H.B. 5005, as well as data and maps from other states, and my experience in drafting and evaluating districting plans for compactness all across

the nation for five decennial redistricting cycles, it is my opinion that the 2011 Virginia House of Delegates Plan H.B. 5005 is compact and compares favorably in terms its level of compactness to other Virginia legislative plans and plans from other states.

4. Based on my review of the geography of HB 5005, I have also determined that there are no contiguity issues with regard to the 2011 House of Delegates Plan.

QUALIFICATIONS

5. I set forth here a summary of my experience that is most relevant to this testimony. The full range of my professional qualifications and experience is included in my resume, which is attached as Exhibit 1.

6. I am a Partner in Geographic Strategies, LLC, located in Columbia, South Carolina. Geographic Strategies provides redistricting services including database construction, strategic political and legal planning in preparation for actual line drawing, support services and training on the use of geographic information systems (GIS) used in redistricting, analysis of plan drafts, and actual line-drawing when requested. The corporation and its principals also provide litigation support.

7. I hold a Ph.D. from Claremont Graduate University, where my major fields of study were American political philosophy, urban studies and American politics. I hold a B.A. from Claremont McKenna College with a major in political science.

8. I have been involved in the redistricting process for over 46 years, and have played a major role in the development of computerized redistricting systems, having first supervised the construction of such a system for the California State Assembly in 1970-71.

9. I have been active in the redistricting process leading up to and following each decennial census since 1970. I have been intimately involved with the construction of databases combining demographic data received from the United States Census Bureau with election information which is used to determine the probable success of parties and minorities in proposed and newly enacted districts. Most of my experience has been related to congressional and legislative districts, but I have also had the opportunity to analyze municipal and county-level districts.

10. I served for a year and one half as Staff Director for the U. S. House Subcommittee on the Census in 1998-99.

11. I was Staff Director of the Subcommittee when the Census Bureau was proposing to substitute the American Community Survey (ACS) for the use of the decennial long form questionnaire in the 2000 and previous decennial Censuses. The long form was not used in the 2010 Decennial Census.

12. I have drafted and analyzed plans in most states including, but not limited to, California, Nevada, Arizona, New Mexico, Colorado, Texas, Oklahoma, Kansas, Missouri, Minnesota, Wisconsin, Illinois, Indiana, Ohio, Arkansas, Mississippi, Louisiana, Alabama, Georgia, Florida, South Carolina, North Carolina, Virginia, New York, New Jersey and Massachusetts.

13. In this decennial round of redistricting, I have already been intensely involved in Texas, Alabama, North Carolina, Virginia and Massachusetts. As much of my consulting activities involve work in states subject to the provisions of Section 5 of the Voting Rights Act, I am very familiar with the data used to

analyze the expected performance of redrawn and newly created minority districts. I regularly advise clients about the characteristics of minority districts in their plans, and whether or not they are meeting the requirements of both Sections 2 and 5 of the Voting Rights Act.

14. I have given testimony as an expert witness in a number of important redistricting cases including, but not limited to, *Gingles v. Edmisten*, 590 F. Supp. 345 (N.D.N.C. 1984), *affd in part and rev'd in part Thornburg v. Gingles* 478 U.S. 30 (1986); *State of Mississippi v. United States*, 490 F. Supp. 569 (D.C.D.C. 1979); *Shaw v. Hunt*, 92-202-CIV-5-BR, U.S. District Court for the Eastern District of North Carolina, Raleigh Division (1993-4); *Ketchum v. Byrne*, 740 F.2d 1398, *cert. denied City Council of Chicago v. Ketchum*, 471 U.S. 1135 (1985), *on remand, Ketchum v. City of Chicago* 630 F. Supp. 551 (N.D. Ill. 1985); and *Arizonans for Fair Representation v. Symington*, CIV 92-0256, U.S. District Court Arizona (1992), *affd mem. sub nom. Arizona Community Forum v. Symington*, 506 U.S. 969 (1992), *David Harris v. Patrick McCrory*, Civil Action No. 1:13 CV-00949 (United States District Court, Middle District of North Carolina Durham Division 2013) and *North Carolina State Conference of the NAACP v. Patrick Lloyd McCrory*, 1:13 CV-658 (United States District Court, Middle District of North Carolina 2013).

15. I have done considerable work regarding compactness as a criterion in redistricting maps, including but not limited to a work I coauthored in *The Journal of Politics*, "Measuring Compactness and the Role of a Compactness Standard in a Test for Partisan and Racial Gerrymandering." *Id.*, Vol. 52,

No. 4 (Nov., 1990), pp. 1155-1181 (with Richard G. Niemi, Bernard Grofman, and Carl Carlucci).

16. In that work, my co-authors and I discussed the advantages and limitations of various measures of compactness as well as differing definitions. As we stated in the article, “disputes about compactness will be numerous . . . there are those who would dismiss it outright as well as those who believe in it passionately.” We further noted that “whatever turns out to be its utility as a districting standard, we hope that we have sufficiently clarified the concept so as to stimulate more rational, enlightened discussion of its merits and faults as well as further study of its supposed effects.”

17. Both prior and subsequent to my coauthorship of the *Journal of Politics* article, I have regularly advised state legislatures and others regarding the concept of compactness and regarding the compactness of specific districts and districting plans.

SOURCES OF DATA FOR THIS REPORT

18. In compiling the maps, figures and tables for this report, I have accessed current and historic redistricting plan files for multiple states, which I have access through my present and former consulting work, along with other analyses provided by other redistricting information sources available through counsel. All of the compactness measures have been computed using U. S. Census Bureau’s TIGER geographic files which contain multiple levels of census geographic units including, but not limited to, census blocks, voting districts (VTD’s), census places, and counties as well as congressional and legislative district boundaries. Current and former political district boundaries are coded into attribute files at the census

block level and are commonly referred to as “block assignment files”. The geographic boundary information for legislative plans enacted in the decade prior to the 2010 Decennial Census and after that Census is available through U. S. Census Bureau data sources. In some cases actual boundary files for the 1991 Virginia legislative districts have been matched to current census geographic files to “move” block assignment from generated from prior redistrictings into the current 2010 TIGER geography.

19. Compactness tests are an integral part of modern redistricting geographic information systems (GIS) and are part of many analytical reports which can be produced for redistricting plans drafted on a redistricting system. I have used the GIS software developed by Caliper Corporation, located in Newton, Massachusetts. This software package is “Maptitude for Redistricting”, and is the most commonly-used software used by redistricting experts across the nation. All the maps used in this report have been produced using Maptitude for Redistricting. The information contained on most of the tables in this report has been compiled from Maptitude reports using Excel, which is a common Microsoft utility spreadsheet software program.

MAKING DETERMINATIONS REGARDING COMPACTNESS

20. Experts in my field are frequently asked by state legislatures or other interested parties to determine whether a map is “compact” under a relevant statutory or constitutional provision. To the best of my knowledge, no state statutes or constitutions define what specific attributes are to be found in a “compact” plan, provide objective tests for measuring the degree to which those attributes are present, or provide

numerical or other objective bright lines for determining whether plans or districts are compact.

21. Compactness is a concept in search of a definition. This is so for two reasons. First, there is not complete agreement among legislators, courts, experts, or the general public about what attributes must or should be present in a “compact” district or an individual redistricting plan. Second, even when specific attributes of compactness are isolated, there are multiple methods of measuring those attributes and there is no general agreement about what minimum measurements are required before a district or plan can be considered compact. Indeed, there is not even agreement that a minimum measurement or bright line should be used for determining whether a given district or plan is compact.

22. Various concepts of compactness can, however, be used to evaluate plans for purposes of comparing one plan to another. These varied concepts are reflected in mathematical tests that attempt to measure the presence of certain attributes. For example, some tests focus on the shape of a district, finding different ways to assign a one-dimensional number to a two-dimensional shape. Some tests focus solely on the perimeter of an area, focusing primarily on intrusions or extrusions and potentially on the size of a district, but not necessarily on how well a district fills in a given area. Other tests focus on population dispersion within a district. Each of these tests rewards certain positive attributes of compactness and penalizes negative attributes.

23. The quantitative scores derived from these tests can be used to make comparisons between plans with respect to certain attributes that the “tester” thinks are important, but they should not be used to

eliminate plans that fail to meet a predetermined level. There is no score for any one measure, much less for all of them, when used together, that, on its face, indicates unsatisfactory compactness. Nor can compactness scores be used to rank all possible plans along a single continuum, from perfectly un-compact to perfectly compact.

24. Despite the inability to meaningfully use mathematical tests in applications beyond a simple comparison between two plans, compactness is not a meaningless concept. For example, while there is no precise temperature that marks the transition from hot to cold, we know that 10 degrees is uniformly regarded as cold and 90 degrees as warm. The same can be said of 30 degrees and 70 degrees and other temperatures closer to the middle, even though there comes a point, not a bright line, where there is no general agreement.

25. In deciding whether a given set of districts are compact, the question that experts ask is not, therefore, whether another plan scores lower or higher using a mathematical test to measure some single attribute of compactness. Instead, experts determine whether the plan is “hot” or “cold;” according to the degree it exhibits the traits of other districting plans that have been determined by legislatures or courts to be compact.

26. For purposes of this report, I have selected two compactness measures which are familiar to courts and widely cited. The first test is called the Reock Test and the second is the Polsby-Popper Test. Both tests are based on the geographic area of a district compared to a calculated circle. Both tests are not affected by the geographic size of the district, or districts, which are being measured.

27. The Reock Test, sometimes described as “Geographic Dispersion Compactness” computes the ratio of the area of a district to the area of the smallest circle that can enclose the district. A “perfectly shaped district” would be a circle for which the area of the district and the circumscribing circle would be the same. The Reock score would be 1.00. Another common geometrically-shaped district would be a square, with a Reock score of 0.6366.

28. The Polsby-Popper Test, sometimes described as “Perimeter Compactness” computes the ratio of the area of a district to the area of a circle with the same perimeter as the district being tested. Once again, a “perfectly shaped” district would be a circle with a score of 1.00. A square-shaped district would have a score of 0.7854.

29. Figure 1 contains examples of three rectangular districts (A, B & C). District A is a square. District B is a rectangle with a width twice as long as its height. District C has a width three times as long as its height. As the rectangle increases in width relative to its height, the Reock score decreases from 0.637 to 0.509 to 0.382. Thus, the Reock test reacts strongly to elongated districts. At the same time, as the rectangle elongates, the Polsby-Popper score decreases from 0.785 to 0.698 to 0.589. The Polsby-Popper score reacts less to the elongation of a district.

30. Figure 2 contains a much more convoluted district with numerous indentations into a basic shape which is almost square. Testing this hypothetical district yields a Reock score of 0.405, but a Polsby-Popper Score of only 0.082, which is much lower. This example illustrates that the Polsby-Popper tests is very sensitive to indentations into the district, or multiple lengthy extrusions. This is the type of

geographic feature which might be caused by water boundaries, such as coastlines or rivers, other mountain ridges. The marked difference between the size of the Reock circle and the Polsby-Popper circle is quite striking in this example.

EXAMPLES OF NON-COMPACT DISTRICTS

31. When Justice O'Connor addressed compactness in *Shaw vs. Reno* (517 U.S. 899 (1995)), she was looking at the districts found on Map 1 of this report. These districts were North Carolina's second attempt to draft a congressional districting plan, following the 1990 Decennial Census, which would receive preclearance from the United States Department (DOJ) under Section 5 of the Voting Rights Act. Enacted in 1992, Congressional District 12 was particularly cited by Justice O'Connor as being bizarre in shape. District 12 was declared unconstitutional. It should be noted that District 12 had a Reock Score of 0.05 and a Polsby-Popper Score of 0.01. Congressional District 1, which is an example of lack of compactness, had a Reock score of 0.26 and a Polsby-Popper score of 0.02. The reason that District 1's Reock score is higher than District 12 is that its width is closer to its length. Both districts are only contiguous by touch, which is not considered to be contiguous in many states, including present-day North Carolina. The compactness scores for the 1992 North Carolina congressional map are listed on Table 1.

32. After North Carolina's 1992 Congressional Plan was tossed out by the Court, the State went through several maps while attempting to gain court approval of its post-1990 Decennial Census congressional map. The final map, passed in 1997 was finally approved by the United States Supreme Court (*Hunt v. Cromartie*

526 U.S., 541 (1999)), and only used in the 2000 Election.

33. In the congressional remap following the 2000 Decennial another map was enacted in 2001 which was in effect through the 2010 General Election. This map, shown on Map 2, shows how Districts 1 and 12 changed though the next redistricting cycle. District 12 had a Reock score of 0.12 and a Polsby-Popper score of 0.03 while District 1 had a Reock score of 0.39 and a Polsby-Popper score of 0.08. In the period from 1992 through 2010 both Districts 1 and 12 elected African-Americans. The compactness scores for the 2001 plan are found in Table 13.

34. The state of Illinois also contains some strangely configured districts which have been crafted to protect minority incumbents from the Chicago area. Illinois has been steadily losing congressional representation for many decades, leaving the Chicago districts severely underpopulated. Map 3 shows the four minority districts anchored in Chicago. The Reock and Polsby-Popper scores for Illinois' 2011 congressional districts are found on Table 2. All these districts contain minority voting-age population (VAP) percentages in excess of 60% in terms of 2010 Decennial Census numbers. The African-American districts are 1, 2, and 7. District 4 is a carefully crafted to separate the Hispanic population from the African-American population, with a Hispanic VAP of 65.92%. District 2 extends from Southeast Chicago, through the southeast Chicago suburbs, through eastern Will County out into Kankakee County. District 1 begins with a narrow neck coming out of Chicago, into the Cook County suburbs and out into western Will County. District 7 is based in Chicago. It has an extension off the main body of the District to the south

side of Chicago connected through a narrow passage just over 500 feet wide. The 7th District also extend west out into Cook county to come within 300 feet of the Cook County-DuPage County line. District 4 is the Hispanic congressional seat which is known by almost all redistricting experts as the “Earmuff District”. It carefully wraps around African-American District 7 running between the western boundary of the 7th District and the DuPage County boundary.

35. I have drawn these districts to the attention of the court because they were clearly crafted with only two goals. First was to create three African-American districts and one Hispanic district. They were drawn to add needed population into seriously underpopulated minority districts and were totally race-based in motivation. The second goal was to create three safe seats for Non-Hispanic White Democrats. Congressional Districts 3, 5 and 9, which also are based in Chicago, have Non-Hispanic White VAP populations in excess of 65% and have successfully elected Non-Hispanic White Democrats.

36. In *King v. State Bd. of Elections* (979 F.Supp. 619 (N.D. Ill. 1997) (*King II*), the court found that, while the Illinois 4th District was irregularly shaped, it was still compact and maintained most of the other traditional redistricting criteria in Illinois. The odd shape was in fact necessitated because of the need to accommodate an existing African-American incumbent. As a result, the court found that the district, which has commonly been referred to as an “earmuff,” met the compactness prong of *Gingles* and was therefore narrowly tailored.

VIRGINIA COMPACTNESS ISSUES

37. Unfortunately, real districts cannot be drawn to conform to basic geometric shapes. This is especially true for the state of Virginia, which is irregularly shaped to begin with. Theoretically, states such as Colorado or Wyoming might be divided into simple square or rectangular districts except that, even in these states, the units of geography, which are combined into districts, are not regularly shaped.

38. Virginia has 7,213 miles of tidal bay frontage, 123 miles of ocean coastline, and 457 miles of on-tidal river frontage. Many county lines follow riverbeds, and the State's western boundary runs along over 400 miles of mountain ridges and rivers. All of these physical features would affect some compactness tests, especially the Polsby-Popper test.

39. Virginia's Tidewater region, which runs from the fall line to the Chesapeake Bay, is divided into four major regions by the James, York and Rappahannock Rivers. The boundaries of Virginia's counties in the Tidewater are shaped by these rivers which were historic avenues of transportation in Virginia.

40. Other factors affecting district shapes are the federal constitutional requirement of equality of population and the requirements of the Federal Voting Rights Act of 1965, as amended. Areas of minority population may not be located in geographic configurations which lend to their inclusion in optimally-compact districts. A state redistricting authority might have to balance other competing redistricting goals against the shapes of districts to draft feasible plans. In Virginia, the Legislature has been afforded considerable latitude in making these policy decisions by the State Supreme Court.

41. Another competing factor is the protection of incumbency interests and maintenance of district core area from one redistricting plan to another. This is equally true for African-American incumbents. In my 45 years of redistricting experience, I have found that most incumbents are unlikely to happily exchange safe districts for more competitive districts, and that also includes minority incumbents.

42. Relative shifts in the balance of population between areas of a state require difficult policy choices. The overriding factor in creating a new districting plan is that, as is the case of Virginia, the map must be enacted by the same legislators who will represent the new districts. If enough legislators do not accept the map, there will be no bill enacted.

43. In my expert opinion, there is no clear national standard or bright line test with which to say that Virginia's current districts meet some theoretical academic standard of permissible compactness. However, Virginia does have a state constitutional provision on compactness, and there are two state Supreme Court decisions which provide considerable guidance and define the compactness standard for Virginia legislative districts. These standards were cited by the House of Delegates a part of their redistricting criteria. See *Jamerson v. Womack*, 244 Va. 506 (1992) and *Wilkins v. West*, 264 Va. 447 (2002). This means that Virginia has a better defined compactness standard than most states. While I leave the legal implications of these cases for the attorneys, it is instructive to examine the facts approved by the Virginia Supreme Court.

44. In *Jamerson*, the Virginia Supreme Court upheld the chancellor's court's determination that reapportionment of Senatorial Districts 15 and 18, as

enacted in Chapter 18 of the Acts of the 1991 Special session of the General Assembly (Code §§ 24, 1-17, 19 and 22), did not violate Article II, §6 of the Virginia Constitution with regard to compactness (See Map 12).

45. The Supreme Court further concluded that proper deference must be given to the wide discretion accorded to the General Assembly in its value judgment of the relative degree of compactness required when reconciling the multiple concerns of apportionment.

46. In *Wilkins v. West*, plaintiffs made a complaint under the State Constitution which mirrors the complaint in this case. The circuit court found for the plaintiffs and determined that the districts did not meet the Virginia Constitution's requirements for compactness and contiguity and found that several of the districts were racially gerrymandered. The Virginia Supreme Court unanimously reversed, finding that all the districts complied with the Virginia constitutional regard compactness and contiguity and, therefore, none of the districts constituted a racial gerrymander.

47. In my expert opinion, the *Jamerson* and *Wilkins* standard of value judgment is clearly satisfied by the evidence cited below. I measured the compactness of Senate Districts 15 and 18 as enacted in 1991 as well as the compactness of all the districts in the 1991 State Senate and 1991 House of Delegates Maps. I will compare the information for the 1991 redistricting plans for both chambers as well as the House of Delegates plans drafted following the Decennial Censuses of 2000 and 2010. Particular attention will be given to the current districting plan for the House of Delegates enacted following the 2010 Decennial Census.

48. In order to give the court a frame of reference, I have also determined the compactness scores for other Southern states which face the same issues of minority representation.

49. I will also discuss the issue of district contiguity and note some of the reasons that the districts under contention in this case were enacted in their present configuration. Although I did not participate in the drafting of any Virginia redistricting plans this decade, my 45 years of redistricting experience across the nation give me good perspective of the drafter's motivations just from a detailed examination of the district configurations of a redistricting map.

THE 1991 VIRGINIA STATE HOUSE AND SENATE PLANS

50. Table 6 contains the compactness scores for all the senate districts enacted in 1991. Both the Reock and Polsby-Popper scores are listed. At the bottom of the table the minimum district score, the maximum district score and the mean district score are shown. Map 12 shows the boundaries of Senate Districts 15 and 18. The Reock and Polsby-Popper score for District 15 are 0.23 and 0.10 respectively and the equivalent score for District 18 are 0.12 and 0.10. For the 1991 Senate Plan as a whole the lowest Reock score was 0.12 (District 18) and the highest Reock score was 0.65 (District 21). In the 1991 Senate Plan as a whole the lowest Polsby-Popper score was 0.10 (Districts 2, 15, 18) and the highest Polsby-Popper score was 0.43 (District 19). It should be noted that District 16 in that plan had a lower Polsby-Popper score of 0.09 (See Map 15) than the two senate districts specifically cited in *Jamerson*. In my judgment, District 16 is somewhat more bizarre shaped, but because its width is closer to its height it received a better Reock score of 0.33. This

demonstrates the problem of just using these mathematical scores to evaluate compactness.

51. The 1991 House of Delegates District 74 was also among the districts examined in *Jamerson* which is important because very similar shapes for this district were adopted in 2001 and 2011 (See Map 19). The 1991 district had a Reock score of 0.14 and a Polsby-Popper score of 0.11. The Virginia Supreme Court did not object to this district (See Table 5). Almost the exact same district was carried over to the 2001 House Plan (See Map13) and then again into the 2011 House Plan (See Map 8). House District 74 in the 2011 Plan had a Reock score of 0.16 and a Polsby-Popper Score of 0.12. Both compactness scores for the 2011 version of House District 74 were better for that same district than in the 1991 Plan.

52. I have included Map 21 which shows examples of 4 additional 1991 House of Delegates districts. These are districts which the *Jamerson* court examined and approved.

53. It should follow, therefore, that if the compactness scores of the 2011 Virginia House of Delegates Plan are not significantly different than the scores accepted by the Virginia Supreme Court in *Jamerson*, then they are compact enough to pass muster under the Virginia Constitution as drawn in the 2011 House of Delegates Plan.

THE 2011 HOUSE OF DELEGATES PLAN (H.B. 5005)

54. I have compiled Maps 4 through 6 which highlight the 12 African-American districts contained in the 2011 House of Delegates Plan (HB5005). District 75 is rural in character and runs along the Virginia-North Carolina border from Franklin City in the east,

to Brunswick County in the west. District 63 stretches from Hopewell City in the northeast through a portion of Prince George County, through Petersburg and a portion of Chesterfield County and out into northern Dinwiddie County. Only a very small portion of the District's population is rural – about 8,000 out of 79,600. Map 4 is the only map which shows District 75 in its entirety.

55. The four African-American districts in the Norfolk-Portsmouth-Chesapeake area (Districts 77, 80, 89 and 90), along with the two African-American districts in the Hampton-Newport News area (Districts 92 and 95), are shown in greater detail on Map 5. District 77 extends out to the southwest into Suffolk County.

56. The remaining four African-American districts, shown on Map 6, are located in the Richmond-Henrico County area (Districts 69, 70, 71 and 74). District 74 extends to the southeast to include all of Charles City County which, it should be noted only contains 7,256 people, living in two precincts.

57. Map 16 shows HB5005 in its entirety with insets for the areas running from Richmond to Hampton Roads along as well as an inset for the Northern Virginia districts.

58. Tables 5 through 10 contain the Reock and Polsby-Popper compactness scores for the following current and historical Virginia Senate and House of Delegates Plans.

- a. Table 5 – 1991 State House Plan
- b. Table 6 – 1991 State Senate Plan
- c. Table 7 – 2001 State House Plan
- d. Table 8 – 2001 State Senate Plan

e. Table 9 – 2011 State House Plan

f. Table 10 – 2011 State Senate Plan

59. The compactness scores for the districts of the redistricting plans of the Virginia General Assembly following the last three Decennial Censuses are summarized on Table 3. This table lists the minimum, maximum, mean and standard deviation score for both the Reock Test and the Polsby-Popper Test. The 1991 compactness scores for the 1991 State Senate Plan which was the subject of the *Jamerson* litigation are shaded red and the scores for the current (2011) House of Delegates Plan are shaded green.

60. Comparing the compactness scores for these two shaded plans on Table 3 is the most relevant to determine if the 2011 House map meets the *Jamerson* standard. The Reock scores for these two maps are, essentially the same. The lowest Reock score for the 2011 House Plan of 0.14 is 0.02 higher than the lowest score for 1991 Senate Plan (0.12). The highest score for the 2011 House Plan (0.62) is only 0.01 lower than the highest score for the 1991 Senate Plan (0.63). The mean scores for the two maps are the same (0.36), as is the standard deviations (0.11).

61. The Polsby-Popper scores for these two maps are, essentially the same or better. The lowest Polsby-Popper score for the 2011 House Plan of 0.08 is 0.01 lower than the lowest score for 1991 Senate Plan (0.09). The highest score for the 2011 House Plan (0.55) is 0.12 greater than the highest score for the 1991 Senate Plan (0.43). The mean scores for the two maps are the same (0.24), and the standard deviation for the 2011 House Plan (0.09) is 0.01 lower than the 0.10 standard deviation for the 1991 Senate Plan. A lower standard deviation score is better.

62. In my expert opinion, the 2011 House of Delegates Plan falls within the discretionary range endorsed by the Virginia State Supreme Court in the *Jamerson* decision.

63. I have also compared the Reock and Polsby-Popper scores for the 2011 House of Delegates map to the same scores for the lower chambers of 8 additional Southern states following their 2010 Decennial Census redistricting. These states are Alabama, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina and South Carolina. These scores are found on the top section of Table 4. The same scores for the same states following the 2000 Decennial Census are found on the bottom section of Table 4.

64. Once again, in my expert opinion, Virginia's House of Delegates' Reock and Polsby-Popper scores compare closely with the other 8 states, which all contain numerous minority districts in their maps.

65. Plaintiffs also contend that lack of compactness is somehow indicative of impermissible attention to race when the 2011 House of Delegates Plan was drafted. Districts 74 and 95 are cited as examples of lack of compactness. There are, however four additional districts, with high percentages of non-Hispanic Whites which are similar in terms of compactness scores. These are Districts 13, 17, 22 and 48. They are arguably as lacking in compactness as Districts 74 and 95. The Reock and Polsby-Popper scores for these 6 districts are found on Table 14 and have similar combinations of both scores for both tests.

66. Maps 7 through 11 provide the outlines of the six districts found on Table 14. District 95, located in Hampton City and Newport New City, is on Map 7. District 74, located in Charles City County, Henrico

County and Richmond City is found on Map 8. District 48, located in Arlington and Fairfax Counties, and is found on Map 9. District 13, located in Prince William County and Manassas Park City, and is found on Map 10. Finally, Districts 17 (Botetourt, Roanoke County and Roanoke City) and 22 (Franklin, Campbell and Bedford Counties plus Lynchburg City), are found on Map 11.

PROBABLE REASONS FOR THE SHAPE OF DISTRICTS 74 AND 95

67. Once again, I should make it clear that I did not play any part in the drafting of the 2011 House of Delegates Plan HB 5055. But having 40 years of redistricting plan drafting experience places me in a unique position to ascertain possible motivation for the way individual districts have been crafted. I gave both District 74 and 95 a closer examination to understand why these two districts are configured as drawn.

68. First is the issue of total district population. Table 11 lists all 12 African-American Districts. The column on the right of Table 11 compares the 2010 Decennial population of each district, as it existed prior to the 2011 redistricting, to the ideal district populations for House districts being drafted in 2011. All but one of the 12 African-American districts were significantly under-populated in terms of the 2010 Decennial Census population numbers. Only district 74 was over-populated (by 0.18%) but just slightly. The cumulative under-population of the 12 districts was 98.95%. What this means is that because of the shifts in relative population across Virginia, the 12 African-American districts only contained enough population to draw 11 districts.

69. These districts were also clustered together so that needed areas of population had to be drawn in from neighboring districts, which could not also be African-American districts. Districts 92 and 95, in Hampton and Newport News were adjacent. Districts 77, 80, 89 and 90, in the Norfolk area were adjacent. Finally, the remaining 6 districts (63, 69, 70, 71, 74 and 75) were all adjacent in the greater Richmond Area. Those who have actually drafted redistricting plans in a legislative setting understand that these population issues cannot be solved in a vacuum. In other words, a legislative plan, particularly for a lower chamber, is a highly complex puzzle. Although every legislator would like to believe that the entire map should originate from his or her own district, many policy issues must be resolved to draft a map which can be enacted.

70. Another paramount issue is “core retention”. Almost every legislator wants to keep the majority of his, or her, old district in his, or her, new, district. There is also the issue of incumbent residences. Table 11 contains two district core retention factors. Column 2 shows the portion of the population of the old district which was retained in the new district. Column 3 shows the portion of the new district population which is from the old district. As is demonstrated from Table 11, the core retention rate for the 12 African-American districts was very high; even with the need to add significant new population to the 2011 districts.

71. Table 12 lists all 100 of the districts in the 2011 House of Delegates Plan HB 5005. Column 2 show the percentage of the new district population which was in the old district. One should note that three new House districts (2, 10 and 87) do not contain any of the

population of the old districts with the same number. They should be considered to have been collapsed and moved elsewhere in the State. This table does not consider those members whose residences are no longer in their new districts. A number of incumbents found their residences were now located in a new district with another incumbent's residence. The choice, of course, is either to move, run against the other incumbent, seek another political office, or retire. It should be noted that not one of the African-American incumbents was paired with another legislator and the core retention percentages for the African-American districts are higher than for the districts of the entire plan. This is another factor which influenced the shape and locations of these minority districts.

72. The new District 74 is located in almost the same place as the 1991 and 2001 District 74 (See Map 20 for a side-by-side version of all three districts). See Maps 4 and 13 for the location of the old and new District 74 and Map 19 for the location of 1991 District 74. All three versions of House District 74 (1991, 2001 and 2011) included Charles City County and extended in a long narrow configuration along the northeastern border of Henrico County. District 74 could have been withdrawn from Charles City County, but that would have produced a population ripple which could have disrupted the cores of the neighboring African-American districts. It is also important to note that the 2001 version of House District 74 extended into Hopewell City across the James River which, in my expert opinion, makes the 2011 version of District 74 superior in compactness to the 2001 version of that district. In 1991 the House of Delegates drew the districts, and they certainly did not subsequently object to District 74's configuration then. The

district configuration was not a nefarious scheme to violate civil rights. It was essentially pure redistricting politics, favoring the core retention of the districts of African-American incumbents.

73. The area between the York and James Rivers is commonly referred to as "The Peninsula". There are 6 districts located in the area bounded by western and northern boundary of James City County, the York River, the James River and Chesapeake Bay (Districts 91 to 96). On the 2001 map (See Map 18), old District 64 also crossed the James River into the Peninsula. When the 2011 Plan was drafted (See Map 17), there was not enough population for the new House District 64 to cross over the James River, but 6 new districts could be constructed within the portion of the Peninsula from James City southeast to the end of the Peninsula. That was exactly what the plan drafters did. It was a very logical solution. I have included Map 14, which is the old District 95. Old District 95 was the most underpopulated African-American district at -15.16%, was next to old District 92, which was 11.24% underpopulated.

74. The plan drafters, decided to convert District 93 into a GOP district and use the strong Democrat areas of the old District 93 to bring the population of new Districts 92 and 95 up within 1% of the ideal district population. The new District 93 was shifted north into the area which had been located in the old District 64. This left new Districts 91, 94 and 96 as GOP districts.

CONTIGUITY OF HB 5005

75. I have examined the 2011 House of Delegates Plan with respect to the requirement of contiguity and find no issues in this plan. No districts cross the wide tidal estuaries of the James, York and Rappahannock

Rivers and the only crossing of the Chesapeake Bay is from Northampton County to Norfolk City, which is required to give District 100 enough population (34,484) to bring it up to the ideal district population.

CONCLUSIONS

76. This map and the individual majority minority districts contained therein are at least as compact and contiguous as the 1991 and 2001 maps and individual majority minority districts which were approved under the Virginia constitutional standards in *Jamerson* and *Wilkins*.

77. This map is consistent with lower chamber maps in similarly situated states.

78. The high degree of individual district core retention in the 2011 House map was a major factor in the construction of the map. This is particularly the case with regard to the majority minority districts.

79. There was a high degree of protection extended to incumbents, particular in the case of minority incumbents and Republican incumbents.

80. There were no negative contiguity issues in HB 5005.

I declare under penalty of perjury that the foregoing is true and correct.

Executed this 10th day of April, 2015

/s/ Thomas Brooks Hofeller

Thomas Brooks Hofeller, Ph.D.

JA 1031

Exhibit 1

RESUME

Thomas Brooks Hofeller, Ph.D.

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Qualifications:

A varied career in government, business, academia and politics. Positions of significant responsibility, requiring intelligence, scholarship, communications skills, creativity and leadership include:

- Senior executive management of an office within a large government agency, planning and directing operations of a staff with a diverse number of missions while coordinating activities ranging across an entire agency.
- Successful completion of a Doctorate in Government requiring research and writing skills and the ability to communicate in an academic setting. Also includes a firm grounding in the philosophical and political roots of the American Governmental System.
- Litigation support and courtroom experience as a qualified expert witness in federal court. Clear presentation of difficult demographic and statistical concepts – making them understandable to non-technical audiences.
- Setting up a new U. S. House subcommittee and conducting oversight, developing legislation and interacting with leadership. Experience in statistical, demographic and budgetary analysis.

- Experience in management and information systems – including database construction, geographic information systems and creation of user interfaces that allow access by persons without extensive computer skills.
- Creating and managing small businesses, including budgeting, human resources, facilities management, accounting and shareholder interface.
- Strategic and tactical analysis of political and demographic data for campaigns and political organizations. Understanding of survey design and interpretation, political resource targeting, list development and use of direct mail.

Areas of Expertise:

- Operations: Recruiting, training and directing staffs for existing and newly instituted projects in government and national political organizations. Private sector experience as a business owner and CAO. Proven ability to organize and direct multiple projects with effective use of delegation. Able to function as a team player in both management and support positions.
- Communications: Ability to develop and deliver engaging and informative presentations involving difficult concepts and issues to decision-makers, the public and press. Effective in preparation of affidavits and exhibits as well as giving depositions and delivering courtroom testimony.
- Information Technology: Expertise in analysis of complex technical problems involving large

amounts of data – both for analysis and practical use in business, government and politics. Able to break down information and develop effective solutions. Ability to interface between highly technical personnel and management.

- Considerable experience in integration of mapping and data (geographic information systems).
- Budget & Programs: Experience in budget formulation and managing accurate accounting systems in the private and public sectors.

Education:

- Claremont Graduate University, Claremont, CA – Ph.D. in Government - 1980
- Claremont McKenna College, Claremont CA – B. A. in Political Science - 1970
- U. S. Navy, Electronics School, Treasure Island, CA, Graduate -1966

Publications:

- Thomas S. Engeman, Edward J. Erler and Thomas B. Hofeller (1980). The Federalist Concordance. Chicago: University of Chicago Press.
- Grofman, Bernard and Hofeller, Thomas B (1990). “Comparing the Compactness of California Congressional districts Under Three Different Plans”. In Bernard Grofman (ed) *Political Gerrymandering and the Courts*. New York: Agathon.
- Richard Niemi, Bernard Grofman, Thomas Hofeller, and Carl Carlucci (1990). Measuring

the Compactness and the Role of a Compactness Standard in a Test for Partisan Gerrymanderings”. *Journal of Politics*.

- Reports and affidavits prepared for, and testimony in, numerous court cases (listed below).

References:

Current and recent employer references are available and will be furnished upon request.

Experience:

Geographic Strategies LLC

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Partner

May 2011 – Present

- Geographic Strategies provides redistricting services clients including database construction, strategic political and legal planning in preparation for actual line drawing, support services and training on the use of geographic information systems (GIS) used in redistricting, analysis of plan drafts, and actual line-drawing when requested. The corporation and its principals also provide litigation support.

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1800 Diagonal Road, Suite 230
Alexandria, VA 22314
Redistricting Consultant
April 2011 – April 2012
Contracting Officer: J. Christopher Jankowski
Executive Director
(571-480-4861)

- Retained as a consultant to state legislatures and statewide elected officials in all aspects of their work on the 2011-2012 redistricting process.

Areas of consultation:

- Develop strategic and tactical plans for Legislatures and statewide elected officials to develop and defend redistricting plans for legislative and congressional districts.
- Providing assistance in actual redistricting plan drafting and analysis.
- Providing a linkage between complex legal standards and their practical application to plan drafting in difficult political and technical environments.
- Provide assistance in redistricting litigation
- Identification of specialized GIS software, database and hardware systems to be used by stakeholders.
- Ongoing strategic, technical and legal support to those involved in redistricting in all states.
- Development of a clearinghouse of redistricting activities throughout the nation and analysis of the effects of the process on future elections.

REBUPLICAN NATIONAL COMMITTEE

310 First Street, S.E.

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Redistricting Consultant

May 2009 – April 2011

Contracting Officer: John Phillippe

RNC Chief Counsel

(202) 863-8638

- Retained as a consultant to recreate a new department to coordinate the redistricting activities of the National Committee and the greater GOP community in preparation and execution of the 2011 redistricting Areas of responsibility and to support the Committee's 2011 through 2012 redistricting efforts:
 - Developed a strategic plan for the Committee to best position itself for maximum success in this highly competitive process.
 - Liaison and training with members of Congress, legislators, key statewide officials, state parties and other divisions within the Committee to ensure a high level of political, technical and legal preparation.
 - Recruitment and training of a technical and legal staff.
 - Providing a linkage between complex legal standards and their practical application to plan drafting in difficult political and technical environments
 - Identification of specialized GIS software, database and hardware systems to be used by the Committee and other stakeholders.
 - Ongoing strategic, technical and legal support to members of congress and those involved

in redistricting in all states, including plan drafting.

- Development of a clearinghouse of redistricting activities throughout the nation and analysis of the effects of the process on future elections.

DEPARTMENT OF AGRICULTURE FARM
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Associate Administrator for Operations and
Management

June 2004 – January 2009

Supervisor: Teresa C Lasseter, Administrator

Farm Service Agency

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- Associate Administrator providing management and oversight to staff with diverse missions supporting the activities of the entire Farm Service Agency (FSA).

Areas of responsibility:

- Provides oversight and guidance to the 1,100 person staff of the Deputy Administrator for Management. These functions include management services, human resources, financial management, budgeting, and information technology.
- Directs the activities of the Office of Civil Rights which performs all of the EEO functions for the Agency, as well managing FSA's diversity programs.
- Provides oversight and guidance to the Office of Business and Program Integration. This office supports a wide range of cross-cutting activities

including economic policy analysis, strategic planning, outreach, state and county office review, county service center integration, emergency planning, county office reviews and audits, e-Government, and program appeals and litigation.

- Has primary oversight of the business realignment process underway in the Agency. This realignment includes such projects as Agency-wide enterprise architecture development, field office realignment, and concurrent changes to the Agency's business processes. This realignment is necessary to allow the Agency to meet the present and future challenges involved in providing the best possible customers service and implementation the President's Management Agenda.
- Spearheads the ongoing reform of the FSA county committee election system which included the drafting of guidelines just published in the Federal Register.

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Operations and Management (retired)
(301) 424-5776

- Director of a senior level office directing the activities of subordinate staffs with diverse missions supporting the overall activities of the Farm Service Agency.

Areas of responsibility:

- Provided oversight and guidance to the 75-person staff of the Office of Business and Program Integration. This office supported a wide range of cross-cutting activities including economic policy analysis, strategic planning, outreach, state and county office review, county service center integration, emergency planning, county office reviews and audits, e-Government, and program appeals and litigation.
- Directed the development of administrative strategies essential to the successful management of e-Government initiatives. Coordinated citizen-centered eGovernment initiatives.
- Provided centralized direction for the Agency's strategic plan in compliance with the Government Performance and Results Act of 1993.
- Coordinated outreach efforts for all FSA programs to enhance participation of small or limited resource farmers and ranchers to provide equal access to programs striving to acquire and maintain economic viability for family farmers and ranchers.
- Directed the preparation of policies and dockets on national program determinations to be submitted for CCC Board consideration and Federal Register publications.

REPUBLICAN NATIONAL COMMITTEE

310 First Street, S.E.

Washington, DC 20003

Redistricting Director

Jul. '99 – Mar. 2003

Supervisor: Thomas Josefiak, former RNC Chief

Counsel

(703) 647-2940

- Hired to create a new department to coordinate the redistricting activities of the National Committee mandated by the release of data from the 2000 Decennial Census.

(See the description of present position.)

U.S. HOUSE SUBCOMMITTEE ON THE CENSUS

Staff Director

Feb. '98 – Jul. '99

Supervisor: Hon. Dan Miller, Chairman

(202) 225-5015

- Staff Director at inception of this oversight subcommittee, created by the House in February of 1998, to monitor the preparations for and the execution of the 2000 Decennial Census. Directed all day-to day operations of the subcommittee including:
 - Recruitment and training of a staff for a new subcommittee.
 - Liaison with the Director and Senior Staff of the Census Bureau, the Department of Commerce, and U.S. Senate Staff involved in census oversight.
 - A complete examination of the preparations underway at the Census Bureau for conduct of the 2000 Decennial Census.

- An examination of the proposed statistical methods proposed by the Bureau to improve coverage of the Census.
- Reviewed and made recommendations to the Chairman and House Leadership regarding census policy.
- Coordination with Government Accounting Office personnel involved in census oversight.
- Preparation and support for oversight hearings conducted by the members of the Subcommittee.
- Interface between the academic statistical community and the subcommittee in the development of census policy.
- Liaison with census stakeholders in general, with particular attention to members of the Decennial Census Advisory Committees.

U.S. HOUSE COMMITTEE ON HOUSE
OVERSIGHT

Professional Staff

Nov. '97 – Feb. '98

Supervisor: Hon. William M. Thomas, Chairman
(202) 225-2915

- Involved in the oversight activities of the Committee that supervises the operations of the U.S. House of Representatives. Advised the Chairman and House Leadership on congressional policy with regard to all census operations prior to the establishment of the Subcommittee on the Census.

PARTES CORPORATION

Kirkland, Washington

Director of Administration

Mar. '96 – Nov. '97

Supervisor: Mark Schnitzer, Chairman

- Chief Administrator of a software development company specializing in the creation of databases used by investment professionals to analyze information on securities.

Information was downloaded, parsed, and reformatted from the Securities and Exchange Commission's EDGAR database and other relevant sources. Was responsible for all administrative functions of the corporation including:

- Procurement, renovation and management of facilities housing the company.
- All human resource activities.
- Accounting and payroll.
- Liaison with attorneys and shareholders.

CAMPAIGN MAIL & DATA, INC

Falls Church, Virginia

Professional Staff

Nov. '93 – Mar. '96

Supervisor: John Simms, President

(703) 790-8676

- Supervised development and maintenance of geographic databases that were integrated with the company's various political and commercial lists. Created a new department that collected and converted voter lists from states, counties and towns.

NATIONAL REPUBLICAN CONGRESSIONAL
COMMITTEE

320 First Street, S.E.
Washington, DC 20003

Redistricting Director

Mar. '89 – Nov. '93

Supervisor: Maria Cino, Chief of Staff

- Created a new department to coordinate the redistricting activities of the NRCC and provide support to all GOP members of the U.S. House and their staffs.

Areas of responsibility:

- Recruitment and training of a technical staff.
- Development of specialized GIS software, databases and hardware systems to be used by the Committee and members of Congress.

REPUBLICAN NATIONAL COMMITTEE

310 First Street, S.E.
Washington, DC 20003

MIS Director

Jan. '82 – Mar. 89

- Transformed the Committee's computer capabilities from a single mainframe system operated completely within a computer division into a building-wide network, utilized by all divisions and from remote locations. Supervised all the Committee's data processing activities, including database and software development. Directed research activities involving analyses of demographic and election data. Primary computer consultant to the GOP's state and county party organizations.

ROSE INSTITUTE OF STATE AND LOCAL
GOVERNMENT

Claremont McKenna College

Claremont, California

Associate Director

1973 – 1981

- Co-Founder of this Southern California research center specializing in the examination of current financial and political issues affecting California's state and local governments. Supervised staff and day-to-day operations, directed software and database development, managed research projects and assisted in fundraising.

COMPASS SYSTEMS, INC.
AND LOCAL GOVERNMENT

San Diego, California

Vice President

1970 – 1973

- Part of the management team that developed the first computerized geographic mapping and data retrieval system used by the California State Assembly for redistricting and demographic analysis. Directly supervised programming and database development staffs.

UNITED STATES NAVY

Petty Officer 2nd Class

1965 – 1969

- Electronics Technician. Served on USS Porterfield, DD682, in Tonkin Gulf operations during Vietnam War. (Honorable Discharge)

Summary of Participation in Lawsuits:

Shaw v. Hunt, 92-202-CIV-5-BR, U.S. District Court for the Eastern District of North Carolina, Raleigh Division (1993-4)

This case was the second trial phase following the U.S. Supreme Court's reversal of the lower court in *Shaw v. Reno* (1993). Prepared alternative plans for presentation to the court. Prepared political and demographic analyses of the state's plans, along with numerous exhibits supporting the plaintiffs' complaints. Gave a deposition and served as plaintiffs' primary expert witness at trial.

Arizonans for Fair Representation v. Symington, CIV 92-0256, U.S. District Court Arizona (1992), aff'd mem. sub nom. *Arizona Community Forum v. Symington*, 506 U.S. 969 (1992)

Prepared an affidavit evaluating the three major plans submitted to court for redistricting of Arizona's six congressional districts. Plans were examined with regard to all major redistricting criteria. Also examined minority voting strength in proposed new sixth district in State Senate Plan. Gave expert testimony in trial phase. Drafted a new map for presentation in court that was adopted, with minor changes, by the three-judge panel.

De Grandy v. Wetherell, No 92-40015-WS, U.S. District Court Florida (1992)

Prepared model plans and submitted affidavits evaluating alternative plans for two of the parties in the congressional phase of the case and gave testimony on the political and voting rights implications of various other plans. Presented an affidavit and gave expert testimony in the legislative phase of the case for the De Grandy plaintiffs.

Good v. Van Straten, 800 F. Supp. 557, U.S. District Court Eastern & Western Michigan (1992)

Prepared compactness analysis of plans submitted to court to redistrict Michigan's congressional districts. Gave testimony on compactness theories and other relevant redistricting criteria.

Pope v. Blue, U.S. District Court Western District of North Carolina (1992)

Prepared an affidavit containing compactness analysis and political analysis of the plan passed by North Carolina Legislature and approved by U.S. Department of Justice.

Ketchum v. Byrne, 740 F.2d 1398, cert. denied *City Council of Chicago v. Ketchum*, 471 U.S. 1135 (1985), on remand, *Ketchum v. City of Chicago* 630 F. Supp. 551 (N.D. Ill. 1985)

Consultant to African-American plaintiffs (P.A.C.I.). Assisted in building Plaintiffs' political and demographic database, performed a racial and ethnic analysis of City of Chicago, gave a deposition, and testified in court. Participated in second remedy phase of case, gave a second deposition, was prepared to give testimony (the case was settled before retrial).

Carrillo v. City of Los Angeles, No. CV-85-7739 JMI-JRX (unreported) (C.D. Cal. 1986)

Consultant to Mexican American Legal Defense Fund (MALDEF). Constructed database, performed analysis of ethnic voter registration levels, analyzed various plans submitted by all parties, submitted affidavit to the court.

McNeil v. Springfield School District, 656 F. Supp. 1200, 66 F. Supp. 1208 (C.D. Ill 1987), 851 F.2d, 937 (7th Cir. 1988)

Consultant to counsel for Springfield School Board. Constructed demographic database, performed analyses on various proposed districts, gave deposition, presented affidavit to court. Prepared an analysis determining levels of African-American voting strength in proposed districts.

State of Mississippi v. United States, 490 F. Supp. 569 (D.C.D.C. 1979)

Principle consultant to Joint Reapportionment Committee of Mississippi State Legislature. Compiled data-bases, drew plans, prepared analysis for the legislature, and gave general redistricting advice to Committee Chairman and Counsel. Gave an extensive deposition and testified before the District Court in DC. Assisted in the preparation of all briefs.

Badham v. Eu, 568 F. Supp. 156; 721 F.2d 1170 (1983); – F.Supp. – (Apr. 21 1988), appeal docketed, No. 87-1818 56 U.S.L.W. 3791 (U.S. May 4 1988)

Principle technical consultant to counsel for Badham Plaintiffs and Republican National Committee. In charge of all database construction, development of sample court plans, analyses of Burton Plans and preparation of maps, charts and other materials for trial. Submitted affidavits.

Bandemer v. Davis, 478 U.S. 109 (1986)

Consultant to counsel for amicus, Republican National Committee. Prepared a demonstration plan for brief submitted to U.S. Supreme Court.

California Legislature v. Reinecke, 6 Cal. 3d 595 99 Cal. Rptr. 481, 492 P.2d 385 (1972)

As consultant, drafted redistricting plan for California State Senate and Assembly that were subsequently accepted by California Redistricting Commission.

Jordan v. Winter, 541 F. Supp. 1135 (N.D. Miss. 1982)

Performed analyses and gave court testimony on behalf of the defendants.

Gingles v. Edmisten, 590 F. Supp. 345 (N.D.N.C. 1984), aff'd in part and rev'd in part *Thornburg v. Gingles* 478 U.S. 30 (1986)

Consultant to Attorney General. Performed demographic analysis of state with regard to creation of African-American districts for North Carolina General Assembly. Gave deposition and testified in court on behalf of Legislature.

City of Port Arthur v. United States, 459 U.S. 159 (1982)

Consultant to City Attorney. Performed analysis of racial content of City Council Districts. This was required for the case required because the 1980 Decennial Census data were not yet available. Analysis required extensive residential survey to determine racial characteristics of individual districts. Gave a deposition in the case.

Ryan v. Otto, 661 F.2d 1130 (7th Cir. 1981)

Consultant to Republican plaintiffs and Illinois Congressional Delegation. Drew alternative plans for presentation to Court, gave deposition and testimony.

Rybicki v. State Board of Elections, 584 F. Supp. 849 (N.D. Ill. 1984)

Principle technical consultant to State House of Representatives and the Senate Minority Caucus.

Supervised construction of all political and demographic databases. Responsible for design and programming of House's computerized redistricting information system. Analyzed and drafted numerous redistricting plans. Gave depositions and testified at trial.

La Comb v. Growe, 541 F. Supp. 145 (D.Minn.), *aff'd* sub nom. *Orwall v. La Comb*, 456 U.S. 966 (1982)

Consultant to Minority members of Congressional Delegation. Drafted a plan for presentation to Court and submitted an affidavit.

Karcher v. Daggett, 462 U.S. 725 (1983), 467 U.S. 1222 (1984)

Participated in presentation of briefs on Republican side. Consultant to members of New Jersey Congressional Delegation.

Flanagan v. Gillmor, 561 F. Supp. 36 (S.D.Ohio 1982)
Brown v. Brandon, (unreported), (S.D.Ohio Jan. 30, 1984), as modified (Feb. 13, 1984), *aff'd* 467 U.S. 1223 (1985)

Consultant to State Legislature. Modified 1981 congressional district redistricting plan to conform to "one person, one vote" standard imposed by decision of the Court.

Massachusetts Republican State Committee v. Connolly, 679 F. Supp. 109 (D. Mass. 1988)

Consultant to counsel for plaintiffs. Examined evidence submitted in regard to 1985 Massachusetts State Census (particularly for Boston), analyzed legislative redistricting plan, submitted affidavit, gave deposition.

Sinkfield v. Bennett, Civil Action CV 93-689-PR
(Circuit Court of Montgomery County, Alabama)

Gave testimony supporting the replacement of the Alabama congressional plan drawn by the Federal Court with a plan drawn by the Circuit Court.

Mississippi State Conference of the NAACP v. Haley Barbour, Civil Action No. 3:11-ev-159 TSL-EGJ-LG
(SD Mississippi, Jackson Division – 2011)

Prepared a declaration for the intervenors analyzing the compactness and deviations of various legislative plans submitted to the Court for consideration.

Dickson v. Rucho, Civil Action 11 CVS 16896 and
North Carolina State Conference of the NAACP v. State of North Carolina, Civil Action 11CVS 16940 (General Court of Justice, Superior Court Division, Raleigh, North Carolina – 2011)

Submitted two affidavits and gave a deposition concerning my role as a consultant to the General Assembly with regard to the redistricting of North Carolina State Senate and State House of Representative districts as well as the redistricting of that state's congressional districts. Testified at hearing before 3-judge panel.

Boone v. Nassau County Legislature, Civil Action CV 11-cv 02712 (Supreme Court of the State of New York, County of Nassau - 2011)

Prepared an affidavit evaluating the 2011 redistricting plan enacted by the Nassau County Legislature and other sample plans presented by the Plaintiffs, with particular attention to the efficacy of the use of the U.S. Census Bureau's American Community Survey for measuring compliance with the provisions of Section 2 of the Federal Voting Rights Act.

Petteway v. Henry, Civil Action CV 11-411 (SD Texas, Galveston Div. 2011)

Prepared and presented at trial an alternative redistricting plan Galveston County's commissioner districts to the court for defendant intervenors.

Pearson v. Koster, Civil Action 11AC-CC00624 (Circuit Court of Cole County, Missouri, Div. I - 2012)

Prepared an affidavit evaluating the compactness of Missouri's newly enacted congressional districts (2011) in light of the State Supreme Court's remand of this case for determination of whether or not, in light of Plaintiffs' alleged claims to the contrary, the districts reflected in H.B. 193 were sufficiently compact to meet the requirement contained in the Missouri Constitution that districts be "composed of territory as compact as may be." Served as the expert witness at trial for the defendant intervenors.

Bob Johnson v. State of Missouri, Civil Action 12AC-00056 (Circuit Court of Cole County, Missouri 2012)

Prepared an affidavit analyzing the compactness and deviations of the enacted State House of Representative districts.

Harris v. Arizona Independent Redistricting Commission, Civil Action cv-12-0894-PHX-ROS (United States District Court, District of Arizona 2012)

Prepared affidavits analyzing the state legislative districts enacted by the Arizona Independent Redistricting Commission concerning population deviations, ethnic and racial characteristics and adherence to other neutral redistricting criteria. Presented expert testimony at trial.

Cynthia Hauser v. Martin O'Malley, Civil Action September Term 2012, Misc. No 5 – 2012, (Maryland Court of Appeals)

Prepared a declaration analyzing the State Senate and State House of Maryland enacted by the Governor following the 2010 Census and comparing both plans to senate and house plans submitted by plaintiffs.. Conclusions were made concerning the integrity of county lines, and district deviations as well as adherence to the provisions of the federal Voting Rights Act.

Kermit L. Moore, Jr. v. State of Tennessee, In the Chancery Court Case No. 120402-III (2012)

Prepared an affidavit analyzing the State Senate redistricting plan enacted by the Legislature for the 2012 elections and compared it to a plan submitted as a bill by the opposition. Conclusions were made analyzing the compliance of both plans with the federal and state provisions of one-person/one vote.

David Harris v. Patrick McCrory, Civil Action No. 1:13 CV-00949 (United States District Court, Middle District of North Carolina Durham Division 2013)

Retained by Defendant's counsel to prepare a declaration in response to plaintiffs' expert report' concerning the congressional redistricting plan enacted by the North Carolina General Assembly in 2011. Gave a deposition concerning the construction and characteristics of the congressional district contained in the enacted plan as well as other relevant congressional maps.

Terry Petteway v. Galveston County, Texas, Civil No. 3:-cv-00308, United States District Court, Southern district of Texas, Galveston Division 2013)

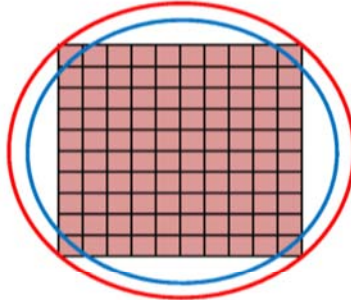
Retained by Defendant's counsel to prepare a redistricting map for Galveston County's Justice of the

Peace Precincts, prepared a declaration in response to plaintiffs' experts' reports and gave testimony at trial.

North Carolina State Conference of the NAACP v. Patrick Lloyd McCrory, 1:13 CV-658 (United States District Court, Middle District of North Carolina 2013)

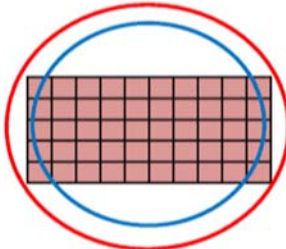
Retained by Defendant's counsel to prepare an expert report summarizing a study of information from the voter files of North Carolina's State Board of elections as compared to the North Carolina Department of Motor Vehicles' (DMV) customer file as well as locations of DMV offices proximity to potential registered voters who do not appear to have drivers licenses or DMV ID,s Performed and analyses of demographics and registration information with regard to this information. Analyzed the locations and hours of one-stop voting centers.

FIGURE 1
HYPOTHETICAL LEGISLATIVE DISTRICTS A, B & C
Showing Reock and Polsby Circles



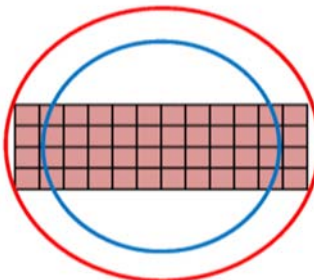
DISTRICT A

Reock Circle is Red. Reock Score is 0.6367
Polsby-Popper Circle is Blue. Polsby-Popper Score is 0.7853



DISTRICT B

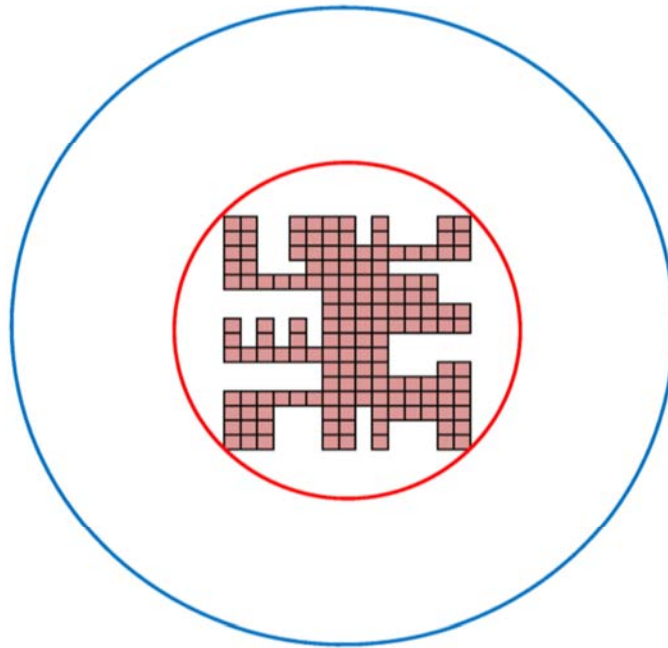
Reock Circle is Red. Reock Score is 0.509
Polsby-Popper Circle is Blue. Polsby-Popper Score is 0.698



DISTRICT C

Reock Circle is Red. Reock Score is 0.380
Polsby-Popper Circle is Blue. Polsby-Popper Score is 0.589

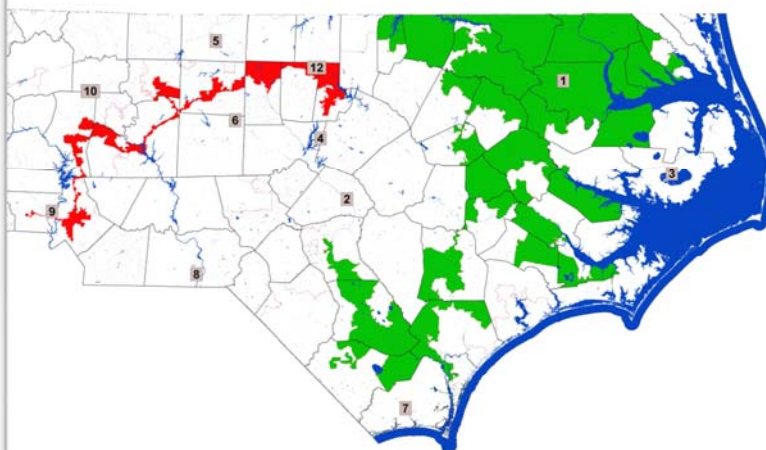
FIGURE 2
HYPOTHETICAL LEGISLATIVE DISTRICT D
Showing Reock and Polsby Circles



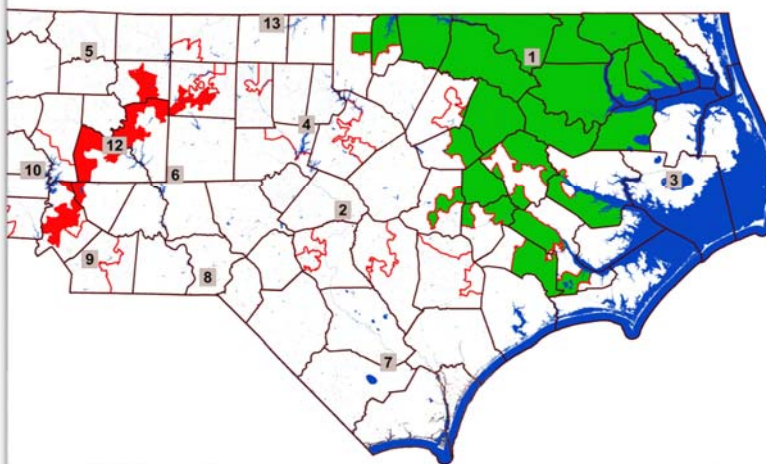
Reock Circle is Red. Reock Score is .405

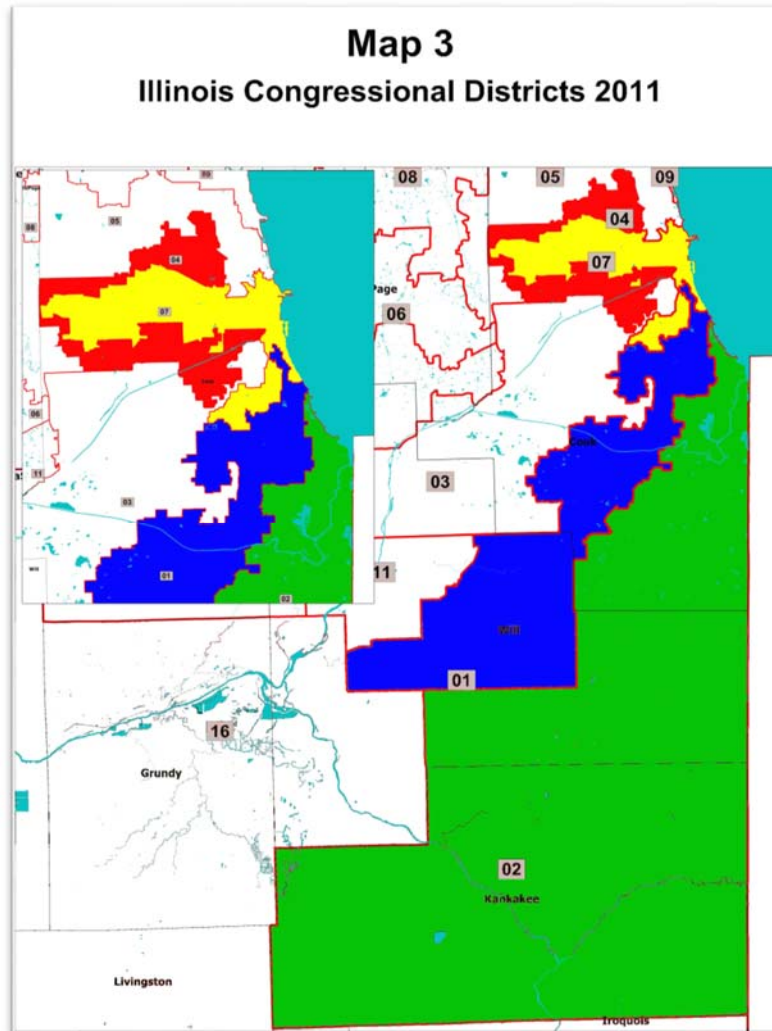
Polsby-Popper Circle is Blue Polsby-Popper Score is .082

Map 1
North Carolina Congressional Districts 1992



MAP 2
North Carolina Congressional Districts 2001



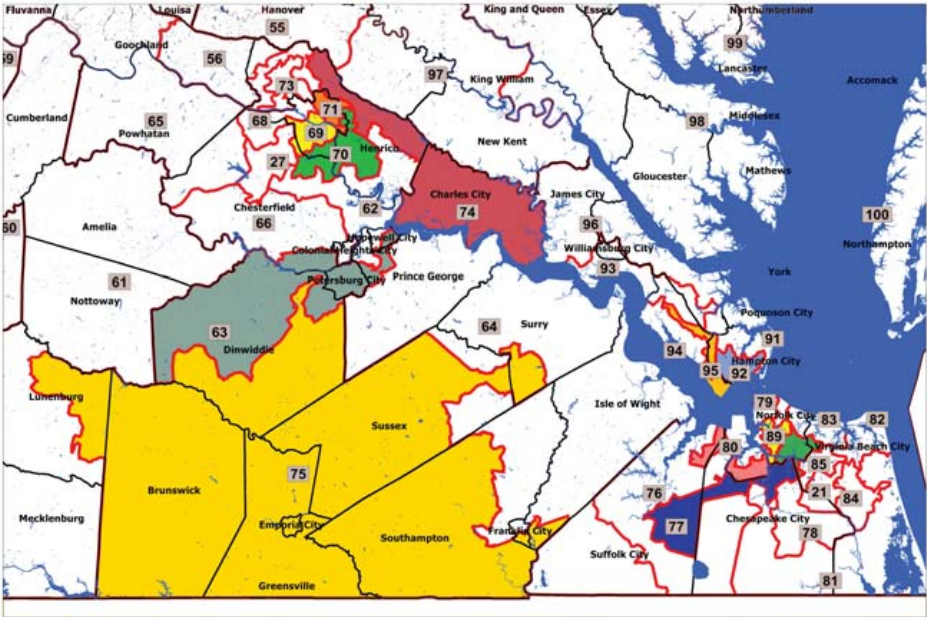


JA 1058

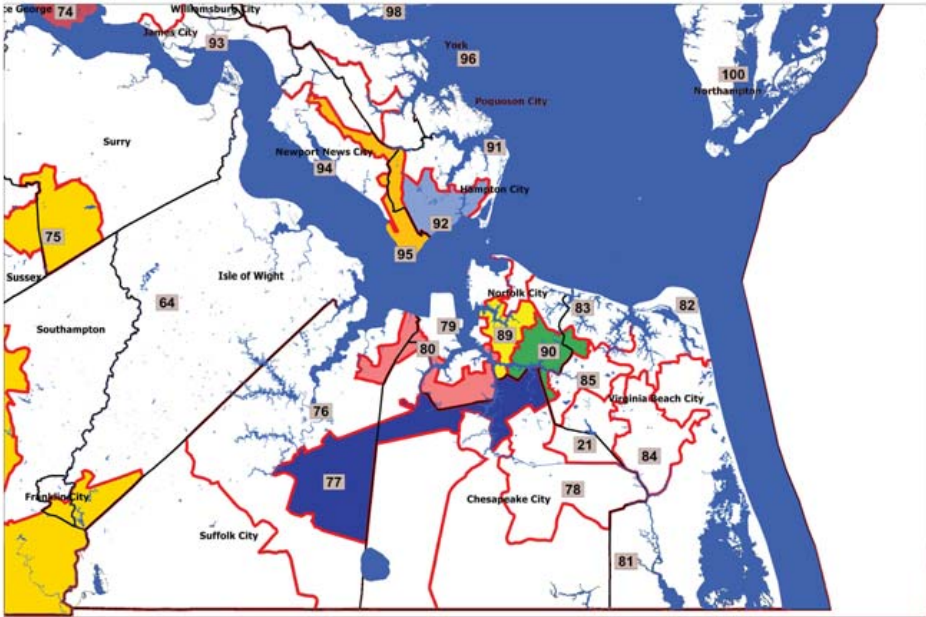
(See foldout next page)

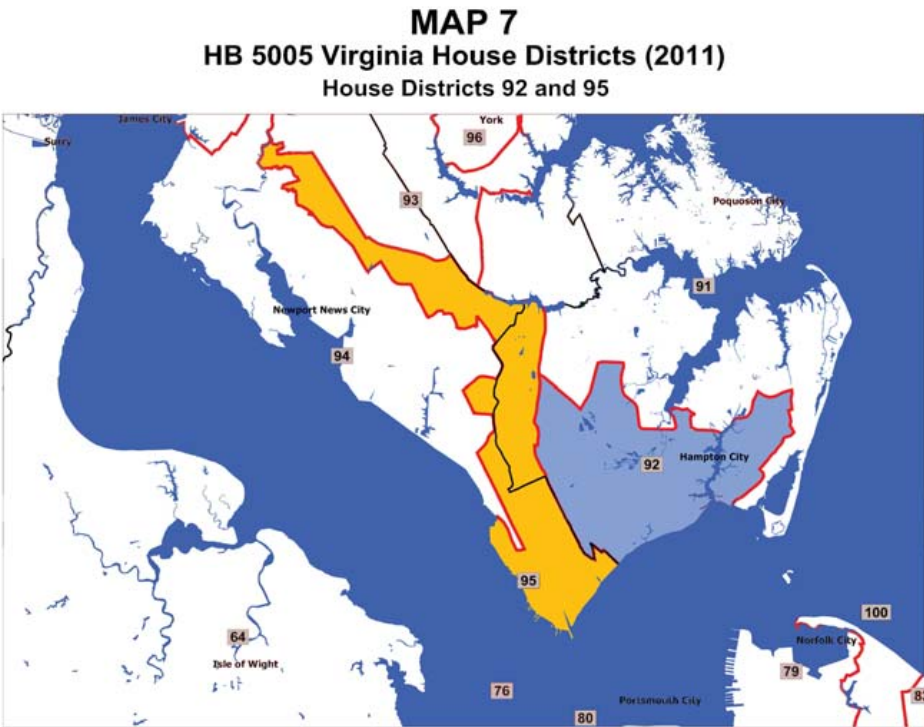
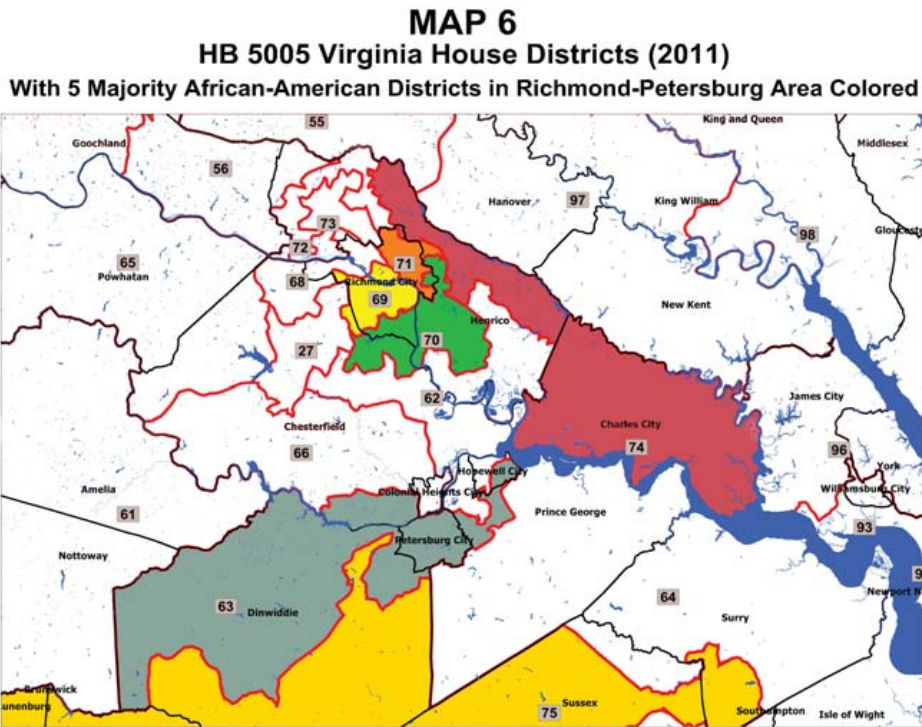
JA 1059

MAP 4
HB 5005 Virginia House Districts (2011)
With 12 Majority African-American Districts Colored



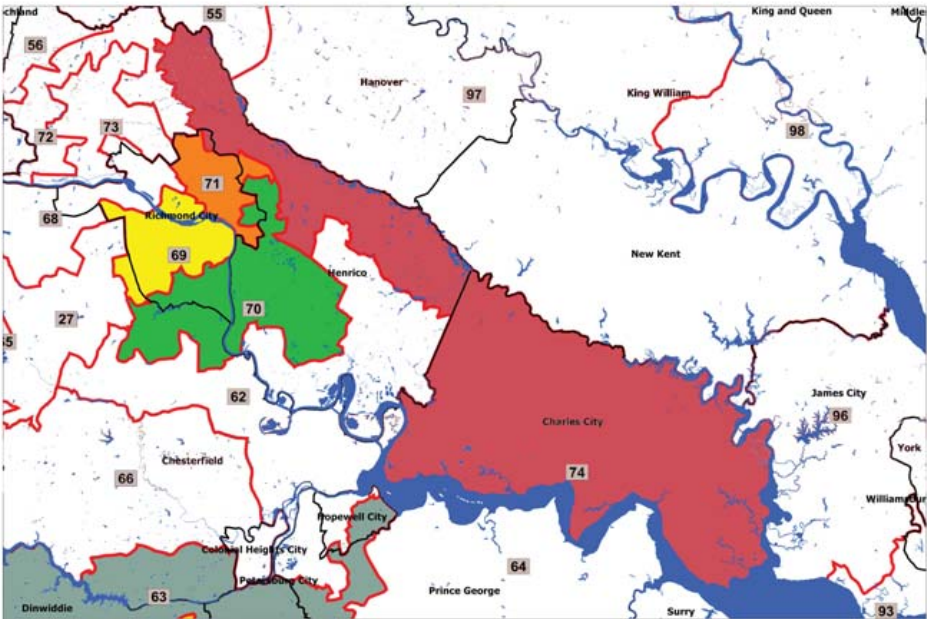
MAP 5
HB 5005 Virginia House Districts (2011)
With 6 Majority African-American Districts in Norfolk Area Colored



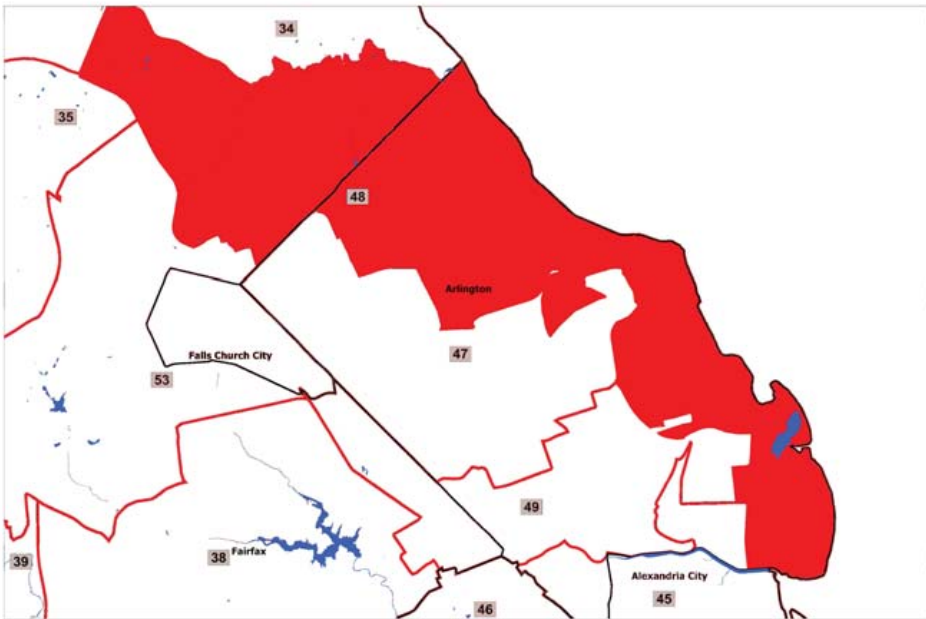


JA 1061

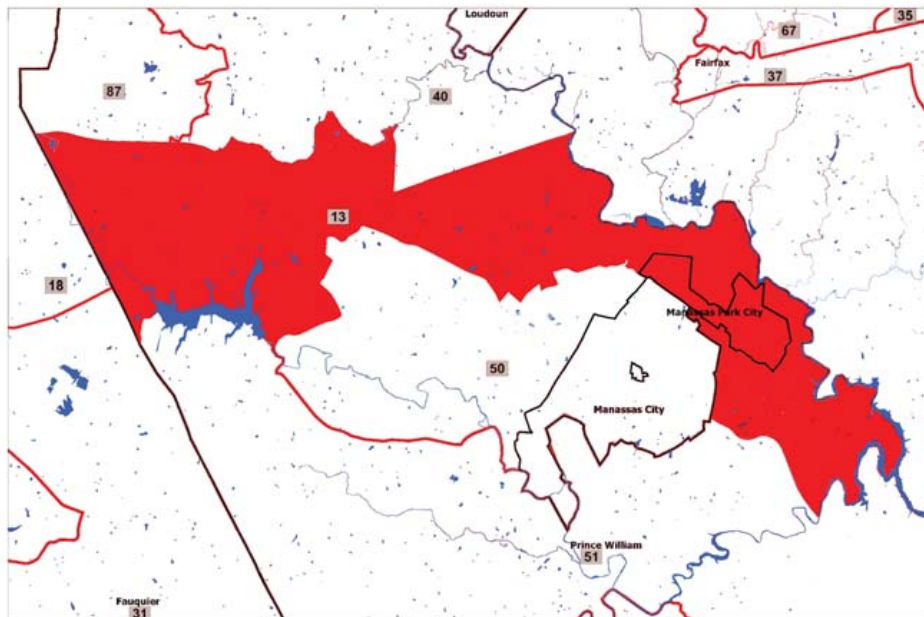
MAP 8
HB 5005 Virginia House Districts (2011)
House District 74



MAP 9
HB 5005 Virginia House Districts (2011)
House District 48

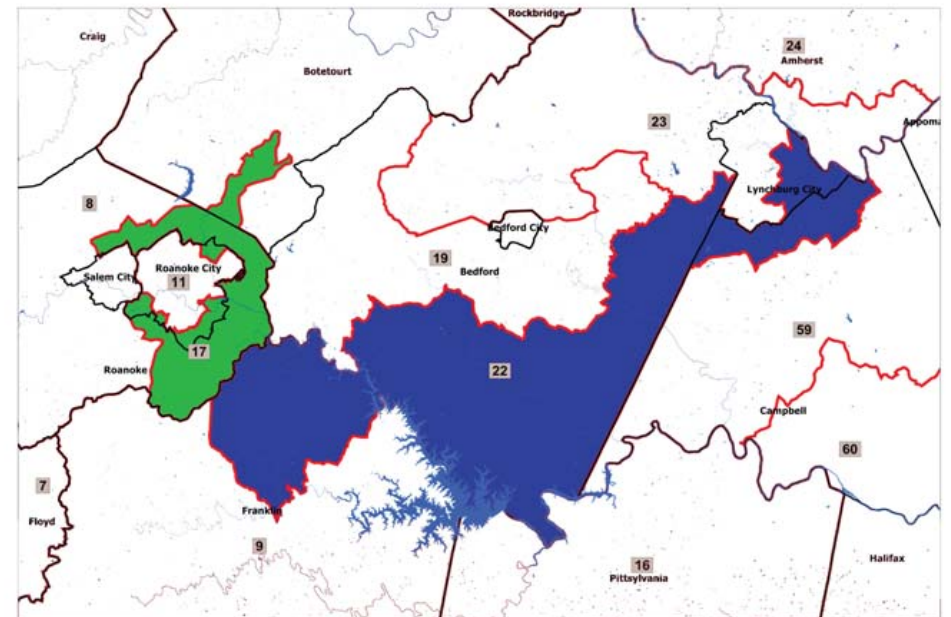


MAP 10
HB 5005 Virginia House Districts (2011)
House District 13



DEFENDANT-INTERVENORS TX 014 - Page 050

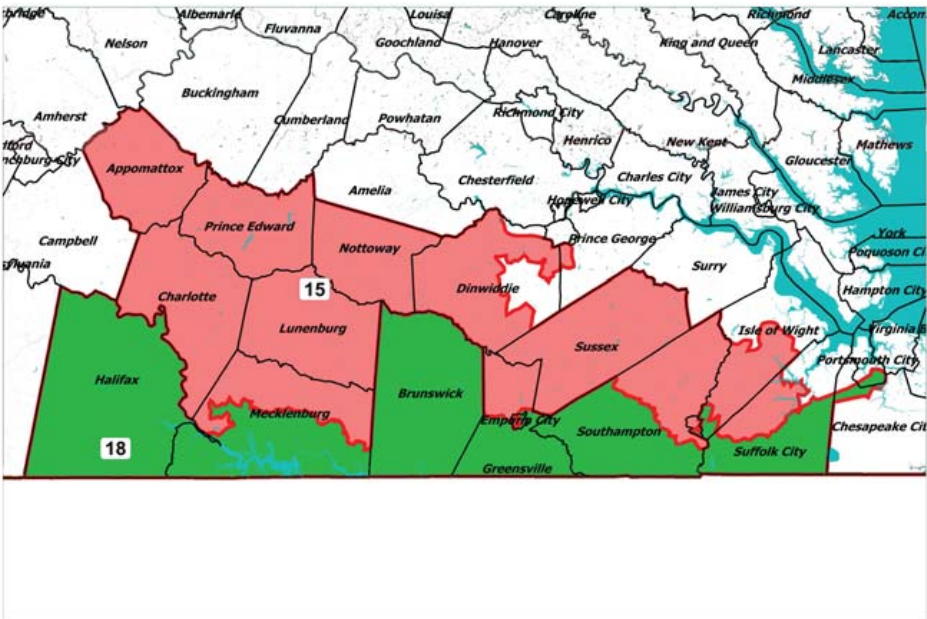
MAP 11
HB 5005 Virginia House Districts (2011)
House Districts 17 & 22



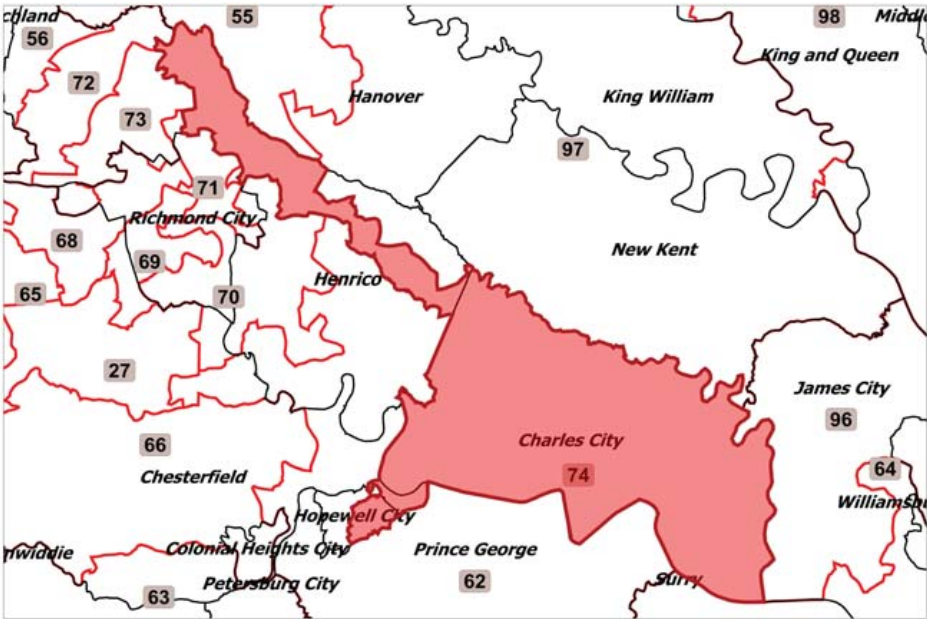
DEFENDANT-INTERVENORS TX 014 - Page 051

JA 1063

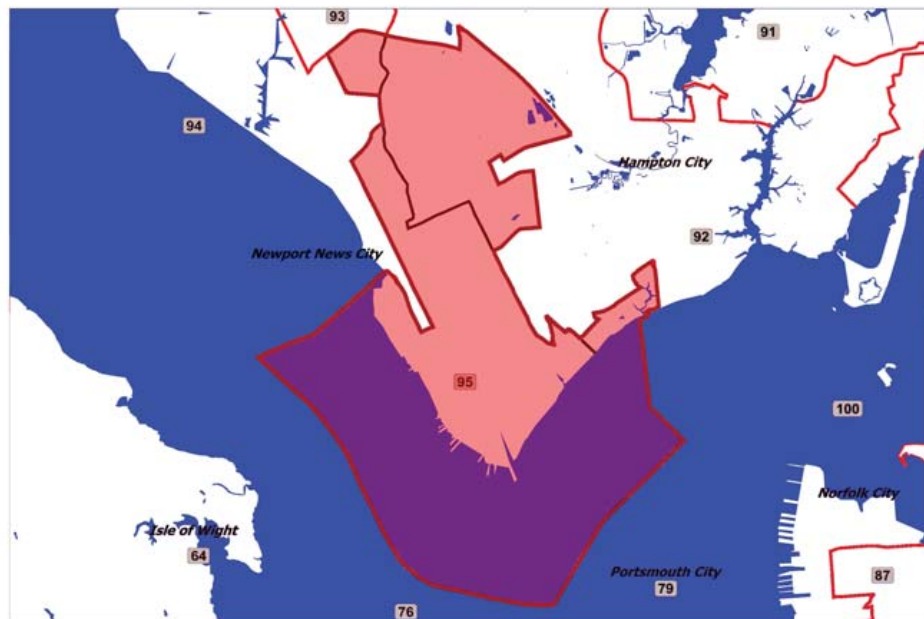
MAP 12
1991 State Senate Districts
Senate Districts 15 & 18



MAP 13
2001 State House Districts
House District 74

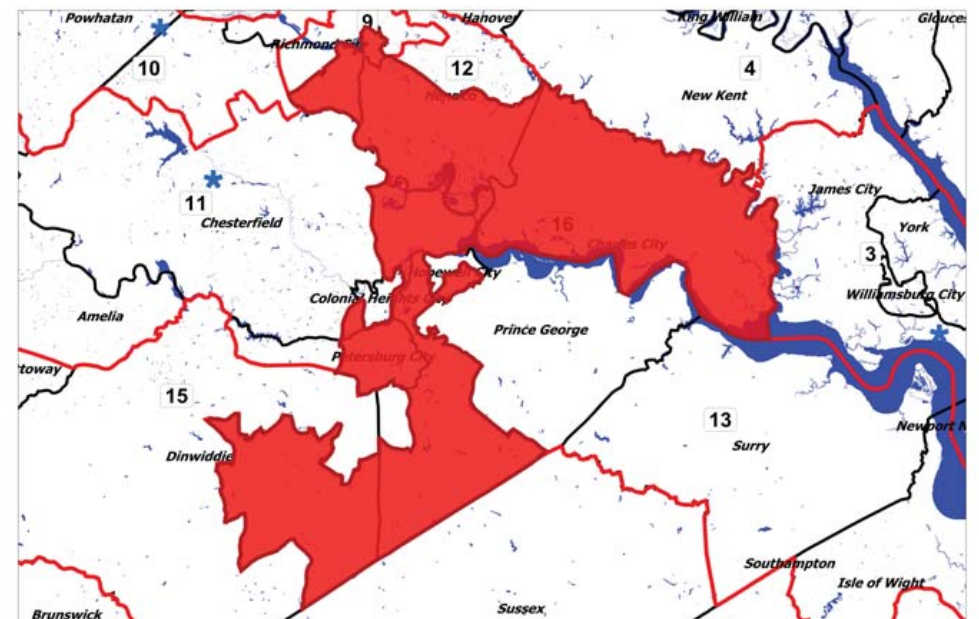


MAP 14
2001 State House Districts
House District 95



DEFENDANT-INTERVENORS TX 014 - Page 054

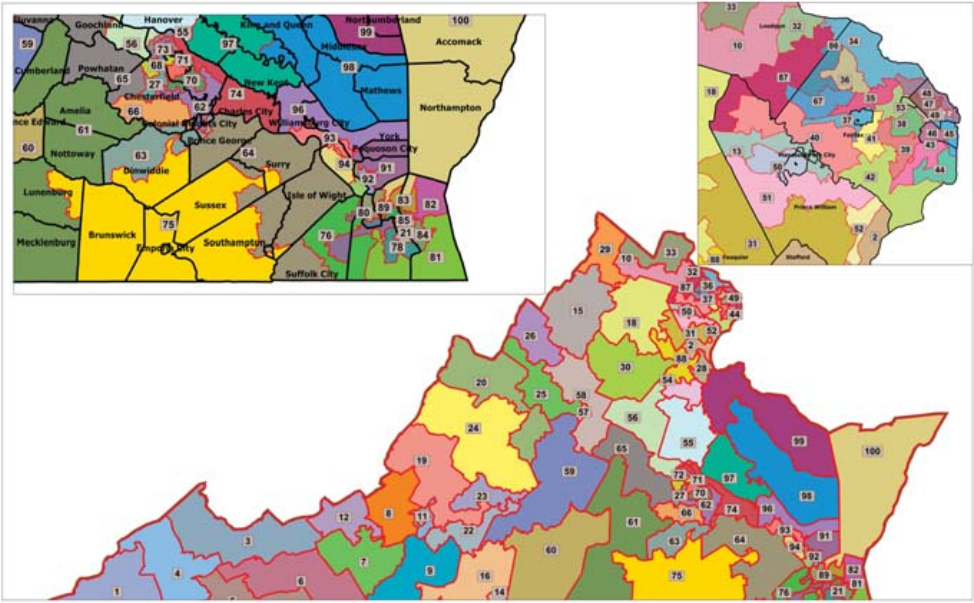
MAP 15
1991 SENATE DISTRICT 16



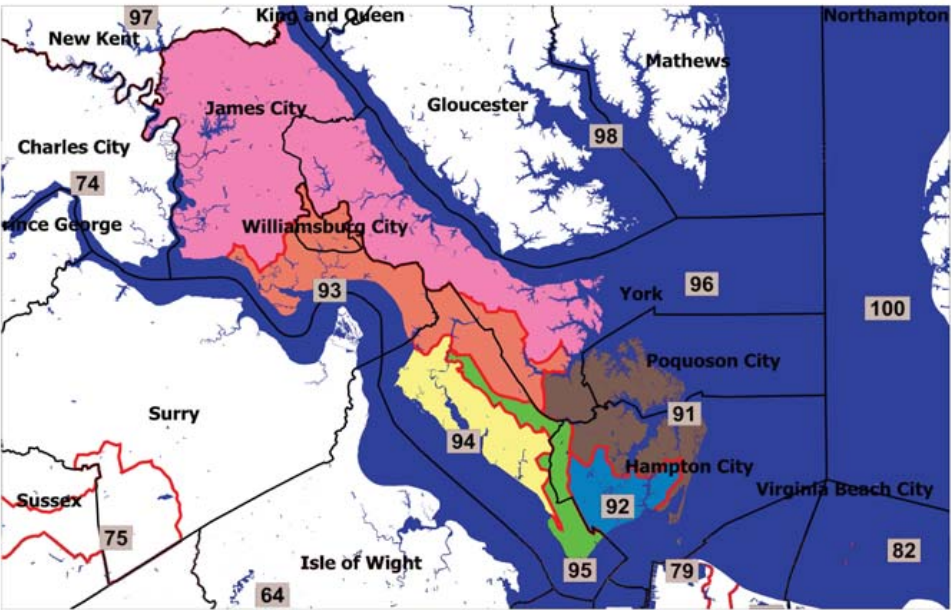
DEFENDANT-INTERVENORS TX 014 - Page 055

JA 1065

MAP 16
2011 Virginia House Districts - HB 5005

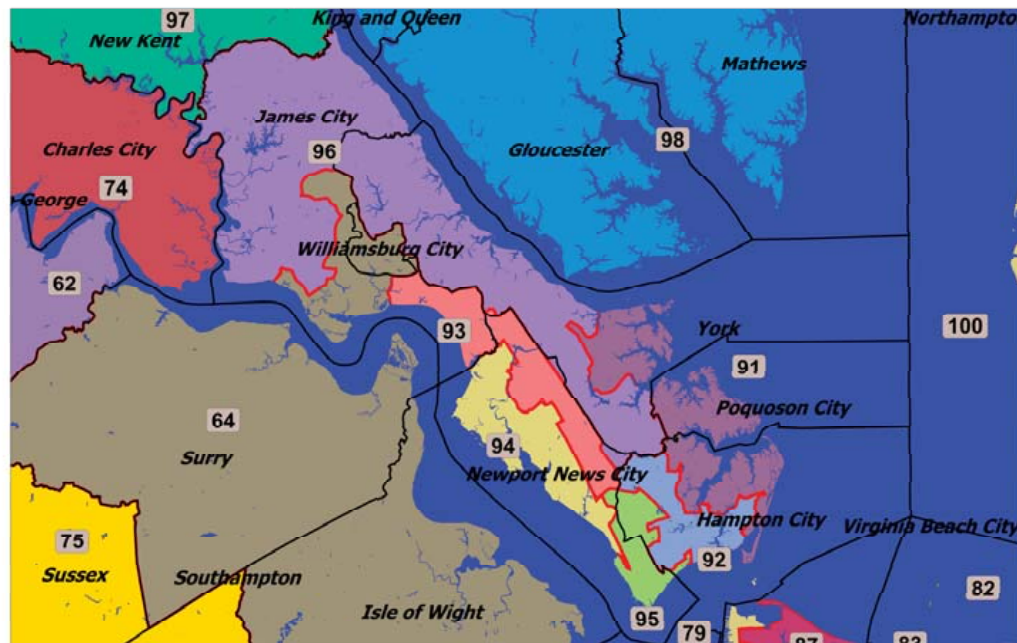


MAP 17
2011 HOUSE DISTRICTS - THE PENINSULA



MAP 18

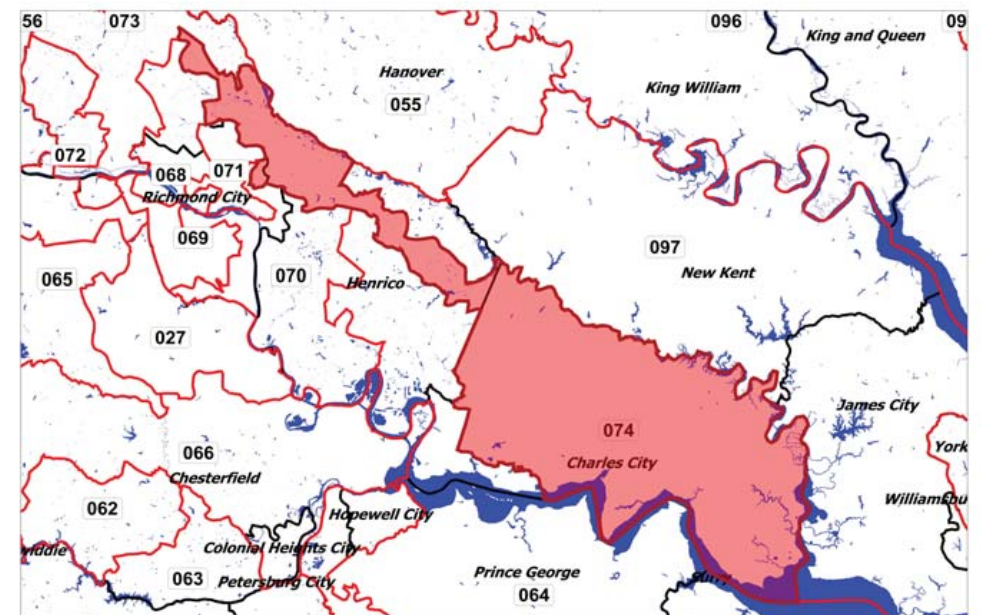
2001 HOUSE DISTRICTS ON "THE PENISULA"



DEFENDANT-INTERVENORS TX 014 - Page 058

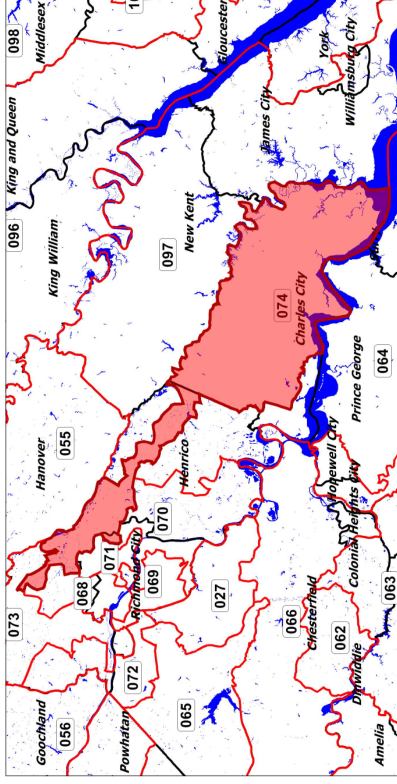
MAP 19

1991 House of Delegates District 74



DEFENDANT-INTERVENORS TX 014 - Page 059

Comparison of House District 74 in 1991, 2001 & 2011

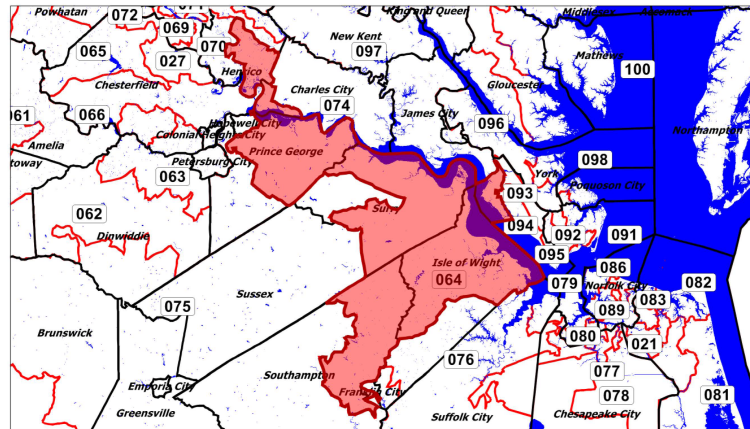


A map of the New Kent County area in Virginia. The map shows several towns and roads. The towns labeled are Gloucester, James City, York, Williamsburg City, Charles City, New Kent, Hanover, Henrico, Richmond City, Powhatan, Goochland, Amelia, and Dinwiddie. The roads are numbered with black boxes containing white numbers: 98, 96, 93, 97, 74, 64, 56, 71, 70, 69, 68, 67, 66, 65, 63, 62, 61, 55, 54, 53, 52, 51, 50, 49, 48, 47, 46, 45, 44, 43, 42, 41, 40, 39, 38, 37, 36, 35, 34, 33, 32, 31, 30, 29, 28, 27, 26, 25, 24, 23, 22, 21, 20, 19, 18, 17, 16, 15, 14, 13, 12, 11, 10, 9, 8, 7, 6, 5, 4, 3, 2, 1. The map also shows the James River and the York River. The area around Charles City is shaded in red.

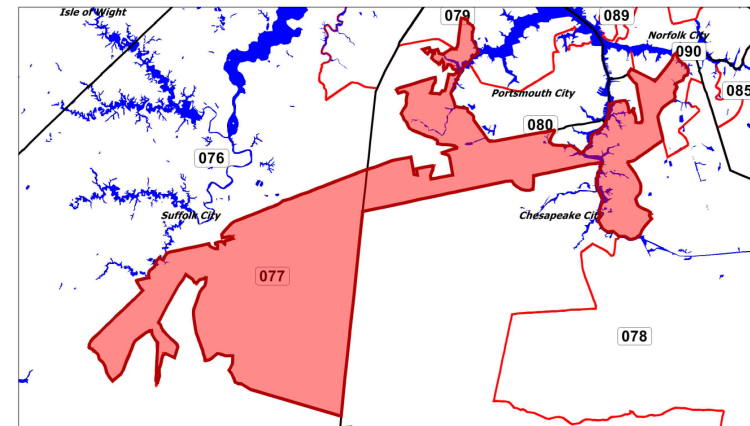
MAP 21

Examples of Non-Compact Districts in 1991 House Plan

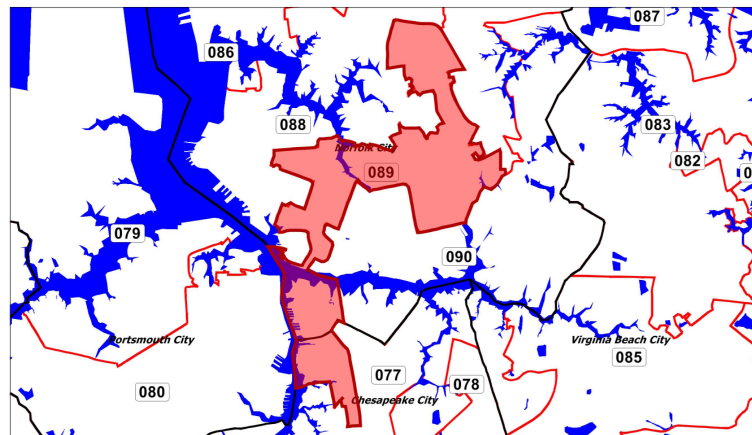
District 64



District 77



District 89



District 98

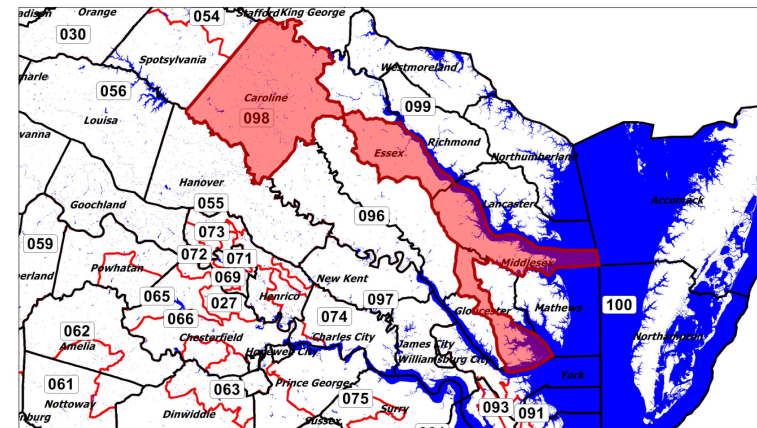


TABLE 1
1991 NORTH CAROLINA CONGRESSIONAL PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.26	0.02
2	0.25	0.05
3	0.37	0.05
4	0.41	0.31
5	0.14	0.07
6	0.45	0.08
7	0.32	0.05
8	0.34	0.14
9	0.28	0.06
10	0.30	0.05
11	0.29	0.12
12	0.05	0.01

Min	0.05	0.01
Max	0.45	0.31
Mean	0.29	0.09
Std. Dev.	0.11	0.08

Scores: North Carolina General Assembly Legislative Services for shape file United States Bureau of the Census TIGER Line File

TABLE 2

2011 ILLINOIS CONGRESSIONAL PLAN

Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
01	0.19	0.12
02	0.32	0.36
03	0.28	0.17
04	0.30	0.05
05	0.31	0.09
06	0.31	0.11
07	0.25	0.08
08	0.40	0.12
09	0.24	0.13
10	0.35	0.18
11	0.36	0.12
12	0.31	0.24
13	0.29	0.19
14	0.32	0.17
15	0.32	0.21
16	0.35	0.23
17	0.31	0.19
18	0.49	0.23
Min	0.19	0.05
Max	0.56	0.62
Mean	0.33	0.19
Std. Dev.	0.08	0.13

Source: United States Bureau of the Census TIGER Line File

JA 1071

TABLE 3
VIRGINIA HOUSE AND SENATE COMPACTNESS 1991, 2001 AND 2011
Showing Reock and Polsby-Popper Scores

State	Reock				Polsby-Popper			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
1991 House	0.14	0.61	0.37	0.11	0.07	0.60	0.25	0.10
2001 House	0.16	0.61	0.38	0.10	0.10	0.58	0.26	0.10
2011 House	0.14	0.62	0.36	0.11	0.08	0.55	0.24	0.09
1991 Senate	0.12	0.63	0.36	0.11	0.09	0.43	0.24	0.10
2001 Senate	0.14	0.54	0.36	0.10	0.13	0.41	0.24	0.08
2011 Senate	0.14	0.46	0.27	0.08	0.08	0.39	0.16	0.06

Source: United States Census Bureau 2010 Redistricting Data TIGER File.

TABLE 4
MULTIPLE STATE LOWER HOUSE PLAN FOR SOUTHERN STATES
 Reock and Polsby Popper Compactness Scores Before and After 2010 Census

District Enacted After the 2010 Decennial Census

State	Reock				Polsby-Popper			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
Louisiana	0.11	0.65	0.38	0.11	0.05	0.51	0.26	0.10
Mississippi	0.16	0.61	0.38	0.10	0.07	0.66	0.26	0.12
Alabama	0.11	0.64	0.37	0.10	0.06	0.49	0.21	0.10
Georgia	0.13	0.63	0.39	0.11	0.09	0.54	0.28	0.09
Florida	0.08	0.65	0.43	0.11	0.08	0.68	0.43	0.13
South Carolina	0.11	0.61	0.39	0.09	0.11	0.54	0.28	0.09
North Carolina	0.12	0.57	0.38	0.10	0.04	0.57	0.24	0.11
Maryland	0.16	0.59	0.36	0.10	0.01	0.42	0.18	0.11
Virginia	0.14	0.62	0.36	0.11	0.08	0.55	0.24	0.09

District Enacted Prior to the 2010 Decennial Census

State	Reock				Polsby-Popper			
	Minimum	Maximum	Mean	Std. Dev.	Minimum	Maximum	Mean	Std. Dev.
Louisiana	0.13	0.62	0.37	0.11	0.06	0.54	0.26	0.10
Mississippi	0.10	0.61	0.34	0.11	0.04	0.59	0.19	0.11
Alabama	0.13	0.61	0.39	0.10	0.07	0.74	0.25	0.12
Georgia	0.19	0.65	0.41	0.11	0.07	0.62	0.29	0.10
Florida	0.14	0.58	0.35	0.11	0.09	0.50	0.24	0.10
South Carolina	0.14	0.61	0.40	0.10	0.13	0.67	0.30	0.10
North Carolina	0.15	0.64	0.41	0.10	0.06	0.64	0.31	0.11
Maryland	0.16	0.59	0.37	0.10	0.01	0.55	0.22	0.13
Virginia	0.16	0.61	0.38	0.10	0.10	0.58	0.26	0.10

Source: U. S. Census Bureau 2010 TIGER line files

JA 1073

TABLE 5

1991 STATE HOUSE PLAN

Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
041	0.38	0.34
042	0.38	0.24
043	0.29	0.34
044	0.61	0.41
045	0.31	0.28
046	0.50	0.53
047	0.22	0.24
048	0.26	0.21
049	0.37	0.28
050	0.24	0.15
051	0.36	0.33
052	0.34	0.32
053	0.30	0.23
054	0.39	0.30
055	0.35	0.23
056	0.46	0.35
057	0.48	0.32
058	0.42	0.24
059	0.52	0.29
060	0.61	0.35
061	0.42	0.21
062	0.32	0.07
063	0.46	0.23
064	0.26	0.10

JA 1074

065	0.32	0.25
066	0.22	0.16
067	0.45	0.33
068	0.38	0.26
069	0.29	0.17
070	0.39	0.13
071	0.36	0.19
072	0.34	0.19
073	0.35	0.12
074	0.14	0.11
075	0.39	0.17
076	0.43	0.14
077	0.16	0.08
078	0.46	0.37
079	0.48	0.33
080	0.48	0.34
081	0.49	0.49
082	0.57	0.42
083	0.25	0.19
084	0.37	0.35
085	0.54	0.30
086	0.23	0.36
087	0.32	0.29
088	0.41	0.19
089	0.20	0.09
090	0.25	0.13
091	0.42	0.24
092	0.38	0.20
093	0.17	0.16
094	0.32	0.33

JA 1075

095	0.30	0.30
096	0.19	0.13
097	0.23	0.14
098	0.15	0.09
099	0.24	0.31
100	0.39	0.38

Min	0.14	0.07
Max	0.61	0.60
Mean	0.37	0.25
Std. Dev.	0.11	0.10

Source: U. S. Census Bureau 2010 TIGER line file

JA 1076

TABLE 6

1991 STATE SENATE PLAN

Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.51	0.22
2	0.21	0.10
3	0.28	0.21
4	0.39	0.29
5	0.30	0.18
6	0.39	0.28
7	0.32	0.21
8	0.35	0.33
9	0.26	0.13
10	0.29	0.19
11	0.38	0.30
12	0.18	0.13
13	0.24	0.18
14	0.49	0.35
15	0.23	0.10
16	0.33	0.09
17	0.38	0.30
18	0.12	0.10
19	0.37	0.43
20	0.46	0.42
21	0.63	0.38
22	0.26	0.17
23	0.47	0.33
24	0.39	0.27

JA 1077

25	0.35	0.29
26	0.27	0.17
27	0.38	0.24
28	0.14	0.13
29	0.34	0.35
30	0.34	0.16
31	0.43	0.31
32	0.48	0.30
33	0.51	0.40
34	0.28	0.20
35	0.49	0.21
36	0.49	0.30
37	0.36	0.18
38	0.38	0.18
39	0.24	0.15
40	0.20	0.17

Min	0.12	0.09
Max	0.63	0.43
Mean	0.35	0.24
Std. Dev.	0.11	0.09

Source: U. S. Census Bureau 2010 TIGER line file

JA 1078

TABLE 7

2001 HOUSE OF DELEGATES PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.18	0.22
2	0.36	0.23
3	0.38	0.19
4	0.40	0.29
5	0.43	0.23
6	0.38	0.21
7	0.32	0.16
8	0.52	0.43
9	0.32	0.20
10	0.33	0.20
11	0.49	0.26
12	0.23	0.22
13	0.36	0.15
14	0.18	0.18
15	0.44	0.22
16	0.33	0.12
17	0.23	0.11
18	0.47	0.27
19	0.54	0.22
20	0.47	0.18
21	0.21	0.18
22	0.39	0.20
23	0.38	0.20
24	0.57	0.19
25	0.45	0.24

JA 1079

26	0.52	0.54
27	0.30	0.23
28	0.48	0.28
29	0.45	0.30
30	0.59	0.32
31	0.34	0.14
32	0.35	0.35
33	0.42	0.31
34	0.30	0.25
35	0.38	0.28
36	0.47	0.34
37	0.50	0.35
38	0.52	0.33
39	0.29	0.26
40	0.39	0.29
41	0.44	0.25
42	0.39	0.24
43	0.49	0.58
44	0.36	0.26
45	0.33	0.17
46	0.51	0.40
47	0.34	0.33
48	0.26	0.20
49	0.25	0.19
50	0.47	0.26
51	0.40	0.28
52	0.47	0.33
53	0.44	0.24
54	0.37	0.33
55	0.39	0.25

JA 1080

56	0.41	0.32
57	0.30	0.18
58	0.34	0.15
59	0.59	0.26
60	0.34	0.28
61	0.36	0.15
62	0.34	0.14
63	0.61	0.48
64	0.42	0.19
65	0.48	0.34
66	0.31	0.24
67	0.44	0.26
68	0.35	0.19
69	0.37	0.20
70	0.47	0.14
71	0.24	0.19
72	0.25	0.22
73	0.37	0.18
74	0.16	0.10
75	0.42	0.22
76	0.39	0.18
77	0.18	0.17
78	0.54	0.46
79	0.35	0.22
80	0.39	0.26
81	0.40	0.28
82	0.56	0.57
83	0.31	0.38
84	0.35	0.31
85	0.53	0.43

JA 1081

86	0.34	0.28
87	0.38	0.24
88	0.35	0.16
89	0.58	0.31
90	0.35	0.24
91	0.57	0.40
92	0.28	0.15
93	0.17	0.19
94	0.35	0.40
95	0.43	0.28
96	0.23	0.15
97	0.27	0.11
98	0.25	0.26
99	0.27	0.21
100	0.27	0.35

Min	0.16	0.10
Max	0.61	0.58
Mean	0.38	0.26
Std. Dev.	0.10	0.10

Source: U. S. Census Bureau 2010 TIGER line file

JA 1082

TABLE 8

2001 STATE SENATE PLAN

Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.41	0.23
2	0.46	0.30
3	0.28	0.17
4	0.31	0.24
5	0.35	0.15
6	0.31	0.31
7	0.29	0.20
8	0.29	0.41
9	0.24	0.14
10	0.54	0.31
11	0.48	0.38
12	0.43	0.34
13	0.42	0.20
14	0.44	0.32
15	0.39	0.19
16	0.36	0.16
17	0.49	0.34
18	0.22	0.13
19	0.41	0.25
20	0.32	0.23
21	0.32	0.18
22	0.24	0.13
23	0.53	0.25
24	0.42	0.23

JA 1083

25	0.23	0.14
26	0.43	0.27
27	0.33	0.19
28	0.16	0.18
29	0.31	0.26
30	0.29	0.19
31	0.51	0.34
32	0.38	0.29
33	0.47	0.39
34	0.46	0.29
35	0.49	0.25
36	0.32	0.20
37	0.26	0.24
38	0.21	0.14
39	0.30	0.20
40	0.14	0.16

Min	0.14	0.13
Max	0.54	0.41
Mean	0.36	0.24
Std. Dev.	0.10	0.08

Source: U. S Census Bureau 2010 TIGER line file

TABLE 9

2011 HOUSE OF DELEGATES PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.26	0.30
2	0.30	0.18
3	0.28	0.21
4	0.49	0.20
5	0.19	0.17
6	0.27	0.26
7	0.50	0.25
8	0.47	0.26
9	0.35	0.24
10	0.23	0.18
11	0.59	0.26
12	0.39	0.22
13	0.16	0.13
14	0.24	0.16
15	0.55	0.34
16	0.36	0.18
17	0.25	0.09
18	0.62	0.24
19	0.43	0.17
20	0.27	0.15
21	0.42	0.31
22	0.20	0.11
23	0.26	0.15
24	0.44	0.25
25	0.26	0.18

JA 1085

26	0.46	0.36
27	0.35	0.25
28	0.39	0.26
29	0.36	0.21
30	0.53	0.36
31	0.38	0.19
32	0.46	0.31
33	0.33	0.23
34	0.24	0.22
35	0.20	0.19
36	0.43	0.30
37	0.18	0.18
38	0.62	0.45
39	0.35	0.19
40	0.26	0.17
41	0.36	0.32
42	0.35	0.20
43	0.22	0.21
44	0.43	0.32
45	0.29	0.26
46	0.52	0.55
47	0.41	0.33
48	0.18	0.16
49	0.24	0.16
50	0.46	0.34
51	0.24	0.18
52	0.23	0.25
53	0.46	0.34
54	0.47	0.25
55	0.57	0.28
56	0.34	0.22

JA 1086

57	0.45	0.41
58	0.32	0.19
59	0.30	0.21
60	0.38	0.31
61	0.32	0.17
62	0.36	0.13
63	0.25	0.16
64	0.37	0.16
65	0.37	0.27
66	0.31	0.27
67	0.32	0.25
68	0.36	0.25
69	0.52	0.34
70	0.40	0.19
71	0.33	0.24
72	0.26	0.08
73	0.39	0.15
74	0.16	0.12
75	0.41	0.19
76	0.48	0.17
77	0.19	0.15
78	0.46	0.35
79	0.45	0.26
80	0.26	0.11
81	0.40	0.23
82	0.57	0.45
83	0.52	0.34
84	0.44	0.26
85	0.40	0.24
86	0.35	0.25
87	0.22	0.17

JA 1087

88	0.28	0.13
89	0.40	0.20
90	0.46	0.20
91	0.60	0.47
92	0.34	0.26
93	0.22	0.16
94	0.35	0.38
95	0.14	0.14
96	0.20	0.17
97	0.43	0.21
98	0.28	0.26
99	0.27	0.21
100	0.28	0.37

Min	0.14	0.08
Max	0.62	0.55
Mean	0.36	0.24
Std. Dev.	0.11	0.09

JA 1088

TABLE 10

2011 STATE SENATE PLAN

Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.16	0.16
2	0.23	0.15
3	0.29	0.11
4	0.33	0.18
5	0.36	0.17
6	0.30	0.30
7	0.32	0.24
8	0.30	0.39
9	0.19	0.11
10	0.30	0.13
11	0.36	0.20
12	0.46	0.23
13	0.31	0.17
14	0.24	0.13
15	0.22	0.13
16	0.31	0.10
17	0.38	0.17
18	0.27	0.14
19	0.30	0.13
20	0.20	0.12
21	0.21	0.14
22	0.35	0.18
23	0.34	0.20
24	0.23	0.15

JA 1089

25	0.30	0.15
26	0.43	0.28
27	0.25	0.20
28	0.15	0.08
29	0.16	0.10
30	0.21	0.10
31	0.17	0.16
32	0.25	0.17
33	0.26	0.15
34	0.31	0.16
35	0.42	0.24
36	0.21	0.09
37	0.18	0.10
38	0.21	0.15
39	0.32	0.20
40	0.14	0.15

Min	0.14	0.08
Max	0.46	0.39
Mean	0.27	0.17
Std. Dev.	0.08	0.06

Source: U. S. Census Bureau 2010 TIGER line file

TABLE 11

COMPARISON OF CORE CONSTITUENCIES
Comparing Baseline Districts to Enacted Districts
2011 House of Delegates Plan

District	Part of Old District in New	Part of New District from Old	2010 Population Deviation
63	86.59	80.20	-7.86
69	83.17	74.70	-10.89
70	67.31	67.31	-0.79
71	84.78	78.31	-7.27
74	79.52	80.08	0.18
75	88.50	78.64	-11.94
77	77.02	74.40	-3.85
80	68.53	59.94	-11.78
89	82.40	76.86	-7.19
90	71.52	63.21	-11.16
92	86.70	77.27	-11.24
95	73.31	62.15	-15.16
All 12 Dists.	79.11	72.76	-98.95

Source: Maptitude Reports using 2010 Decennial
Census Data

TABLE 12

2011 VIRGINIA HOUSE DISTRICTS Core District
Retention Percentages

District	Core Retension Percentage	African-American Majority#	A.A. Core Retension Percentage
1	78.79		
2	-		
3	79.81		
4	21.97		
5	36.06		
6	17.05		
7	52.71		
8	71.76		
9	57.90		
10	-		
11	80.68		
12	51.08		
13	55.98		
14	81.49		
15	81.90		
16	71.47		
17	69.06		
18	59.22		
19	69.15		
20	55.03		
21	68.77		
22	50.33		
23	68.04		
24	75.65		

JA 1092

25	60.19		
26	96.34		
27	48.40		
28	84.12		
29	68.93		
30	95.69		
31	68.56		
32	87.65		
33	74.32		
34	53.98		
35	67.55		
36	77.68		
37	53.62		
38	53.01		
39	58.44		
40	80.42		
41	69.82		
42	78.87		
43	74.65		
44	86.34		
45	74.03		
46	87.94		
47	80.88		
48	69.20		
49	50.99		
50	58.40		
51	66.09		
52	34.51		
53	76.07		
54	100.00		

JA 1093

55	63.44		
56	93.97		
57	82.49		
58	83.37		
59	61.35		
60	86.10		
61	81.91		
62	56.65		
63	80.20	1	80.20
64	56.20		
65	78.05		
66	87.43		
67	90.57		
68	65.45		
69	74.70	1	74.70
70	67.31	1	67.31
71	78.31	1	78.31
72	51.53		
73	49.89		
74	80.08	1	80.08
75	78.64	1	78.64
76	93.25		
77	74.40	1	74.40
78	94.48		
79	42.35		
80	59.94	1	59.94
81	67.37		
82	71.08		
83	52.01		

JA 1094

84	75.83		
85	60.22		
86	73.13		
87	-		
88	59.00		
89	76.86	1	76.86
90	63.21	1	63.21
91	61.66		
92	77.27	1	77.27
93	51.43		
94	76.26		
95	62.15	1	62.15
96	65.56		
97	60.95		
98	94.97		
99	100.00		
100	56.91		

Indicated by a “1”

Note: Three Districts should be considered to have collapsed. They are Districts 2, 10 and 87.

Note: Average core retention for the 100 districts is 67.09%. For the 97 districts which were not collapsed average retention is 69.09%. For the 12 African-America majority districts, average core retention is 72.76%.

Source: Mapitude Reports using 2010 Decennial Census Date

TABLE 13
2001 NORTH CAROLINA CONGRESSIONAL PLAN
Reock & Polsby-Popper Compactness Scores

District Number	Reock Score	Polsby-Popper Score
1	0.39	0.08
2	0.30	0.07
3	0.41	0.07
4	0.48	0.23
5	0.40	0.23
6	0.38	0.09
7	0.61	0.20
8	0.34	0.21
9	0.34	0.12
10	0.41	0.18
11	0.34	0.25
12	0.12	0.03
13	0.24	0.08

Min	0.12	0.03
Max	0.61	0.25
Mean	0.37	0.14
Std. Dev.	0.12	0.08

Scores: North Carolina General Assembly Legislative Services for shape file

United States Census Bureau for TIGER line file

JA 1096

TABLE 14

2011 HOUSE PLAN HB 5005

Comparison of Compactness Scores for 6 Least
Compact Districts

District Number	Reock Score	Polsby- Popper Score	% 18+ AP African- American
13	0.16	0.13	13.66
17	0.25	0.09	6.22
22	0.20	0.11	20.75
48	0.18	0.16	4.88
74	0.16	0.12	57.88
95	0.14	0.14	61.16

Score: U.S. Census Bureau TIGER Line File

JA 1097

IN THE UNITED STATES DISTRICT COURT
FOR THE EASTERN DISTRICT OF VIRGINIA
(RICHMOND DIVISION)

Civil Action No. 3:14-cv-00852-REP-GBL-BMK

GOLDEN BETHUNE-HILL, *et al.*,
Plaintiffs,

v.

VIRGINIA STATE BOARD OF ELECTIONS, *et al.*,
Defendants.

DECLARATION OF M.V. HOOD III

I, M.V. Hood III, do hereby declare the following:

I. INTRODUCTION AND BACKGROUND

My name is M.V. (Trey) Hood III, and I am a tenured professor at the University of Georgia with an appointment in the Department of Political Science. I also serve as the Director of Graduate Studies for the Department. I have been a faculty member at the University of Georgia since August of 1999. I am an expert in American politics, specifically in the areas of electoral politics, racial politics, election administration, and Southern politics. I teach courses on American politics, Southern politics, and research methods and have taught graduate seminars on the topics of election administration and Southern politics.

I have received research grants from the National Science Foundation and the Pew Charitable Trust. I have also published peer-reviewed journal articles

specifically in the areas of election administration and redistricting. My academic publications are detailed in a copy of my vita that is attached to the end of this document. Currently, I serve on the editorial boards for *Social Science Quarterly* and *Election Law Journal*. The latter is a peer-reviewed academic journal focused on the area of election administration.

During the preceding four years, I have offered expert testimony in eight cases, *State of Florida v. United States* (No. 11-1428, D.D.C.), *NAACP v. Walker* (11-CV-5492, Dane County Circuit Court), *Jones v. Deininger* (12-CV-00185-LA), *Frank v. Walker* (2:11-CV-01128-LA), *South Carolina v. United States* (No. 12-203, D.D.C), *Rios-Andino v. Orange County* (6:12-cv-1188-Orl-22KRS), *Veasey v. Perry* (2:13-cv-193, NGR), and *United States v. North Carolina* (1:13-CV-861). In assisting the defendants in analyzing Virginia's current House of Delegates districting plan, I am receiving \$300 an hour for this work and \$300 an hour for any testimony associated with this work. In reaching my conclusions, I have drawn on my training, experience, and knowledge as a social scientist who has specifically conducted research in the area under examination in this expert report.

II. SCOPE AND OVERVIEW

I have been asked by counsel for the State of Virginia to respond to the expert report of Professor Stephen Ansolabehere and in so doing, to provide my own assessment of Virginia's current districting plan for the House of Delegates. In Section III, I provide some brief background on the districting plan under challenge. Section IV analyzes this plan on a number of traditional redistricting principles; Section V discusses the preclearance process; Section VI examines the legislative districts under challenge; Section VII

performs a legislative roll-call analysis relating to action in the House of Delegates; and Section VIII evaluates the current redistricting plan in light of the 2011 elections. The final section of my report (XI) provides a synopsis of my overall conclusions in this case.

III. BACKGROUND

Following the 2010 Census and prior to the primary election period in 2011, the Virginia General Assembly redrew legislative district boundaries for both the House of Delegates and the Senate. Legislation to accomplish this goal (HB 5005) was signed into law by Governor McDonnell on April 29, 2011.¹ Elections for the House of Delegates were held under this plan for the 2011 and 2013 election-cycles. At issue under the current House of Delegates plan are 12 majority-black districts which are being challenged by the plaintiffs in this case.²

IV. PLAN COMPARISONS³

A. Population Deviation

The principle goal of any legislative redistricting plan is to ensure that districts have equal population counts. State legislative plans have been given more tolerance on this point compared to congressional

¹ See <http://redistricting.dls.virginia.gov/2010/News.aspx>.

² These districts are 63, 69, 70, 71, 74, 75, 77, 80, 89, 90, 92, and 95.

³ Data used for analyses presented in this report were acquired through counsel for the State of Virginia. Redistricting materials can be found at the Virginia Division of Legislative Services (<http://redistricting.dls.virginia.gov/2010/Default.aspx>) and election data can be found at the Virginia Department of Elections (<http://elections.virginia.gov/>).

plans (where essentially no deviation is permitted).⁴ Nevertheless, it is in the interest of the state to assure political equality among citizens is maintained; and thus, it is paramount to limit population deviations across districts to the extent possible.

In this section I will undertake an examination of population deviations across the 2011 House of Delegates plan. In doing so I will also make some observations about the House of Delegates districts under the previous plan (2009). Following the 2010 Census the total population of Virginia was 8,001,024. With 100 House of Delegate districts this made the ideal district size 80,010. Prior to drawing new districts it is no surprise that many of the existing districts were under-populated or over-populated, sometimes drastically so, in relation to this target number. Looking at Table 1, one can see that prior to redistricting, the smallest district had a population of only 64,074 (.80 the ideal district size), while the largest district had a population of 190,620 (or 2.4 times the ideal district size). Relatively speaking, this would translate to a range of 19.9% below to 138.3% above the ideal district size.

Table 1. Population Deviation-Virginia House of Delegates

	2009 Districts	2011 Districts
Ideal District Size	80,010	80,010
Least Populated	64,074	79,210

⁴ See Charles S. Bullock, III. 2010. *Redistricting: The Most Political Activity in America*. New York: Rowman & Littlefield Publishers.

Highest Populated	190,620	80,800
Absolute Range	126,546	1,590
Relative Range- Low	-19.92%	-1.00%
Relative Range- High	+138.25%	+0.99%

Notes: Ideal District Size based on 2010 Census.

Following the redistricting undertaken by HB 5005, population across districts was essentially equalized. The smallest district stood at 79,210 and the largest at 80,800—an absolute range of only 1,590. In relative terms, all 100 House of Delegates districts ranged between 1.0% below to .99% above the ideal district size. A +/-1% tolerance is certainly below the +/- 2% range that characterized the benchmark plan. The 2011 redistricting plan more than meets the first and most overriding goal of any redistricting plan, namely ensuring population equality across election districts.

B. Maintaining Communities of Interest

Another traditional redistricting principle involves an effort, where possible, to respect existing political boundaries such as counties. Virginia also has another designation, independent cities, which are equivalent to counties. For this part of my analysis, I will also treat counties and independent cities as equivalent. The table below (Table 2) compares the previous plan for the House of Delegates (2009) to the currently implemented plan (2011) on this dimension. The percentage of counties and independent cities not split across legislative districts, at 44%, remained constant across the two plans. More than a majority of the counties

and independent cities in Virginia then are wholly preserved within House of Delegate districts in both the 2009 and 2011 plans. The only difference between the two plans does not involve the number of counties/independent cities which are split geographically, but where such splits do not contain any population. In this case there are three counties/independent cities split but unaffected in the 2009 plan and one present in the 2011 plan. If we include this category with the number of counties/independent cities that are not split, 56.0% are unaffected in 2009 versus 56.0% in 2011. The number of counties and independent cities *unaffected* then remains the same across the redistricting cycle.

While maintaining existing communities of interest is an important principle when drawing legislative district boundaries, this consideration does not override the dictate that population counts across districts should be equal. As the previous section of this report outlines, the 2011 plan accomplishes this criteria, keeping deviations across House districts within the +/-1% range. Given that population equality overrides the goal of maintaining existing communities of interest, it is not always possible to fully accomplish the latter. In this light, the House of Delegates plan for 2011 does a suitable job of balancing this consideration against the chief goal of population equality.

Table 2. Communities of Interest across Legislative Plans

	2009 Plan	2011 Plan
Counties/Independent Cities	44.0%	44.0%
Split	[59]	[59]
Not Split/Unaffected	56.0%	56.0%
	[75]	[75]
Split Counties/	2.2%	0.7%
Independent Cities- Unaffected	[3]	[1]
Total	134	134

C. VTD Splits

Another area I will examine involves the number of voting tabulations districts (VTDs) that were split between legislative districts. I will compare the previous plan (in place for the 2009 elections) to the current plan (in place for the 2011 elections). The results are summarized in Table 3. below.⁵ In the previous plan there were 86 VTDs split between legislative districts. Another three VTDs were split, but essentially unaffected in that the split was geographic in nature and did not involve actual population residing within the VTD. All told, 96.4% of the VTDs in the previous plan were not split (or were unaffected in population terms) between legislative districts. Looking at the current

⁵ The summary numbers provided in Table 3 related to split VTDs do not match the figures reported by Professor Ansolabehere. He records just over twice the number of split VTDs: 174 under the benchmark plan and 236 under HB 5005 (Ansolabehere Expert Report. March 11, 2015. Paragraph 61).

plan, the number of split VTDs increases slightly to 116 (8 VTDs were split but unaffected in population terms). Of the total, the percentage of VTDs not split or unaffected in the current plan equals 95.1%. In summary, while the percentage of VTDs split across House of Delegate districts does increase with the 2011 plan, the increase equates to a little more than 1%. Looking at things from the opposite direction, the vast majority of VTDs in the previous plan are not split across districts. This observation also applies to the 2011 plan as well.

Table 3. Examination of Net VTD Splits across Legislative Plans

	2009 Plan	2011 Plan
Split VTDs	3.6%	4.9%
	[86]	[116]
Not Split/Unaffected	96.4%	95.1%
	[2,287]	[2,257]
Split VTDs- Unaffected	0.1%	0.3%
	[3]	[8]
Total VTDs	2,373	2,373

D. District Compactness

Another important redistricting principle is that of drawing districts that are compact in nature. I use two commonly accepted measures of compactness, the Perimeter-to-Area measure and Smallest Circle score, to analyze the previous House of Delegates plan in place in 2009 and the current plan enacted for the 2011 elections. Hereafter, I will use the term Reock to

refer to the Smallest Circle score of compactness measure and the Polsby-Popper measure to refer to Perimeter-to-Area measure of compactness. Niemi et al. (1990: 1161) classify the Reock measure as one that compares the area of the district to the area of a circle. More formally the Reock measure is the *ratio of the district area to the area of the minimum circumscribing circle*. The Polsby-Popper measure is a perimeter-area comparison which calculates the *ratio of the district area to the area of a circle with the same perimeter* or formally $[(4\pi\text{Area})/\text{Perimeter}^2]$. Both the Reock and the Polsby-Popper measures range between 0 and 1, with 1 an indication of perfect compactness. Again, in both cases a district which was a perfect circle would score a value of 1.⁶

Looking at Table 4, the average district compactness changed little across these two districting plans. Overall, the average district was slightly less compact in 2011 as compared to 2009. Using the Reock measure, the mean score for 2009 districts was .38, compared to .36 for the 2011 plan. The mean Polsby-Popper value was .24 in 2009 and .22 in 2011. Both sets of compactness measures also show approximately the same range in values (minimums and maximums) and variation (standard deviation calculations) for the 2009 districts as compared to the 2011

⁶ For more information on these measures see: Polsby, David, and Robert D. Popper, 1991. "The Third Criterion: Compactness as a Procedural Safeguard against Partisan Gerrymandering." *Yale Law and Policy Review*, 9: 301-353; Reock, Jr., Ernest C. 1961. "A Note on Measuring Compactness as a Requirement of Legislative Appointment." *Midwest Journal of Political Science* 5: 70-74; and Niemi, Richard G., Bernard Grofman, Carl Calucci, and Thomas Hofeller. 1990. "Measuring Compactness and the Role of a Compactness Standard in a Test for Partisan and Racial Gerrymandering." *Journal of Politics* 52: 1155-1181.

districts. In summary, using two different commonly accepted measures, it is difficult to discern any appreciable changes in legislative district compactness across the two districting plans.

Table 4. Examination of District Compactness across Legislative Plans

	2009		2011	
	Reock	Polsby-Popper	Reock	Polsby-Popper
Mean	.38	.26	.36	.24
Median	.38	.24	.35	.22
Minimum	.16	.10	.14	.08
Maximum	.61	.58	.62	.55
Standard Deviation	.10	.10	.11	.09

E. Partisanship and Incumbent Pairings

In this section I will examine the district partisanship and incumbent pairings by comparing the previous House of Delegates plan (in place for the 2009 elections) to the current plan (in place for the 2011 elections). Virginia does not have a closed primary system and, as a consequence, does not have political party registration. One can, however, estimate the partisan preferences of a legislative district using election data. In this case, I calculated a Democratic Vote Average (DVA) based on the share of the Democratic vote cast for the three statewide constitutional offices in 2009—governor, lieutenant governor, and attorney

general.⁷ The DVA was calculated for the House of Delegate districts as they existed in 2009 and then recalculated using the 2011 district boundaries. These elections are the most proximate to the House of Delegate contests under analysis and are representative of the off-year electorate for state elections in Virginia. Using a vote average also helps to mitigate against election-specific effects that may be tied to a particular candidate or contest.

Table 5. below compares Democratic partisanship across redistricting cycles. As configured in 2009, the districts had an average DVA of 43.9%, compared to 43.6% in 2011. The minimum, maximum, and standard deviations also showed very little variation. Overall then, the mean DVA figure was hardly altered by redistricting. However, when one categorizes these districts by the party holding the seat, an interesting pattern does emerge.⁸ First, one may note that the maximum value for the DVA index for GOP-held districts went from 51.4% in 2009 to 49.2% in 2011. Prior to the 2011 elections then no Republican delegate seat contained a majority of Democratic partisans. Second, in reference to Democratic-held seats

⁷ Democratic Vote Average = [(Democratic percentage of the two-party vote for governor + Democratic percentage of the two-party vote for lieutenant governor + Democratic percentage of the two-party vote for attorney general) / 3]. I would also like to note that I disagree with Professor Ansolabehere's choice of elections that he used in his analyses, specifically the 2008 and 2012 presidential contests, the 2012 U.S. Senate race, and the 2013 gubernatorial race (Ansolabehere Expert Report. March 11, 2015. Paragraph 138).

⁸ Party of seat in 2009 is defined by the party affiliation of the election winner from that election cycle. In 2011, party is defined by the incumbent (or previous incumbent if open) holding the seat just prior to the 2011 elections.

the DVA has a much greater range, from a low of 31.9% to a high of 79.8%. Almost a third (28.2%) of the seats held by Democrats going into the 2011 elections contained less than a majority of Democratic partisans. While the overall range was diminished by the 2011 plan, it is still almost 50-points (the range for GOP-held seats is only 25.9). Likewise, another measure of dispersion, the standard deviation is 11.8—more than twice that for Republican districts at 5.0. Such is an indication that, across Democratic-held districts, the partisan composition showed much greater variation in comparison to the partisan composition of Republican-held districts.

To summarize, the 2011 redistricting plan for the House of Delegates in Virginia appears to purposefully concentrate Republican voting strength in existing GOP-held districts while at the same time dispersing Democratic partisans. In fact, Democratic voting strength is so depleted in a number of districts as to put the probability of continued Democratic control of these seats in jeopardy. Section VIII of this report specifically examines the effect of this action before and after the 2011 election.

Table 5. Democratic Partisanship Index (DVA) Descriptives

	All Districts	Democratic	Republican	Independent
2009 Districts				
Mean	43.9%	57.2%	35.5%	33.3%
Maximum	76.6%	76.6%	51.4%	40.4%
Minimum	22.5%	25.9%	22.5%	26.3%

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Standard Deviation	14.1	12.6	6.2	10.0
2011 Districts				
Mean	43.6%	57.1%	35.0%	34.8%
Maximum	79.8%	79.8%	49.2%	36.5%
Minimum	23.3%	31.9%	23.3%	33.1%
Standard Deviation	13.6	11.8	5.0	2.4

Next, I will examine the 2011 plan in light of incumbent pairings that were created. The 2011 plan as implemented created six districts in which incumbents were paired against one another (see Table 6. below). More specifically, three sets of Democratic incumbents were paired against one another, while only one district featured a set of paired GOP incumbents. Two other districts featured a Democratic incumbent facing a Republican incumbent. All told, few incumbents were placed in jeopardy by the 2011 redistricting plan for the House of Delegates. Half of the incumbent pairings featured a Democratic versus Democrat matchup, additional evidence that the plan was designed, in part, to promote GOP seat gains. In addition, none of the incumbent pairings featured a minority legislator. The six incumbent pairings created six open seats. A closer look at these districts indicates that only one of these open seats had a DVA value greater than 50%.⁹ The average DVA value for the five other seats was only 39.8%. The formation of these open seats then created an opportunity for additional Republican seat gains.

⁹ District 49 had a DVI value of 68.8%.

Table 6. Incumbent Pairings Created by the 2011 Redistricting Plan

2011 District Number	Partisan Pairing	2009 District Numbers
4	D, D	4, 2
100	D, D	100, 87
45	D, D	45, 49
29	R, R	29, 18
16 ¹⁰	D, R	10, 16
94 ¹⁰	D, R	93, 94

F. District Core Retention

A secondary goal that often manifests itself in redistricting plans involves maintaining the core population of a district. In other words, some population component from the old district is held over and becomes the core of the new district. This component is closely related to incumbent electoral success and, as such, is a major element of any plan drawn with the idea of protecting incumbents across a redistricting cycle.

The intuition is straightforward. Over time certain advantages accrue to incumbent office holders such as

¹⁰ Delegate Robin Abbott was elected to District 93 in 2009. With the redistricting plan enacted in 2011, she was placed in District 94 with another incumbent, Glenn Oder (who represented the former District 94). Before the 2011 election, Abbott relocated to the new District 93 and ran for re-election. For purposes of any election analysis, therefore, she is coded as a Democratic incumbent representing District 93. Likewise, Ward Armstrong represented District 10 in 2009. Before the 2011 elections he was placed in District 16 with another incumbent, Donald Merricks. Armstrong moved and ran for reelection from the new District 9, facing Republican incumbent Charles Poindexter.

increased familiarity among their constituents. In this sense incumbents are able to cultivate a *personal vote* that typically exceeds what the partisan balance of the district alone would yield in terms of their vote share. When an incumbent's constituents are drawn out of their district they are replaced with a new set of citizens who are unfamiliar with the incumbent. Large shifts of this type can be detrimental to the incumbent's reelection effort. Those voters new to the district (and likewise new to the incumbent) act more like voters in an open seat scenario. These voters may, therefore, fall back on their own partisan proclivities as a voting cue because of a lack of familiarity with the incumbent. Retaining a large population core representative of an incumbent's previous constituency helps to insulate the office holder from political uncertainty that can accompany redistricting.¹¹

To the extent that core population segments from previous districts are being carried over to new districts, the probability of reelection for incumbents will be buoyed. In order to explore this factor, I analyze the percentage of the voting age population in a 2011 district (post-redistricting) that was comprised of its former self. More simply, the figure could be thought of as the percentage of an incumbent's old district

¹¹ For examples of the linkage between redistricting and electoral effects see M.V. Hood III and Seth C. McKee. "Trying to Thread the Needle: The Effects of Redistricting in a Georgia Congressional District." *PS: Political Science and Politics* 42(4): 679-687; M.V. Hood III and Seth C. McKee. 2012. "Unwelcome Constituents: Redistricting and Countervailing Partisan Tides." *State Politics and Policy Quarterly* 12(2): 203-224 and M.V. Hood III and Seth C. McKee. 2008. "Gerrymandering on Georgia's Mind: The Effects of Redistricting on Vote Choice in the 2006 Midterm Election." *Social Science Quarterly* 89(1): 60-77.

found in the new district. The results are presented in Table 7 below.

The average 2011 House of Delegates district retained 67.2% of its previous constituents. More than two-thirds of the post-redistricting population for a given district then had been part of the old district as configured in 2009. This finding is certainly one hallmark of a redistricting plan designed to protect incumbents. Sub-setting these calculations by the party holding the seat following the 2009 elections, one may note some differences. First, the average GOP-held district retained a higher percentage of former constituents, at 70.4%, as compared to the average Democratic district at 62.4%. An even larger difference can be denoted if we examine seats held by white Democrats where the average drops to 58.0%. While all these groups, on average, maintained more than a majority of their former district population base, the slippage on this metric is most notable when comparing GOP-seats to those held by white Democrats—a 12.4 percentage point difference. To the extent then that a secondary goal of this plan, beyond protecting incumbents of both parties, can be discerned from this examination it would appear to be an effort for the Republican Party to pick up some additional number of seats by depleting districts represented by white Democrats of their former constituents. These GOP efforts did not extend to black legislators who, on average, retained the highest percentage of previous constituents at 71.3%.

Table 7. Legislative District Population Retention, 2011

	All	Republican	Independent	Democratic	White Democrats
Mean	67.2%	70.4%	65.5%	62.4%	58.0%
Median	69.4%	69.5%	65.5%	69.7%	61.9%
Minimum	0.0%	17.3%	61.7%	0.0%	0.0%
Maximum	100.0%	100.0%	69.3%	100.0%	100.0
Standard Deviation	19.7	16.1	5.4	24.0	26.9
Totals	100	59	2	39	26

V. U.S. DEPARTMENT OF JUSTICE PRE-CLEARANCE

When the current districting plan for the Virginia House of Delegates was signed into law on April 29, 2011 Section 5 of the Voting Rights Act was still in place. As such, the State of Virginia submitted this plan to the Department of Justice for preclearance. In a letter dated June 17, 2011 the Attorney General indicated that he was not interposing any objection to the State's legislative districting plans (either the House of Delegates or the Senate).¹² Given the Section 5 standard that the new plan cannot leave minorities worse off than the *status quo*, the failure of the U.S. Department of Justice to object to the legislative redistricting plan should serve as evidence that it judged the 2011 plan would not lead to retrogression.

¹² Source: http://redistricting.dls.virginia.gov/2010/Data/Ref/precleanance_letters.pdf.

The pre-2011 plan for the House of Delegates contained 12 majority-black districts, as did the 2011 plan.¹³ The 2011 plan also created an additional multi-racial/ethnic majority district comprised of Hispanic and black voters. As noted above, black legislators, on average, retained an even larger share of their constituents in the new plan than did the Republicans who drew the plan. While Section 5 is currently unenforceable following a U.S. Supreme Court decision, the 2011 redistricting plan for the Virginia House of Delegates should be viewed through this lens as it was fully in effect when the plan was created. Even without Section 5, had Virginia reduced the number of majority-minority districts in the 2011 plan the state would then be open to a possible Section 2 claim.

VI. DISTRICTS UNDER CHALLENGE

The plaintiffs in this case are challenging twelve districts, all of which are majority-black, on the basis that racial composition was the predominant factor in the creation of these districts. In this section I will examine these twelve districts on a number of redistricting metrics. The first table (Table 8) surveys the 12 districts by exploring district population deviations and racial composition for these districts as they existed in 2009 and again, following redistricting, in 2011. The first column of the table lists the population over- or under-count from the 2011 ideal district size of 80,010. The next column translates these raw totals into a percentage measure of deviation.

¹³ Two of these majority-black districts elected white Democrats (Carr-District 69 and Morrissey-District 74). Three black members were elected from districts which were not majority black (Ware-District 11; Herring-District 46; and Torian-District 52).

Ten of the twelve districts were under-populated by far more than -1.0% (the goal of the redistricting plan was to keep all House of Delegate districts within a $\pm 1\%$ range). Even if one were to use the $\pm 5\%$ tolerance level, nine of the districts would fall below the -5% threshold. Given that most of these districts were under-populated, it was necessary to shift additional population from surrounding areas to bring them up to an acceptable level. The next two columns in the table demonstrate that the redistricting plan accomplished this goal—all twelve districts in 2011 fall within the $\pm 1\%$ range. In fact, these districts fall within an even tighter band, ranging from -0.9% to +0.9%.

The next columns examine the black voting age population in each district before (2009) and after redistricting (2011). Looking at 2009, the percentage black VAP ranges from a low of 46.3% to a high of 62.7%. One district (71) has slipped below the threshold to be classified as a majority-black district. Comparing the 2009 figures with 2011, one can note that percent black VAP increased in six districts while falling in the remaining six. In 2011, the percent black VAP ranged from a low of 55.2% to a high of 60.7%. In 2011 then the upper-bound was reduced 2.0 percentage points (from 62.7% to 60.7%). Looking at these twelve districts as a group, the mean black VAP value across these two time periods remained essentially unchanged, increasing only a tenth of a percentage point from 57.1% to 57.2%. District 71 saw the largest increase in terms of black voting age population at +9.0%, however recall that this was the district that had fallen below the majority-black threshold. Closer examination of Table 8 refutes the idea that the new plan *packed* the black voting age population into districts. The new plan reduced the

concentration of black Virginians in each of the four most heavily black districts (more than 60%) as of 2009. Conversely, it was districts which contained the lowest concentrations of black VAP that were enhanced.

Table 8. Challenged Districts-Population Deviation and Racial Composition

District	Population				Black VAP		
	2009-Diff.	2009-Dev.	2011-Diff.	2011-Dev.	2009	2011	Diff.
63	-6,287	-7.9%	-408	-0.5%	58.1%	59.5%	+1.4
69	-8,711	-10.9%	-624	-0.8%	56.3%	55.2%	-1.1
70	-630	-0.8%	-628	-0.8%	61.8%	56.4%	-5.4
71	-5,816	-7.3%	312	0.4%	46.3%	55.3%	+9.0
74	143	0.2%	-416	-0.5%	62.7%	57.2%	-5.5
75	-9,556	-11.9%	-715	-0.9%	55.3%	55.4%	+1
77	-3,083	-3.9%	-383	-0.5%	57.6%	58.8%	+1.2
80	-9,425	-11.8%	695	0.9%	54.4%	56.3%	+1.9
89	-5,751	-7.2%	-396	-0.5%	52.5%	55.5%	+3.0
90	-8,930	-11.2%	415	0.5%	56.9%	56.6%	-0.3
92	-8,993	-11.2%	-321	-0.4%	62.1%	60.7%	-1.4
95	-12,128	-15.2%	61	0.1%	61.6%	60.0%	-1.6
Mean		-8.26%		-0.25%	57.1%	57.2%	

The next table (Table 9) examines the twelve challenged districts looking at another redistricting principle: compactness. The Reock measure of district compactness in 2009 ranged from .16 to .61, while in 2011 the range was .14 to .52. Looking at the mean values for these two measures one may note that the 12 challenged districts became less compact overall (.37 versus .32). Note as well, however, that across the redistricting cycle six of these districts became more compact or saw no change and six became less

compact. The Polsby-Popper measure demonstrates a similar pattern, with the five districts becoming more compact and the average score for these districts moving from .23 to .19.¹⁴

Table 9. Challenged Districts-Compactness

District	Compactness-Reock			Compactness-Polsby-Popper		
	2009	2011	Diff.	2009	2011	Diff.
63	.61	.25	-.36	.48	.16	-.32
69	.37	.52	+.15	.20	.34	+.14
70	.47	.40	-.07	.14	.19	+.05
71	.24	.33	+.09	.19	.24	+.05
74	.16	.16	0	.10	.12	+.02
75	.42	.41	-.01	.22	.19	-.03
77	.18	.19	+.01	.17	.15	-.02
80	.39	.26	-.13	.26	.11	-.15
89	.58	.40	-.18	.31	.20	-.11
90	.35	.46	+.11	.24	.20	-.04
92	.28	.34	+.06	.15	.26	+.11
95	.43	.14	-.29	.28	.14	-.14
Mean	.37	.32		.23	.19	

Table 10 examines the challenged districts looking at partisan composition, population core retention, and incumbency. From 2009 to 2011 the partisan composition of these districts was essentially unchanged. The average for the DVA in 2009 was 68.3%, compared to 67.6% in 2011. Two districts (69 and 75) experienced

¹⁴ Other House of Delegates districts also experienced drops in compactness from the benchmark (2009) to the enacted plan (2011). For example, examining Reock scores from 2009 to 2011: District 5 (.43 to .19 [-.24]); District 13 (.36 to .16 [-.20]); and District 37 (.50 to .18 [-.32]).

essentially no change in their DVA, five saw a decrease, and the remainder (5) experienced an increase. Seven districts had DVA values of 70 or higher in 2009. Four of the districts that showed a DVA decrease in 2011 were from this former group. The new plan did not, therefore, seek to *pack* Democratic voters in these districts. In 2011 the DVA ranged from a low of 50.6% to a high of 79.8%. In terms of core retention, on average, 73.2% of these districts consist of population counts retained from the previous district (2009). This figure is 6-points higher than the average district overall, at 67.2%. The last column of the table indicates that none of incumbents from these twelve districts were paired with another incumbent due to redistricting.

Table 10. Challenged Districts- Partisanship, Core Retention, and Incumbency

District	2009 DVA	2011 DVA	Diff.	Core Retention	Incumbent Paired
63	57.6%	59.3%	+1.7	82.1%	No
69	76.6%	76.6%	+0.03	74.1%	No
70	75.8%	69.2%	-6.6	67.2%	No
71	74.9%	79.8%	+4.9	80.0%	No
74	71.9%	66.2%	-5.7	79.3%	No
75	50.5%	50.6%	+0.1	78.8%	No
77	65.4%	66.0%	+0.6	74.2%	No
80	70.0%	66.7%	-3.3	62.2%	No
89	71.3%	73.1%	+1.9	76.9%	No
90	64.4%	66.5%	+2.1	63.2%	No
92	72.5%	70.1%	-2.4	77.2%	No
95	68.2%	66.5%	-1.7	62.7%	No
Mean	68.3%	67.6%		73.2%	

Having examined the twelve challenge districts what conclusions can be drawn? First, the vast majority of these districts were heavily underpopulated by the time it was necessary to redraw district lines in 2011. Action was necessary, therefore, to correct the population issue. Second, these districts had all been majority-black districts in the previous legislative plan for the House of Delegates. Another goal then was to maintain this status for these districts to prevent retrogression from taking place. As the above table indicates, this was accomplished, but not in a mechanical fashion. The percentage of the black voting age population was increased in districts having the lowest black percentages and lowered in those which had the highest concentrations. Across these districts the average black VAP was essentially unchanged from 2009 to 2011. Compactness scores for this particular set of districts shows a larger drop, as compared to the overall redistricting plan. While an important criteria in drawing district boundaries, compactness must often give way to the constitutional demand for population equality and the demands of the Voting Rights Act. It is not possible to maximize all redistricting principles simultaneously as they will, at some point, come into conflict with one another. In this case, district compactness, while a priority, was not at the top of the list. Incumbency protection, however, was an important component of the redistricting plan implemented in 2011. These districts fit that criterion as they all score high on partisan composition (in this case Democratic makeup) and core population retention. In addition, none of the incumbents representing these districts were forced to vie electorally with another incumbent in the 2011 election. In 2011, all 12 Democratic incumbents from these districts were returned to office.

VI. LEGISLATIVE ROLL-CALL ANALYSIS

Governor's Veto

Republican Governor Robert McDonnell vetoed the initial redistricting bill discharged from the Virginia General Assembly (HB 5001). The issue, according to the Governor, lay not with the plan for the House of Delegates, but with the State Senate. McDonnell's veto message raised serious reservations concerning issues of compactness and maintaining communities of interest with the Senate plan. He also indicates that population deviations between Senate districts may actually be a 14th Amendment violation. Conversely, the Governor indicates that the House plan scores well on maintaining communities of interest and keeping population deviations between districts to a minimum. He goes as far to call the Senate plan a *partisan gerrymander* and notes that not a single Republican cast a ballot in favor of passage. In contrast, the Governor *applauded the House for its bipartisan approach*, noting that the House plan passed its own chamber 86 to 8, including 28 affirmative votes from Democratic lawmakers and 11 from black members.¹⁵

Legislative Votes on HB 5005

After the Governor's veto of HB 5001, the Senate redistricting plan was reworked and a new bill, HB 5005, was constructed. The House plan in HB 5005 was, for the most part, largely unchanged from its configuration in HB 5001.¹⁶ Table 11 below gives the

¹⁵ Governor's Veto of HB 5001. April 15, 2011. Located at: <http://lis.virginia.gov/cgi-bin/legp604.exe?112+amd+HB5001AG>.

¹⁶ The population shift across these two plans amounted to 26,510 people which equates to .33% of the total population. Looking at voting age population, 19,455 people were shifted to another district (.32% of the VAP).

distribution of floor votes in the House of Delegates for HB 5005. As shown, the bill had overwhelming support with 89.9% of the delegates participating voting in the affirmative. This support was also bipartisan in nature with all Republican delegates, three-quarters of Democrats, and both independents voting to support passage. Only nine Democrats voted against HB 5005. Four of these members had been paired with another incumbent by the plan. These four delegates accounted for 44.4% of the nay votes. Support for HB 5005 within the Black Caucus was even higher than overall Democratic support with 84.6% of this group voting yea.

Table 11. House Floor Vote on HB 5005-Initial Passage

	Yeas	Nays	Not Voting
HB 5001	89.9%	10.1%	----
	[80]	[9]	[11]
Republicans	100%	0%	----
	[52]	[0]	[7]
Democrats	74.3%	25.7%	----
	[26]	[9]	[4]
Black (D)	84.6%	15.4%	----
	[11]	[2]	[0]
Independents	100%	0%	----
	[2]	[0]	[0]

Notes: Entries are row percentages based on number in category voting. Frequencies in brackets.

After passage by the Senate with amendments relating to the Senate plan, the bill was returned to the House for final passage. Again, as demonstrated by Table 12 there is both overwhelming support

overall (90% favoring passage) and from a bi-partisan perspective as well. Again, 100% of Republicans supported passage along with 75% of Democrats. Within the Democratic caucus, 90% of Black Caucus members voting on HB 5005 were in the yea column. Again, a considerable amount of the opposition (42.9% of the nay votes) were cast by Democratic incumbents who had been paired with another incumbent.

Table 12. House Floor Vote on HB 5005-Final Adoption

	Yeas	Nays	Not Voting
HB 5001	90.0%	10.0%	----
	[63]	[7]	[30]
Republicans	100%	0%	----
	[41]	[0]	[18]
Democrats	75.0%	25.0%	----
	[21]	[7]	[11]
Black (D)	90.0%	10.0%	----
	[9]	[1]	[3]
Independents	100%	0%	----
	[1]	[0]	[1]

Notes: Entries are row percentages based on number in category voting. Frequencies in brackets.

VIII. ELECTION ANALYSIS

In this section I will compare the results of the 2009 election (previous plan) to the 2011 election for the House of Delegates (current plan). Table 13 below presents the breakdown following these two elections

by political party. From the 2009 to the 2011 elections the Republican majority in the House of Delegates increased by 8 members. The Democratic caucus lost 7 seats, and the number of unaffiliated delegates decreased from 2 members to 1.

Table 13. Seats Held by Political Party in the Virginia House of Delegates

Party	2009	2011
Republican	59%	67%
Democratic	39%	32%
Independent	2%	1%
Total	100	100

Table 14 categorizes the partisan seat distribution in the House of Delegates while examining the race of the elected members. Across the 2009 and 2011 election cycles the number of black House of Delegates members remained constant at 13. One additional Asian representative was elected along with the chamber's first Hispanic member. The largest change across these two cycles centers on the loss of white Democrats in the House of Delegates. Following the 2009 election there were 26 white Democrats. After the 2011 election this number had dropped to 17. In summary, following the 2011 election the number of seats held by black members remained constant and the number of seats held by other minority groups increased by 2 (1 Hispanic and 1 Asian), while the number of white Democrats declined by nine. The redistricting plan implemented in 2011 appears then to have had the effect of increasing the number of Republican delegates at the cost of white Democrats.

Table 14. Seats Held by Political Party and Race in the Virginia House of Delegates

	2009			2011		
	Republican	Democrat	Independent	Republican	Democrat	Independent
White	58%	26%	2%	66%	17%	1%
Black	0%	13%	0%	0%	13%	0%
Hispanic	0%	0%	0%	0%	1%	0%
Asian	1%	0%	0%	1%	1%	0%
Totals	59	39	2	67	32	1

Notes: Entries are total percentages.

A more detailed look sheds some light on what made these white Democrats vulnerable in 2011. Table 15 below demonstrates that these seven white Democrats occupied districts in 2011 that were marginal from a partisan standpoint (districts that contained less than a majority of Democratic partisans). Following redistricting and just prior to the 2011 elections, there were 11 Democratically-held districts¹⁷ in which the Democratic vote average (DVA) ranged from 25.0% to 49.9%, or less than a majority Democratic. The remaining Democratic-held districts, 28 in all, had DVA values of 50.0% or greater. None of the Republican-held districts had a DVA value greater than 49.2%.

Table 15. Partisan Seat Distribution Categorized by the Democratic Vote Average prior to the 2011 Election

	0-24.9%	25.0-49.9%	50.0-74.9%	75.0-100%	Totals
Republican	1.7%	98.3%	0%	0%	
	[1]	[58]	[0]	[0]	59
Democrat	0%	28.2%	66.7%	5.1%	

¹⁷ Here I am categorizing seats based on the party of the incumbent holding the seat following the 2009 election.

	[0]	[11]	[26]	[2]	39
Independent	0%	100%	0%	0%	
	[0]	[2]	[0]	[0]	2

Notes: Entries are row percentages. Frequencies in brackets.

The next table examines the partisan seat distribution following the 2011 election, again categorizing districts by their DVA values. Looking at Table 16, one may note that the losses for Democratic-held seats all occurred in districts that were marginal from a partisan standpoint. Following the 2011 election, Democrats held only four seats in districts where there were less than a majority of Democratic partisans. Only 12.5% of Democratically-held seats were located in districts comprised of less than 50% of their fellow-partisans, compared to 100% of Republican-held seats which were located in districts with a majority of Republican partisans.¹⁸

Clearly, the redistricting plan adopted kept Democratic partisans spread across far more districts, whereas Republican partisans were more concentrated. This was especially detrimental for white Democrats occupying marginal seats from a partisan perspective. From the standpoint of judging the implemented redistricting plan from a post-election perspective one can state the following: the GOP-majority in the House of Delegates was augmented; racial/ethnic minorities in Virginia realized representational gains;

¹⁸ The incumbent pairings also produced six open seats. Based on the party that previously held these open seats, four were occupied by Democrats and two by Republicans. Following the 2011 election, the GOP gained three of these seats and retained two others, leaving the Democrats in control of only one of these seats.

and the number of white Democrats was diminished. On the other hand, the ability of black Virginians to elect their preferred candidates was retained by the new 2011 plan.

Table 16. Partisan Seat Distribution Categorized by the Democratic Vote Average following the 2011 Election

	0-24.9%	25.0-49.9%	50.0- 74.9%	75.0-100%	Totals
Republican	1.5%	98.5%	0%	0%	
	[1]	[66]	[0]	[0]	67
Democrat	0%	12.5%	81.3%	6.3%	
	[0]	[4]	[26]	[2]	32
Independent	0%	100%	0%	0%	
	[0]	[1]	[0]	[0]	1

Notes: Entries are row percentages. Frequencies in brackets.

IX. OVERALL OPINION

After having analyzed the 2011 Virginia House of Delegates districting plan I have reached a number of conclusions. First, the plan implemented in 2011 meets the criteria of having districts with equal population counts. Deviations across all districts range between +/-1% from the ideal district size.

The plan received overwhelming bi-partisan support with large majorities of Republicans and Democrats voting in favor of passage. This support also included a super-majority of the Black Caucus in the House of Delegates. Viewed from the standpoint of goals to be accomplished, one could term the design as primarily an incumbent protection plan. Indeed, only a small set of incumbents are paired under the 2011 plan and the average district retained more than two-thirds of

its former voters.¹⁹ The former observation helps to explain, to a large degree, the noted support from delegates within the House.

To the extent a secondary political purpose can be detected, it would involve an effort to diffuse Democratic voting strength across Democratically-held districts, while simultaneously maintaining higher concentrations of GOP partisans in Republican-held districts. As demonstrated, no Republican-held district contained less than a majority of fellow partisans. On the other hand, with the new districting plan 11 Democratically-held seats contained somewhere less than a majority of Democratic partisans. An increase in marginal Democratic districts resulted, not surprisingly, in additional seat pickups for the Republicans in the 2011 election-cycle.

It should also be noted that this loss in Democratic-held seats did not come at the expense of minority legislators. In fact, from 2009 to 2011 the number of minority legislators increased by two with the addition of another Asian member and the chamber's first Hispanic delegate. The number of Black Caucus members stayed constant across the redistricting cycle as did the number of majority-black districts. All GOP seat pickups came at the expense of white Democrats (and one white Independent). Such marks a continued trend in Southern politics more recently where Republican gains have been realized at the cost of white Democrats. Moreover, these results are in line with the outcome that one would expect from a plan

¹⁹ For comparison, two alternative plans offered by the Democrats contained many more paired incumbents. Plan 4 had 23 incumbent pairings and Plan 5 contained 16.

drawn by a political party to leverage their majority status.

X. DECLARATION

I declare under penalty of perjury under the laws of the United States that the foregoing is true and correct to the best of my knowledge.

Executed on April 10, 2015.

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Academic Positions

University of Georgia
Professor, 2013-present
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Associate Professor, 2005-2013
Assistant Professor, 1999-2005.
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Education

Ph.D.	Political Science	Texas Tech University	1997
M.A.	Political Science	Baylor University	1993
B.S.	Political Science	Texas A&M University	1991

Peer-Reviewed Books

The Rational Southerner: Black Mobilization, Republican Growth, and the Partisan Transformation of the American South. 2012. New York: Oxford University Press.

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“The Rational Southerner: The Local Logic of Partisan Transformation in the South.” (with Quentin Kidd and Irwin L. Morris). 2008. Paper presented at the Citadel Symposium on Southern Politics. Charleston, SC.

“Stranger Danger: The Influence of Redistricting on Candidate Recognition and Vote Choice.” (with Seth C. McKee). 2008. Paper presented at the Annual Meeting of the Southern Political Science Association. New Orleans.

“Backward Mapping: Exploring Questions of Representation via Spatial Analysis of Historical Congressional Districts.” (with Michael Crespin).

2007. Paper presented at the Annual Meeting of the American Political Science Association. Chicago.
- “Worth a Thousand Words? : An Analysis of Georgia’s Voter Identification Statute.” (with Charles S. Bullock, III). 2007. Paper presented at the Annual Meeting of the Southwestern Political Science Association. Albuquerque.
- “Gerrymandering on Georgia’s Mind: The Effects of Redistricting on Vote Choice in the 2006 Midterm Election.” (with Seth C. McKee). 2007. Paper presented at the Annual Meeting of The Southern Political Science Association. New Orleans.
- “Personalismo Politics: Partisanship, Presidential Popularity and 21st Century Southern Politics.” (with Quentin Kidd and Irwin L. Morris). 2006. Paper presented at the Annual Meeting of the American Political Science Association. Philadelphia.
- “Explaining Soft Money Transfers in State Gubernatorial Elections.” (with William Gillespie and Troy Gibson). 2006. Paper presented at the Annual Meeting of the Midwest Political Science Association. Chicago.
- “Two Sides of the Same Coin?: A Panel Granger Analysis of Black Electoral Mobilization and GOP Growth in the South, 1960-2004.” (with Quentin Kidd and Irwin L. Morris). 2006. Paper presented at the Citadel Symposium on Southern Politics. Charleston, SC.
- “Hispanic Political Emergence in the Deep South, 2000-2004.” (With Charles S. Bullock, III). 2006. Paper presented at the Citadel Symposium on Southern Politics. Charleston.

- “Black Mobilization and the Growth of Southern Republicanism: Two Sides of the Same Coin?” (with Quentin Kidd and Irwin L. Morris). 2006. Paper presented at the Annual Meeting of the Southern Political Science Association. Atlanta.
- “Exploring the Linkage Between Black Turnout and Down-Ticket Challenges to Black Incumbents.” (With Troy M. Gibson). 2006. Paper presented at the Annual Meeting of the Southern Political Science Association. Atlanta.
- “Race and the Ideological Transformation of the Democratic Party: Evidence from the Bayou State.” 2004. Paper presented at the Biennial Meeting of the Citadel Southern Politics Symposium. Charleston.
- “Tracing the Evolution of Hispanic Political Emergence in the Deep South.” 2004. (Charles S. Bullock, III). Paper presented at the Biennial Meeting of the Citadel Southern Politics Symposium. Charleston.
- “Much Ado about Something? Religious Right Status in American Politics.” 2003. (With Mark C. Smith). Paper presented at the Annual Meeting of the Midwest Political Science Association. Chicago.
- “Tracking the Flow of Non-Federal Dollars in U. S. Senate Campaigns, 1992-2000.” 2003. (With Janna Deitz and William Gillespie). Paper presented at the Annual Meeting of the Midwest Political Science Association. Chicago.
- “PAC Cash and Votes: Can Money Rent a Vote?” 2002. (With William Gillespie). Paper presented at the Annual Meeting of the Southern Political Science Association. Savannah.
- “What Can Gubernatorial Elections Teach Us About American Politics?: Exploiting and Underutilized

- Resource.” 2002. (With Quentin Kidd and Irwin L. Morris). Paper presented at the Annual Meeting of the American Political Science Association. Boston.
- “I Know I Voted, But I’m Not Sure It Got Counted.” 2002. (With Charles S. Bullock, III and Richard Clark). Paper presented at the Annual Meeting of the Southwestern Social Science Association. New Orleans.
- “Race and Southern Gubernatorial Elections: A 50-Year Assessment.” 2002. (With Quentin Kidd and Irwin Morris). Paper presented at the Biennial Southern Politics Symposium. Charleston, SC.
- “Top-Down or Bottom-Up?: An Integrated Explanation of Two-Party Development in the South, 1960-2000.” 2001. Paper presented at the Annual Meeting of the Southern Political Science Association. Atlanta.
- “Cash, Congress, and Trade: Did Campaign Contributions Influence Congressional Support for Most Favored Nation Status in China?” 2001. (With William Gillespie). Paper presented at the Annual Meeting of the Southwestern Social Science Association. Fort Worth.
- “Key 50 Years Later: Understanding the Racial Dynamics of 21st Century Southern Politics” 2001. (With Quentin Kidd and Irwin Morris). Paper presented at the Annual Meeting of the Southern Political Science Association. Atlanta.
- “The VRA and Beyond: The Political Mobilization of African Americans in the Modern South.” 2001. (With Quentin Kidd and Irwin Morris). Paper presented at the Annual Meeting of the American Political Science Association. San Francisco.

“Payola Justice or Just Plain ‘Ole Politics Texas Style?: Campaign Finance and the Texas Supreme Court.” 2001. (With Craig Emmert). Paper presented at the Annual Meeting of the Midwest Political Science Association. Chicago.

“The VRA and Beyond: The Political Mobilization of African Americans in the Modern South.” 2000. (With Irwin Morris and Quentin Kidd). Paper presented at the Annual Meeting of the Southern Political Science Association. Atlanta.

“Where Have All the Republicans Gone? A State-Level Study of Southern Republicanism.” 1999. (With Irwin Morris and Quentin Kidd). Paper presented at the Annual Meeting of the Southern Political Science Association. Savannah.

“Elephants in Dixie: A State-Level Analysis of the Rise of the Republican Party in the Modern South.” 1999. (With Irwin Morris and Quentin Kidd). Paper presented at the Annual Meeting of the American Political Science Association. Atlanta.

“Stimulant to Turnout or Merely a Convenience?: Developing an Early Voter Profile.” 1998. (With Quentin Kidd and Grant Neeley). Paper presented at the Annual Meeting of the Southern Political Science Association. Atlanta.

“The Impact of the Texas Concealed Weapons Law on Crime Rates: A Policy Analysis for the City of Dallas, 1992-1997.” 1998. (With Grant W. Neeley). Paper presented to the Annual Meeting of the Midwest Political Science Association. Chicago.

“Analyzing Anglo Voting on Proposition 187: Does Racial/Ethnic Context Really Matter?” 1997. (With Irwin Morris). Paper presented to the Annual

Meeting of the Southern Political Science Association. Norfolk.

“Capturing Bubba's Heart and Mind: Group Consciousness and the Political Identification of Southern White Males, 1972-1994.” 1997. Paper presented at the Annual Meeting of the Midwest Political Science Association. Chicago.

“Of Byrds[s] and Bumpers: A Pooled Cross-Sectional Study of the Roll-Call Voting Behavior of Democratic Senators from the South, 1960-1995.” 1996. (With Quentin Kidd and Irwin Morris). Paper presented to the Annual Meeting of the Southern Political Science Association. Atlanta.

“Pest Control: Southern Politics and the Eradication of the Boll Weevil.” 1996. (With Irwin Morris). Paper presented to the Annual Meeting of the American Political Science Association. San Francisco.

“Fit for the Greater Functions of Politics: Gender, Participation, and Political Knowledge.” 1996. (With Terry Gilmour, Kurt Shirkey, and Sue Tolleson-Rinehart). Paper presented to the Annual Meeting of the Midwest Political Science Association. Chicago.

“¿Amigo o Enemigo?: Racial Context, Attitudes, and White Public Opinion on Immigration.” 1996. (With Irwin Morris). Paper presented to the Annual Meeting of the Midwest Political Science Association. Chicago.

“¡Quedate o Vente!: Uncovering the Determinants of Hispanic Public Opinion Towards Immigration.” 1996. (With Irwin Morris and Kurt Shirkey). Paper presented to the Annual Meeting of the Southwestern Political Science Association. Houston.

“Downs Meets the Boll Weevil: When Southern Democrats Turn Left.” 1995. (With Irwin Morris). Paper presented to the Annual Meeting of the Southern Political Science Association. Tampa.

“¿Amigo o Enemigo?: Ideological Dispositions of Whites Residing in Heavily Hispanic Areas.” 1995. (With Irwin Morris). Paper presented to the Annual Meeting of the Southern Political Science Association. Tampa.

Chair. Panel titled “Congress and Interest Groups in Institutional Settings.” 1995. Annual Meeting of the Southwestern Political Science Association. Dallas.

“Death of the Boll Weevil?: The Decline of Conservative Democrats in the House.” 1995. (With Kurt Shirkey). Paper presented to the Annual Meeting of the Southwestern Political Science Association. Dallas.

“Capturing Bubba’s Heart and Mind: The Political Identification of Southern White Males.” 1994. (With Sue Tolleson-Rinehart). Paper presented to the Annual Meeting of the Southern Political Science Association. Atlanta.

Other Professional Presentations

“Much Adieu About Nothing?: An Empirical Assessment of Georgia’s Voter Identification Statute.” 2010. Presentation made to the Department of Political Science, Texas Tech University. Lubbock, TX.

“Report on the Aftermath of the 2010 Midterm Elections.” 2010. Presentation made to the Oconee County Republican Party. Watkinsville, GA.

“Non-Precinct Voting in Georgia-A Survey of Voters from the 2008 Election.” 2010. Presentation made to the Jeannette Rankin Foundation Program: The Life and Legacy of Jeannette Rankin: Championing Election Reform. Athens, GA.

“Non-Precinct Voting in Georgia, 2008.” (With Charles S. Bullock, III). Presentation made at the Annual Meeting of the Georgia Election Officials Association. Savannah.

Areas of Teaching Competence

American Politics: Behavior and Institutions Public Policy

Scope, Methods, Techniques

Teaching Experience

University of Georgia, 1999-present.

Director of Graduate Studies, 2011-present.

Graduate Faculty, 2003-present.

Provisional Graduate Faculty, 2000-2003.

Distance Education Faculty, 2000-present.

Texas Tech University, 1993-1999.

Visiting Faculty, 1997-1999.

Graduate Faculty, 1998-1999.

Extended Studies Faculty, 1997-1999.

Teaching Assistant, 1993-1997.

Courses Taught:

Undergraduate:

American Government and Politics, American Government and Politics (Honors), Legislative Process, Introduction to Political Analysis, American Public Policy, Political Psychology, Advanced Simulations in American Politics (Honors), Southern Politics, Southern Politics (Honors)

Graduate:

Election Administration and Related Issues,
Political Parties and Interest Groups, Legislative
Process, Seminar in American Politics, Southern
Politics; Publishing for Political Science

Editorial Boards

Social Science Quarterly. Member. 2011-present.

Election Law Journal. Member. 2013-present.

Institutional Service (University-Level)

University Program Review Committee, 2009-2011.
Chair, 2010-2011
Vice-Chair, 2009-2010.

Graduate Council, 2005-2008.
Program Committee, 2005-2008.
Chair, Program Committee, 2007-2008.

University Libraries Committee, 2004-2014.

Search Committee for University Librarian and Asso-
ciate Provost, 2014.

EXPERT REPORT FOR *BETHUNE-HILL V.*
VIRGINIA STATE BOARD OF ELECTIONS

Jonathan N. Katz

April 10, 2015

I asked by legal counsel in this case to examine the reapportionment plan for the Virginia House of Delegates under the map enacted by the Virginia General Assembly in 2011 in HB 5005 as well under the map in place from 2001 until 2011, the Benchmark Map. In particular, I was asked to examine the geographical compactness and the racial composition of the legislative districts as well as voting patterns. I was to pay specific attention to the twelve challenged House districts (HDs 63, 69, 70, 71, 74, 75, 77, 80, 89, 90, 92, and 95), which I will refer to as the “Challenged Districts”. In particular, I was asked to assess whether African-Americans in these districts have the ability to elect the preferred candidate of their choice and whether it appears that the General Assembly packed African-Americans into these districts to dilute the voting strength of minorities in other districts. In addition to providing my own analyses and opinions, I was asked to provide my opinions on the analysis and conclusions of Dr. Stephen Ansolabehere as detailed in his expert report dated March 11, 2015. In making my findings, I have applied standard statistical methods, which I regularly employ in my research and which have been published in peer-reviewed journals

A summary of my report and basic findings is as follows:

- Dr. Ansolabehere’s choice of the particular compactness measure used in his analysis is arbitrary and not justified. Using an alternative and more justified measure of compactness, I show

that the HB 5005 map is as compact as the Benchmark map.

- Dr. Ansolabehere's ecological regression analysis of racially polarized voting is flawed using a discredited statistical method and does not examine the most relevant elections, those for the House of Delegates.
- I show that elections for the Virginia House of Delegates in the Contested Districts show substantial racially polarized voting using the currently accepted statistical methodology.
- In the Contested Districts, my analysis shows that a Black voting population of 55% predicts only an 80% chance of a Black candidate winning that district.
- I show that Dr. Ansolabehere's results on the inclusion of particular VTDs in the Contested districts is overwhelmingly predicted by its racial composition is incorrect as he did not account for geographical distance in his analysis.

In the next section of the report I review my qualifications. In section 2, I discuss and analyze the compactness of the legislative maps. Section 3 examines Dr. Ansolabehere's ecological regression analyses. The final section presents my own analysis of racial polarization and the racial packing of the Contested Districts.

1. QUALIFICATIONS

I am currently the Kay Sugahara Professor of Social Sciences and Statistics at the California Institute of Technology. I was also formerly on the faculty at the University of Chicago and a visiting Dr. at the

University of Konstanz (Germany). A complete copy of my curriculum vitae is in the Appendix.

I received my Bachelor of Science degree from the Massachusetts Institute of Technology and my Masters of Arts and Doctor of Philosophy degrees, both in political science, from the University of California, San Diego. I have also done post-doctoral work at Harvard University and the Harvard-MIT Data Center. I am an elected fellow of both the American Academy of Arts and Sciences and the Society for Political Methodology. I am a former fellow of the Center for Advanced Study in the Behavioral Sciences.

I have written numerous articles published in the leading journals as set forth in my curriculum vitae. I am currently the co-editor of Political Analysis, the journal of the Society for Political Methodology¹, and I am a co-founding editor of the Political Science network (a collection of online journals). I sit on the editorial board of two leading journals, Electoral Studies and Political Research Quarterly, and I previously also served on the editorial board of the American Journal of Political Science. I have also served as a referee of manuscripts for most of the major journals in my fields of research and for the National Science Foundation.

I have done extensive research on American elections and on statistical methods for analyzing political science data. I am a member of the Caltech/MIT Voting Technology Project, serving as the co-director of the project from October 1, 2005 to September 30, 2010.

¹ Political methodology is the development of statistical and research tools in political science.

Over the past decade, I have testified or consulted in numerous elections cases for both Democratic and Republican clients involving the Federal Voting Rights Act, the evaluation of voting systems, or the statistical evaluation of electoral data. I have testified or consulted in court cases in both state and Federal courts in the states of Arizona, California, Florida, Georgia, Indiana, Illinois, Maryland, Michigan, Missouri, New Mexico, Nevada, Oklahoma, Texas, and Washington.

2. COMPACTNESS

Compactness is a concept related to whether or not a district is closely or neatly packed together. Shapes such as circles and hexagons are relatively compact, and so districts that look like them are considered to be more compact than winding districts with borders that have many twists and turns. In an effort to quantify compactness, scholars have employed more than 20 distinct measures to evaluate legislative districts throughout the United States.² Unfortunately, these measures can often lead to different conclusions about a given plans compactness³.

In Dr. Ansolabehere's report, he chose to use the Reock measure from this large array of compactness measures for his analysis, but he used no theoretical or empirical justification for its application in Virginia. There is no indication whether this measure is appropriate for the data at hand or instead whether it was cherry picked to support the plaintiff's case.

² See Niemi et al. (1990)

³ Altman (1998, chapter 5), Niemi et al. (1990), and Young (1988)

Reock measure is based on the idea that a circle is the most compact geometric shape, and it therefore computes the ratio of the area of each district to the area of the minimum bounding circle enclosing that district. Unfortunately, Reock and similar measures based on circle geometry have several serious limitations. I discuss these flaws below.

Since the academic literature does not identify a definitive standard by which to evaluate compactness, the determination of whether or not the Challenged Districts and the remaining districts throughout the state should not be based on one ad hoc choice and certainly not on one measure alone. Further, if one measure were chosen it would likely not be Reock.

Thus, I provide here an alternative measure of compactness that is based on an academic standard used and cited in the academic literature almost three times as often as Earnest Reock's original paper, and that avoids key challenges befalling Reock and similar measures based on circle geometry. I first discuss the flaws of the Reock measure and then discuss the results from the better measure that I introduce.

2.1. Inappropriateness of the Reock Measure for Virginia Districts

The first important limitation of the Reock measure is that it consistently penalizes districts that are long and narrow, or that have long and narrow sections — even if these districts have fixed state borders or other reasons for these shapes. This occurs because a long district will necessarily produce a minimum bounding circle with a large diameter. Since the area of the resulting minimum bounding circle is a function of its diameter, a long district will typically produce a minimum bounding circle with an area much larger

than its own. In fact, Virginia as a whole displays this elongated shape.

An example of this narrowness penalty can be seen in Figure 1 which displays the maps of Districts 4 and 66. While District 4 does not appear visually to be substantially more compact than District 66 — note especially the many turns and arms off the shape on the right — the latter has a much lower Reock score as a result of its narrower shape.⁴ This happens because the Reocks measure ignores everything about the shape of the district except for the diameter of the bounding circle.

The Reock measure applies its penalty to long, narrow districts even when their shape is constrained by state lines, coastlines, or other features that cannot be altered in the process of drawing districts. District 1 illustrates this point as can be seen Figure 2.

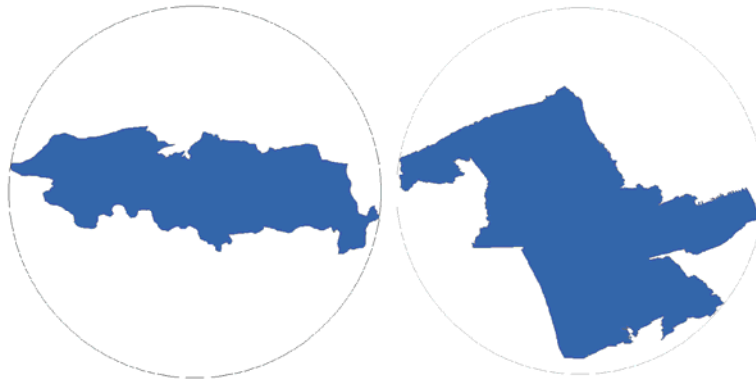


Figure 1: Maps of Districts 66 (Left) and 4 (Right) in HB 5005

⁴ Approximately 0.25 for District 66 and 0.41 for District 4

This district has a low Reock score⁵ The area shaded in dark blue represents the area within District 1.

The area shaded in light blue represents the only area in the minimum bounding circle that actually falls within the state of Virginia. All of the remaining area falls within Kentucky and Tennessee. While it is feasible to draw a district which contains all of the light blue area within this bounding circle, it is not feasible to draw a district that includes area in neighboring states.

In other words, Dr. Ansolabehere uses a measure that judges the compactness of District 1 badly because of the unalterable shape of Virginia. Clearly the shape of the entire state of Virginia cannot be changed as a result of this redistricting, and people living in neighboring states have nothing to do with the compactness of districts within Virginia.

As a result, the Reock score for District 1, as well as other districts similarly bordered by features that cannot be included in their area, will always be low. These low Reock scores, however, would not be indicative of any attempt to strategically include or exclude certain areas of the state.

Further, the Reock measure can likewise reward a district that is “arbitrarily misshapen”, so long as it “meanders around within a confined area.”⁶ Districts 2 and 17 both serve to illustrate this point as can be seen in Figure 3. While District 17 appears less compact than District 2, District 17 scores higher on the Reock scale. This is because the maximum distance between any two points on the perimeter of

⁵ Approximately 0.22 on the Reock scale.

⁶ Young (1988)

District 17 is smaller than the maximum distance between any two points on the perimeter of District 2, producing a slightly smaller bounding circle⁷. The Reock minimum bounding circle, in this case, does not capture the fact that the shape of District 17 is at least as unusual as District 2.

Finally, it is crucial to note that minimum bounding circles are purely an abstraction that do not and logically cannot correspond to real districts within any state. Indeed, a statewide legislative district map comprised of perfectly compact, circular districts with high Reock scores would necessarily violate the principle of contiguous, non-overlapping districts. After all, a set of circles cannot tile a plane. That is, if you try to tile the state (or your kitchen floor) with circular shapes, you will left with large gaps between the circles.

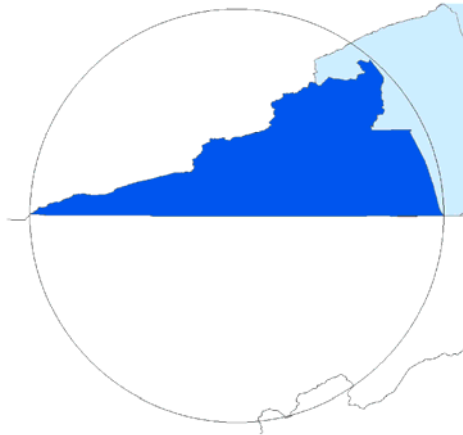


Figure 2: Map of District 1 in HB 5005

⁷ The diameter of the minimum bounding circle enclosing District 2 is approximately 38,999 miles, while the diameter of the bounding circle for District 17 is approximately 31,181 miles

In fact, the only way the Reock measure could be relevant to Virginia is if voters were legally permitted to cast ballots in multiple House of Delegates districts in the same election. This is because the only way to have perfectly compact districts by the Roeck measure would be for them to be circles. The only way to avoid gaps, which would disenfranchise the voters living in these unincorporated areas, would be for the circular districts to overlap.

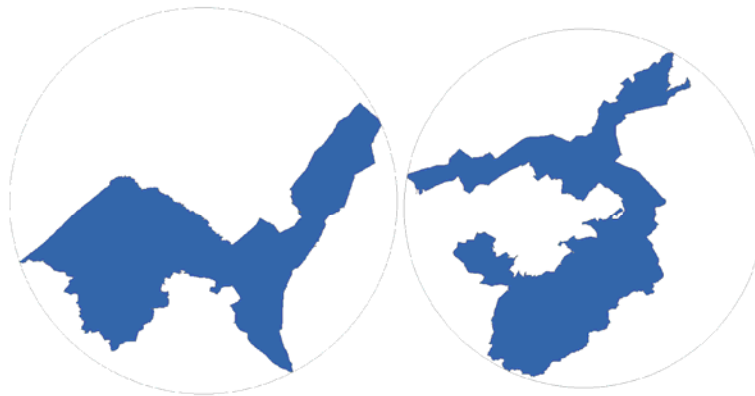


Figure 3: Map of Districts 2 (Left) and 17 (Right) in HB 5005

The image on the bottom of Figure 4 represents the state of Virginia with the HB 5005 district boundaries outlined in grey. The image on the top represents the ideally compact minimum bounding circles around each district. While these may be useful for some theoretical purposes, in practice they produce illegal districts that both overlap and escape state boundaries. Thus satisfying the Roeck measure is impossible: No set of circular districts can produce a contiguous, non-overlapping district map without leaving territory that fell outside of the districts or used territory from outside of the state.

Thus, a better strategy is to use a measure that respects the geometry of each district, rather than comparing each district to a theoretically ideal shape. Below, I detail and implement an approach that relies exclusively on the actual shape of each state legislative district under both the Benchmark and HB 5005 maps.

2.2. *Alternative Measures of Compactness*

I now introduce a more appropriate measure of compactness, one that fits better with the geographic nature of the state of Virginia.

Instead of measuring the compactness of a district by encasing it in some idealized shape, a circle in the case of Reock measure discussed above, an alternative approach is based on examining the distribution of voters within the district. These are referred to as “moment-of-inertia” measures in literature.⁸ Moment-of-inertia measures describe the spread of each voter in a district from its own “center of gravity”. Intuitively, the “center of gravity” is the point in the district that minimizes the total distance from every home in district to this point. In particular, the alternative measure that I use to evaluate the Virginia House of Delegate maps is the Boyce-Clark measure.⁹

⁸ see Niemi et al. (1990)

⁹ Boyce and Clark (1964)

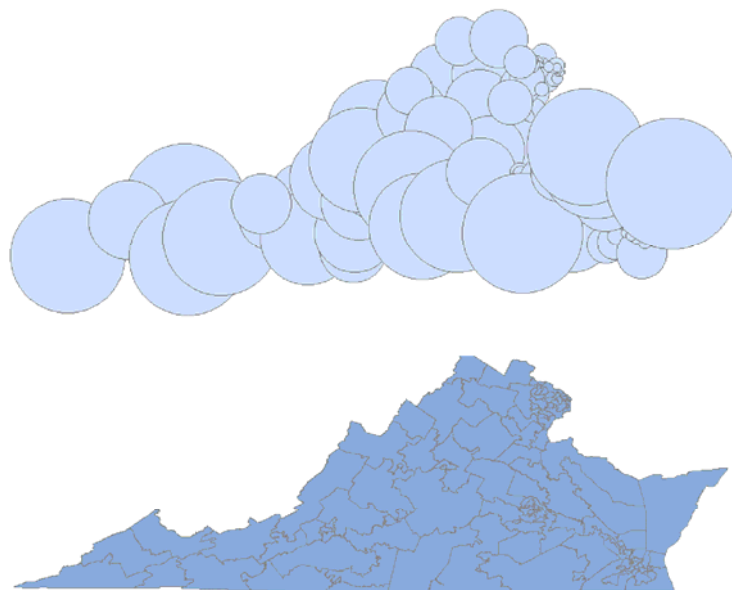


Figure 4: Minimum Bounding Circles for all of Virginia under HB 5005

The Boyce-Clark measure of compactness is based on the mean distance from each district's center of gravity to the points on its perimeter. This measure is well-documented and widely used in the academic literature, with 178 citations (relative to 60 for Earnest C. Reock's original article documenting his minimum bounding circle measure). I calculate an improved Boyce-Clark measure using the following steps:

1. Determine the center of gravity for each district under the Benchmark Map and HB 5005
2. For each district, measure the distance from its center of gravity to each of the vertices on the perimeter of the district (see Figure 5). This

represents a slight improvement to the original Boyce-Clark approach, which recommends measuring the distances from the center of each district to points on its perimeter along a set of equally spaced radial lines. Using lines to the vertices rather than equally spaced lines to the perimeter makes the measure invariant to rotation.¹⁰ By always drawing a line from the center of the district to each vertex, I ensure that I always capture the outermost vertices of each district.



Figure 5: Average Distance from Center of Gravity to District Vertices in District 11 of the Benchmark Map

3. Calculate the average distance from each vertex in the district to its center.

¹⁰Consider a district shaped like a five pointed star, but with unequally spaced points. Under one set of equally spaced radial lines, I would capture some short distances from the center to the inner walls of the star and some long distances from the center to the outer points. But rotating the radial lines slightly might lead me to capture more of the longer distances from the center to the points, and fewer of the shorter distances. This would increase my estimate of the average distance from the center to the outermost points, and it might increase my estimate of the variation from that average.

4. Calculate the absolute value of the percent difference between each center-vertex distance in the district and the average of all center-vertex distances in the district

5. For each district the modified Boyce-Clark measure represents the average of the differences between each center-vertex distance and the average for the district. This can be thought of as the average percent deviation from the mean among the distances from the center of each district to its perimeter. Since this measure is scaled as a percentage, it is bounded between 0 and 1. The most compact district, under this measure, would have a score of 0.

A summary of my findings based on the modified Boyce-Clark measure are as follows:

1. In the Benchmark Map, the Challenged Districts had an average Boyce-Clark score of 0.46 whereas in HB 5005 they show an average Boyce-Clark score of 0.44. Since a smaller value on the Boyce-Clark scale indicates greater compactness, this represents an improvement of approximately 0.02 points on the Boyce-Clark scale, or 4%.

2. In the Benchmark Map, the remaining 88 districts in the state had an average Boyce-Clark score of 0.46 whereas in HB 5005, the remaining 88 districts show an average Boyce-Clark score of 0.47. This represents a small decrease in compactness of approximately 0.01 on the Boyce-Clark scale, or 2%.

3. In the Benchmark Map, there is no appreciable difference in compactness between Challenged Districts and statewide districts. In HB 5005, compactness in the Challenged Districts is 0.03

points higher on the Boyce-Clark than it is statewide — i.e., are more compact.

4. 9 of 12 Challenged Districts saw increased in compactness in HB 5005, as did 39 of the remaining 88 districts in the state.

The complete set of findings from my compactness analysis can be found in the Appendix. A summary measure of the compactness across both the Benchmark and HB 5005 can be found in Table 2 and the results the Challenged Districts can be found in Table 3

3. DR. ANSOLABEHERE'S "ECOLOGICAL REGRESSION" ANALYSES

In order to estimate the voting behavior of African-Americans, Whites, and members of other races that vote for particular candidates, Dr. Ansolabehere uses a statistical technique called "ecological regression analysis". Ecological regression was invented more than a half century ago (Goodman, 1953). Since then, considerably better statistical procedures for ascertaining the voting preferences of minority groups have been invented and are now in widespread use throughout the academic literature and in litigation in numerous voting rights cases. One well-documented indication of ecological regression's many failures is that it produces estimates for the share of each racial group who voted for a specific candidate that are logically impossible. In fact, this technique routinely estimates, for instance, that more than 100% of the white population within a particular district will have voted for a certain candidate. The sections that follow discuss the reasons for those results.

I replicate Dr. Ansolabehere's results in the analysis that follows, finding that many of the estimated vote

shares he estimated are indeed outside of the 0%-100% interval and therefore logically impossible. In nearly every Challenged District, his method produces an estimate outside of possible bounds for each racial group's vote share limit. This defect in his approach is not discussed in the report, which instead hides the problem by rounding results outside of possible bounds to 0 or 1 and neglects to discuss the error.

If estimates that are logically impossible are so common in his results, the ones that are logically possible, but produced by the same procedure, certainly should not be trusted. In fact, all I know about these other estimates is that they are theoretically possible (something I knew without the analysis or without any data). In other words, a method that routinely produces some estimates that anyone would know are wrong does not inspire confidence that any other estimates are correct either. Several studies with access to data with the true proportions being estimated have shown that many of those numbers tend to be wrong as well.

3.1. *Determining Vote Share By Race*

A common starting point in the process of estimating the share of each racial group voting for a specific candidate is to consider only homogeneous districts. That is, I could examine the election results from districts that are closest to racially homogeneous in character. For example, if a districts were completely racially homogeneous, say with a population that was 100% African-American, then I know what fraction of African-Americans voted for a given candidate in the district: it is just the share the given candidate got in the district. While this might be a useful starting point, as a statistical procedure, it is

problematic since it throws out most of the data unless most of the districts are homogeneous.

However, I can use the intuition from the homogeneous districts to place bounds on the level of support each group gives a candidate. Consider the following equation, which is true by definition, that relates the vote share of given candidate to the voting behavior of African-Americans and Whites:

$$V = \lambda^B_i X_i + \lambda^W (1 - X_i),$$

(1) where V_i is the share of the vote a given candidate received in district i , X_i is the fraction of African-Americans in the district and therefore $(1 - X_i)$ is the fraction of White (or more correctly non-African-American) voters, assuming for the moment that there are only two groups in the electorate. λ^B_i is the fraction of African-Americans voting for the given candidate and similarly λ^W_i is the fraction of Whites voting for the given candidate. In other words, the equation states the fact that the total vote share for a candidate must equal the proportion of African-American voters who support them multiplied by the proportion of the electorate that is African-American plus the proportion of the White voters who support the candidate multiplied by the proportion of the electorate which is White. In the case of only two groups e.g., African-Americans and Whites and only two candidates, then racially polarized voting occurs when $\lambda^B_i \neq \lambda^W_i$. The larger the difference between support levels, the greater the level of polarization. Duncan and Davis (1953) fully developed the method of bounds outlined above to analyze ecological data.

3.2. *Ecological (or "Goodman's") Regression*

One approach to estimating λ^B_i and λ^W_i , the shares of African-American and White voters voting for a

specific candidate, is referred to in the literature as ecological regression or Goodman's regression. This is the procedure that Dr. Ansolabehere uses in his report. Like the method of bounds, it is based on the identity in Equation 1. Suppose that the fraction of support for a given candidate for both Whites and African-Americans was the same across all precincts in the district. A bit more formally, suppose that $\lambda^B_i = \lambda^B$ and $\lambda^W_i = \lambda^W$ for every precinct i . Then I could estimate these fractions by choosing the best fitting line to the precinct-level data. This is just a standard linear regression, the most commonly used statistical procedure in the social sciences. From these estimates I could then compare the voting behavior between groups.

As I noted above, ecological regression can produce widely inaccurate estimates of group voting behavior.¹¹ First, the assumption that the fraction of group support is constant across every precinct is highly implausible. Second, ecological regression does not use the bounds information either at the district level (discussed above) nor even the overall bounds that the average fraction of a group's support for a given candidate must be between zero and one. For example, as I will see some of the elections examined here, ecological regression analysis produced negative estimates for the fraction of a group supporting a particular candidate, and estimates of more than 100% of a group supporting a particular candidate in some cases.

3.3. *Replication of Ecological Regression Results*

Dr. Ansolabehere's report presents ecological regression estimates of each Democratic candidates

¹¹ See King (1997).

two-party vote share among African-Americans, Whites and members of other races in his Table 13. In this section, I replicate his procedure and report these results. I do not aggregate my elections by level of jurisdiction. My replication results show a series of logically impossible vote share estimate. Rather than rounding these to their logical minimum or maximum value, as Dr. Ansolabehere did, I display these results and highlight the ones that cannot possibly represent real vote shares. Taking the 2014 U.S. House election results under the Benchmark Map as an example, my estimates show that 114%, 103%, 107%, 102%, 109%,

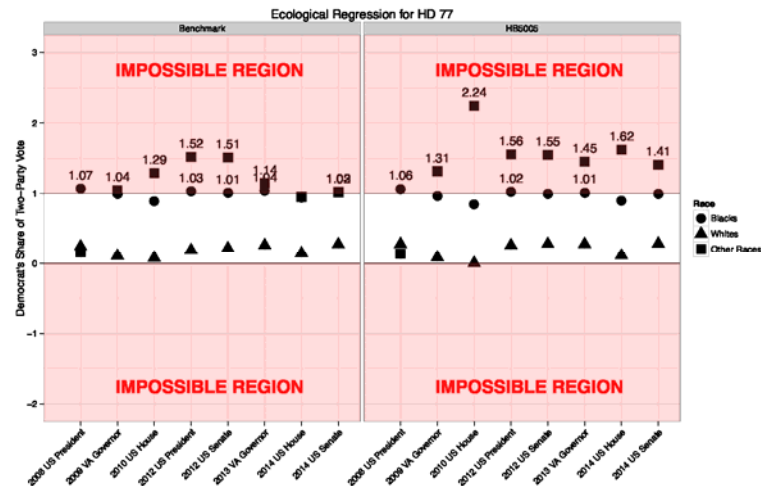


Figure 6: Ecological Regression Results, District 77

108%, 104%, and 102% of the African American vote went to the Democratic candidate in Districts 63, 69, 70, 71, 74, 80, 90, and 95, respectively.

I similarly show several cases in which the share of votes from members of other races won by the Democratic candidate is negative in multiple elections under the Benchmark Map and HB 5005. For

example, In the 2009 gubernatorial race in District 95, an ecological regression approach produces estimates indicating that the Democratic candidate won -106% of the vote among members of other races. The Democratic candidate likewise won -30% of their vote in the 2010 U.S. House election and -2% of their vote in the 2012 U.S. Senate race. (see Figure 6). Note that the Democratic candidate's share of the African-American vote in this district is over 100% in all but three elections under the Benchmark map, as well as in three elections under HB 5005.

Figure 7 provides a detailed depiction of ecological regression results for every Challenged District in both the Benchmark and HB 5005. A summary of the finding for these districts are:

District 63 Dr. Ansolabehere's report indicates that 100% of the African-American vote went to the Democratic candidate for governor in 2013 under HB5005. My results indicate that the true estimate from his methodology, rounded to 100% in his report, is 106%. Clearly, this is impossible. Similarly, Dr. Ansolabehere's report indicates that the average share of the African-American vote going to the Democratic candidate in federal elections under the benchmark map is 100%. In fact, my results show that the ecological regression procedure yields estimates of over 100% of the African-American vote share going to the Democratic candidate in every federal election I analysed since 2008. This is also impossible.

District 69 Dr. Ansolabehere's report indicates that 100% of the African-American vote went to the Democratic candidate for governor in 2013 under the benchmark map. My results indicate that the true estimate, rounded to 100% in his report, is 101%. This is impossible. Similarly, Dr. Ansolabehere's report

indicates that the average share of the African-American vote going to the Democratic candidate in federal elections under the benchmark map is 100%. In fact, my results show that the ecological regression procedure yields estimates of over 100% of the African-American vote share going to the Democratic candidate in my of the federal elections I analyzed since 2008. This is also impossible.

District 74 Dr. Ansolabehere's report indicates that 100% of the African-American vote went to the Democratic candidate for governor in 2013 under both the Benchmark Map and HB5005. My results indicate that the true estimates, rounded to 100% in his report, are 105% for each map. This is impossible. Similarly, Dr. Ansolabehere's report indicates that the average share of the African-American vote going to the Democratic candidate in federal elections under both the Benchmark Map and HB5005 is 100%. In fact, my results show that the ecological regression procedure yields estimates of over 100% of the African-American vote share going to the Democratic candidate in every federal election I analyzed since 2008 under the Benchmark Map. This is also impossible.

District 77 Dr. Ansolabehere's report indicates that 100% of the African-American vote went to the Democratic candidate for governor in 2013 under both the Benchmark Map and HB5005. My results indicate that the true estimates, rounded to 100% in his report, are 104% and 101% for the Benchmark Map and HB5005, respectively. This is impossible.

District 89 Dr. Ansolabehere's report inidicates that 100% of the African-American vote went to the Democratic candidate for governor in 2013 under both the Benchmark Map and HB5005. My results indicate that the true estimates, rounded to 100% in his report,

are 103% and 100% for the Benchmark Map and HB5005, respectively. The first result is impossible. Similarly, Dr. Ansolabehere's report indicates that the average share of the African-American vote going to the Democratic candidate in federal elections under both the Benchmark Map and HB5005 is 100%. In fact, my results show that the ecological regression procedure yields estimates of over 100% of the African-American vote share going to the Democratic candidate in all but one federal election I analyzed since 2008 under the Benchmark Map. This is also impossible.

District 90 Dr. Ansolabehere's report indicates that 100% of the African-American vote went to the Democratic candidate for governor in 2013 under the Benchmark Map. My results indicate that the true estimate, rounded to 100% in his report, is 103%. This is impossible. Similarly, Dr. Ansolabehere's report indicates that the average share of the African-American vote going to the Democratic candidate in federal elections under the Benchmark Map is 100%. In fact, my results show that the ecological regression procedure yields estimates of over 100% of the African-American vote share going to the Democratic candidate in all but one federal election I analyzed since 2008 under the Benchmark Map. This is also impossible.

District 92 Dr. Ansolabehere's report indicates that the average share of the African-American vote going to the Democratic candidate in federal elections under the Benchmark Map and HB5005 is 100%. In fact, my results show that the ecological regression procedure yields estimates of over 100% of the African-American vote share going to the Democratic candidate several federal elections under the Benchmark Map and HB5005. This is impossible.