

LAND AND WATER AREAS OF DELAWARE

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HISTORICAL NOTES ON THE EXISTING AREAL FIGURES OF DELAWARE

Deeds and titles to tracts of land usually contain a description of their location, boundaries, and size. But if we expect to find in historical references definite indication of how much land the Duke of York conveyed on the 24th of August, 1682, to William Penn in the two deeds of feoffment for "the Town of New Castle, and all that tract of land lying within the compass or circle of twelve miles about the same, and all that tract of land extending southward from it, along the Delaware, to Cape Henlopen,"¹ which at present constitutes the State of Delaware, we are to be disappointed, for there is none. There are cogent reasons for the omission. First, to be able to determine the size of an area, its boundaries must be known; and second, in case of an extensive portion of land, it must be mapped. The grant was obscure on both counts. No definite boundary was mentioned in the deed, making it "certain to provoke great opposition from the Marylanders, since the Duke's patents did not include the territory granted away," and no accurate maps of the area existed at that time.

Historic records show that Lord Baltimore did oppose William Penn's claim vigorously. The dispute that

¹ Scharf, John Thomas, History of Delaware, 1609-1888. Philadelphia, 1888, Vol. I, P. 114.

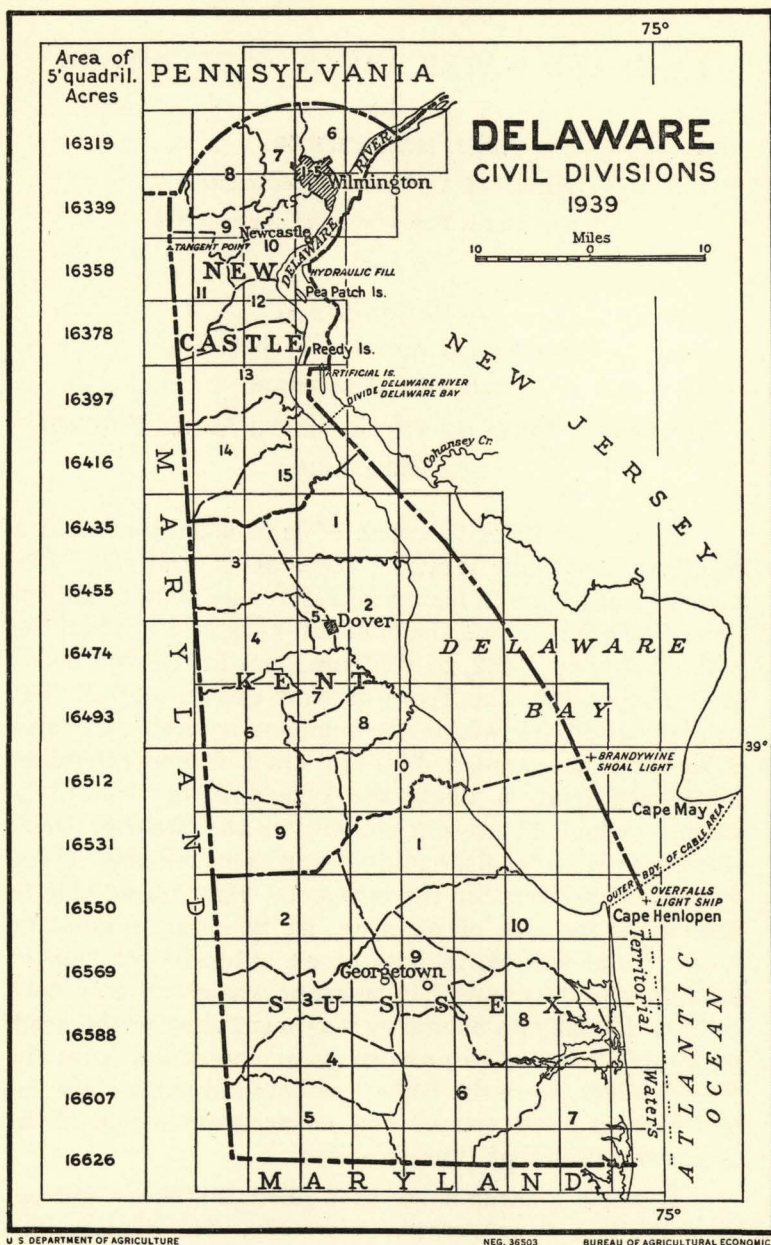


FIGURE 1—Present State, County, and Representative District Boundaries of Delaware.

arose was settled in 1685 by royal order to divide the territory equally between the claimants. Commissions were appointed twice to survey the line, but could not agree. A third commission was appointed in 1760 after an agreement had been reached between Pennsylvania and Maryland on the basis of a decision made by Lord Chancellor Hardwick in 1750.

"A due East-West line was to be run across the peninsula from Cape Henlopen to Chesapeake Bay. From the exact middle of this line, a line was to be drawn North which would be tangent to the Western arc of a circle having a radius of 12 English statute miles measured horizontally from the center of the town of New Castle. From the tangent point a line was to be drawn due North until it intersected a parallel of latitude 15 miles due South of the southernmost part of the City of Philadelphia. This point of intersection would be the Northeast corner of Maryland, and from it the line was to be run West on a parallel as far as it formed the boundary between the two provinces."²

The boundary was run accordingly, although it will be observed that Cape Henlopen as the starting point of the boundary on the Atlantic Coast is not the point known by that name at the present time, but is the point Lord Hardwick had indicated as Cape Henlopen for the purpose.³ Before the boundary was accepted, it was verified by the two English surveyors, Charles Mason and Jeremiah Dixon, who also ran the boundary between Maryland and Pennsylvania known as the Mason-Dixon line. The boundary thus established was confirmed by the King in January 1769, but it was not until April 8, 1775, that the Governor and the Commander in Chief of the Counties of New Castle, Kent and Sussex, upon Delaware, published his proclamation, officially establishing the

² Douglas, Edward M., *Boundaries, Areas, Geographic Centers and Altitudes of the United States and the Several States*, U. S. Geological Survey Bulletin No. 817, Washington, 1930, P. 120.

³ Douglas, E. M.—*Idem*, P. 126.

boundary.⁴ This was on the eve of the Revolutionary War, from which Delaware emerged as the first State of the Union.

Delaware started statehood with boundaries fairly well established on the land. The arc of the twelve mile circle separating Delaware from Pennsylvania had been surveyed and marked in 1701 under a warrant issued by William Penn.

As a matter of geographic information, statements of the size of the State and even of the size of the counties began to appear shortly after the turn of the century. In the geographical description of Delaware by Scott⁵ in 1807, the following areal figures appear for Delaware:

State total	1,267,200 acres ⁶ —(P. 159)
New Castle County	336,000 acres —(P. 175)
Kent County	355,000 acres —(P. 181)
Sussex County	576,000 acres —(P. 184)

Colton's Atlas,⁷ 1857 and subsequent editions, contain tables of the areas of the States, in which Delaware is credited with an area of 2,120 square miles. No explanation is given as to what this figure includes, but considered on the supposition that this figure applies to the land area of Delaware as outlined on the map—for no boundary is indicated between Delaware and New Jersey that would warrant the conclusion that part of the water surface of the Delaware River and Bay is included—it still leaves out a triangular tract of land of about 840 acres located West of the arc, East of Maryland and South of the Mason-Dixon line. This tract had been assigned to Pennsylvania in 1850 in a resurvey of the boundary, but it reverted to Delaware in 1897.⁸

⁴ Hanston, John W., Address on the History of the Boundaries of the State of Delaware, Wilmington, The Historical Society of Delaware, 1879, P. 106.

⁵ Scott, Joseph, A Geographical Description of the States of Maryland and Delaware. Philadelphia, 1807.

⁶ This figure appears in the book but is evidently erroneous, as the County totals show the state acreage to be 1,267,000.

⁷ Colton's General Atlas of the World, New York, 1857.

⁸ Douglas, E. M.—Idem. P. 121-122.

Up to the 1870's there existed no survey of the entire state. State maps that could be used as basis for areal measurements must have been compilations from varied sources. This condition changed with the appearance of Beers' Atlas of Delaware in 1868. Beers' maps of the hundreds were not only made from actual surveys (road traverse surveys no doubt) but were published on scales comparable with our topographic quadrangle sheets, 1 inch to the mile. They provided, therefore, a new base for measurements, and were used for this purpose. Tables included in the Atlas contain the area of each hundred, of which the county and state totals are as follows:

State total	2002.6 sq. mi. ⁹
New Castle County	424.2 sq. mi.
Kent County	613.6 sq. mi.
Sussex County	964.8 sq. mi.

The first areal figures for the states and counties issued by the federal government appeared in 1881 as a census publication.¹⁰ In this, the area of Delaware is itemized as: (P. 4)

Gross area	2050 sq. mi.
Coast waters (gulfs, bays, sounds, etc.) .	30 sq. mi.
Rivers and smaller streams	60 sq. mi.
Lakes and ponds
Total water surface	90 sq. mi.
Total land surface	1960 sq. mi.

The water surface "includes half of the boundary portion of the Delaware River as far south as Cohansey Creek; also Rehoboth Bay and Indian River." As authorities "for the Atlantic Coast, Delaware Bay, and the Delaware River south of latitude 39°30', the Coast Survey maps; for the Delaware River north of 30°30', the Geological Survey map of New Jersey; for the remaining boundaries, Colton's map and the Eclectic Geography Maps" (P. 5), are cited.

⁹ Beers, D. G., Atlas of Delaware, P. 18. From actual surveys by and under the direction of D. G. Beers, Philadelphia, 1868.

¹⁰ Gannett, Henry, The Areas of the United States, the Several States and Territories and their Counties, U. S. Census Office, Washington, D. C., 1881.

"The areas of counties . . . are the results of direct measurements from the best County maps, corrected arbitrarily in order to make them add up to the areas of the State." A note of caution is added for the States having no rectangular land survey, "where the county lines are located by minor natural or artificial points, such as houses, fences, roads or small streams, the probabilities are against their being correctly drawn on even the latest maps, and the areas are correspondingly uncertain. This is the case in most of the States on the Atlantic border . . ." (P. 10). For Delaware, the land area of the counties is given as: (P. 12)

Kent County	630 sq. mi.
New Castle County	430 sq. mi.
Sussex County	900 sq. mi.

A second table of the area of the states and territories was published by the General Land Office in 1899, in which the following figures appear for Delaware:¹¹

Land surface	1969 sq. mi.	1,260,160 acres
Water surface	411 sq. mi.	263,040 acres
Total area	2380 sq. mi.	1,523,200 acres

The two tables, as is evident from the Delaware figures, did not agree. The differences were slight in most cases, but were considerable in others. To avoid confusion, new measurements were made, and an agreement was reached between the offices concerned. The results set forth in a new table appeared in 1906. In this, the area of Delaware is recorded as being:¹²

Land surface	1965 sq. mi.
Water surface	405 sq. mi.
Total area	2370 sq. mi.

This last figure for the land area of Delaware is the one to which the figures of the approximate land area of

¹¹ Report of the Commissioner of the General Land Office, U. S. Department of the Interior, Washington, D. C., 1899, P. 86.

¹² Gannett, Henry, The Areas of the United States, the States, and the Territories, Bulletin No. 302, U. S. Geological Survey. Washington, D. C., 1906, P. 7.

the counties total and is used by the U. S. Census Bureau since 1910. Census figures are:

Total land area ...	1,257,600 acres	1,965 sq. mi.
New Castle County.	278,400 acres	435 sq. mi.
Kent County	394,880 acres	617 sq. mi.
Sussex County	584,320 acres	913 sq. mi.

Up to the present, the census figures have been used almost exclusively in statistical tables, although for Kent and Sussex Counties new figures, which differ considerably from the census figures, appeared with the soil survey reports in 1920 and 1924. The land area according to the Soil Survey is:

Kent County	380,160 acres ¹³
Sussex County	604,800 acres ¹⁴

It is obvious from these citations—and they are not given with any assurance of completeness—that there is no dearth in distinct figures for the area of Delaware and its counties. In fact, there is a superabundance of them, creating a perplexing situation for an investigator who must decide what constitutes factual value, especially when more rigorous demands of accuracy are made that cannot be satisfied with figures of doubtful validity. Only Gannett¹⁵ informs us how the area of the state was obtained. The areas of square degrees were used as control. Controlled measurements to determine the areas of counties are not reported for any of these figures.

SCOPE, METHOD, AND PROCEDURE OF NEW MEASUREMENTS

As long as areal figures served the primary purpose of providing a ready reference to permit general comparison among themselves, or to secure some ratios

¹³ Soil Survey of Kent County, Delaware: Field Operations of the Bureau of Soils, 1918, U. S. Department of Agriculture, Washington, D. C., 1920, P. 14.

¹⁴ Soil Survey of Sussex County, Delaware: Field Operations of the Bureau of Soils, 1920, U. S. Department of Agriculture, Washington, D. C., 1924, P. 1544.

¹⁵ *Idem*, 1906, P. 6.

roughly indicating the relationship of other factors to the area, the need for a definite degree of accuracy for these figures was not so evident. The situation changed when land use became the subject of economic investigation and analysis. In this process, it is necessary that the areas of political units and their subdivisions supply definite functional and factual values. Meeting these requirements has increased the significance of areal statistics as representing measured facts.

Especially in the more densely populated states, where land is used more intensively, investigations in land use of restricted areas such as have been undertaken for each of the Delaware counties by the Department of Agricultural Economics of the University of Delaware, necessarily have to rest on a reliable foundation in regard to size of area involved. But counties are still comparatively large areas within which the prevailing natural background and even economic conditions may, and quite often do, vary considerably in different parts. In order to apprehend significant distinctions in physical, economic, and social characteristics of the various land areas through comparative study and statistical analysis, these distinctions must be localized in their occurrence as they are found in subdivisions of a county.

The minor civil divisions of counties in Delaware are now known as representative districts, which serve voting purposes and are also used by the census as enumeration divisions. Statistics of population and agriculture are available in tabulated form for these districts and, in order to establish their relationship to the area, the areal extent of the districts must also be known. The need for information on the size of these districts, and the contradictory nature of the existing figures for the land area of the counties and their consequent uncertain factual value, made a redetermination of the area of the state by counties and representative districts an absolute necessity.

In land economics investigations, the areal extent is one of the important elements that must be considered

in its association with the quality and location of the land. The numerous quality grades, produced by the interaction of land relief, climate, and soil, form a most irregular pattern in outline, distribution, and areal composition. Uniformity does not extend over large areas. Even within the comparatively narrow limits of a farm, the differences in the quality of various portions of the land may be such as to preclude the same use possibilities for each portion. What is true of individual farms applies with equal or even greater force to the land area of political divisions and the state as a whole.

The range in possible land uses may be very large but also very restricted, depending upon prevailing regional conditions. How severe the natural restrictions can be for the higher use of the land becomes evident if reference is made to some of our western states. Nevada, for instance, although having about 56 times as much land as Delaware, reports a somewhat lower average crop acreage.¹⁶ Such marked differences in land use reflect, of course, the contrast in the climatic background of the regions in which they occur. Nevertheless, they furnish an effective example to press home the point that the over-all land area alone, whether of a state, county, or in most cases even of a farm, is not a true measure of land equipment for economic production of organic supplies or raw material furnished by farms and forests. Distinctions in land quality grades must be recognized, and their areal extent measured separately. To test the reliability of the results obtained, the independently determined total land area provides then the necessary check, for the sum of the acreages of these land classes must equal the total land area.

The area of water bodies within the limits of political units and divisions is usually only a secondary interest in land-use investigation, although it throws light on the nature of the land itself. It also helps to interpret the combined use-capabilities of these resources.

¹⁶ Agricultural Statistics, 1938, U. S. Department of Agriculture, Washington, D. C., 1938. Table 552, P. 429.

Management of water resources and land use frequently cannot be divorced but must be considered jointly. Artificial changes in the distribution of land and water in the form of ponds, reservoirs, ship and drainage canals, etc., on the one side, and made and reclaimed land on the other, are some of the external cultural manifestations found in a region. They furnish evidence of how far man will go in his endeavor to master and adjust the natural environment to suit his convenience, and permit a more efficient utilization of the natural resources. Moreover, land plus water surface area discloses the areal limitations of governmental jurisdiction.

Delaware has only in recent years been put in a position to have its measures taken with a greater degree of accuracy. The first topographic quadrangle sheets representing portions of Delaware were published by the U. S. Geological Survey, Washington, D. C., in 1898, while the last one was issued as recently as 1936. With the completion of this survey, the entire state of Delaware was covered for the first time with horizontally controlled surveys, on a uniform scale of 1:62,500, that could be used as the basis of direct areal measurements yielding results of determinable reliability.

Controlled surveys are essential to obtain controlled areal measures on maps. On horizontally controlled surveys the triangulation net provides a rigid framework that acts as control in the representation of natural and cultural features in the area. For every one of the triangulation stations, the geographic position in terms of latitude and longitude has been computed to a high degree of precision. Before the survey starts, the triangulation points are plotted in corresponding position in the grid of parallels and meridians of the field sheets, thus serving as points of reference of location for the other features. As a result, all of the surface features are represented on the map, correctly placed with reference to the geographic coordinate system of parallels and meridians.

Survey maps of this kind, on which only a small portion of the earth spheroidic surface is represented on

the plane, may be considered for practical purposes as images true to scale in all directions; consequently they are also free of angular and areal distortions. The quadrilaterals formed by the parallels and meridians are therefore preserved in true proportion to the scale of the map, and their known acreage provides a positive control for direct areal measures taken on the map.

The acreage of quadrilaterals bounded by parallels and meridians, computed independently of the map as geometric surface divisions of the mathematical figure of the earth, permits not only a close control of areal measures themselves, but at the same time eliminates the error induced by the small variations in map scale as a result of the instability in the size of the paper on which the maps are printed. Shrinkage and expansion of the paper are primarily the reaction to its hygroscopic sensitive-ness, which is by no means a constant, applicable alike to all sheets. Rather frequent minor adjustments in the setting of the planimeter must be made to counteract the vagaries in behavior of the paper of different map sheets on the same scale.

The degree of accuracy obtainable in direct areal measurements taken on a miniature image of the original in terms of actual size is, of course, not absolute. It would be illusory to expect for every square inch recorded as measured quantity on the map an areal equivalent of exactly 3,906,250,000 square inches in nature. This, at least, is the areal ratio of represented to natural surface that applies to maps on the scale of 1:62,500. A certain amount of error is unavoidable in such direct measurements, but the margin of probable error can be held within definite bounds. The recording precision of a high-class instrument is perhaps more than equal to the precision with which a careful and skilled operator can follow the outline of an irregular area with the tracer point of the planimeter. Differences in the recorded amount from repeated measurements of the same area are, therefore, not so much the result of instrumental imperfections as of the inability of the operator to trace

the outline of an area without the slightest deviations. Repeated measurements are necessary, therefore, in most cases to average and verify the results.

In the mensuration of the Delaware land and water areas, the procedure followed is that of using the 122 quadrilaterals of 5 minutes square, within which Delaware is located, as units for which their known acreage functioned as control. Their acreage is not uniform. On account of the convergency of the meridians, their size decreases with advancing latitude quite noticeably even in the narrow zone of $1^{\circ}23'$ within which Delaware is located. The area of these quadrilaterals along the southern boundary is 16,626 acres, and for those farthest north 16,300 acres.¹⁷ In every one of these geometric areal units, the component parts in the form of portions of representative districts, major water bodies, and in border cases, the area outside the state line as complements, were measured separately and their sum compared with the total acreage of the quadrilateral. If it was found that the difference did not exceed $\pm 0.2\%$ of the total area of the quadrilateral, adjustments in the measured areas were made proportionate to their size. In other words, ± 32 acres difference between the sum of the measured areas and the actual area of the quadrilaterals 5 minutes square, which in our case contain in all more than 16,000 acres, constituted the admissible maximum of proportional adjustment.

Objections may be raised to the method employed in adjusting differences, in that it does not conform strictly to the proper principle applicable in the case. The relative probable error of measurements for the various acreages, which varies inversely with the size of the area, it may be argued, should have been taken into account in the apportionment of the difference. Considering, however, the magnitude of the task, the relatively

¹⁷ Marschner, F. J., *The Need of Revision of Areal Figures of the United States by Counties with Tables of the Areas of Quadrilaterals of the Earth's Surface of Five Minutes Extent in Latitude and Longitude*. U. S. Department of Agriculture, Washington, D. C., October 1929. Mimeographed.

small quantities involved, the existing differential in precision of areal outline on the map, and the compensative nature of the errors themselves, the resulting theoretic improvement would hardly justify the prodigious expenditure in time and labor needed for the process.

Measurements were taken with a Coradi rolling disk planimeter set to record acres as vernier units. Small areas containing less than 5 or 6 acres, for which the relative possible errors of measurement are likely to be the highest, were estimated to the nearest acre with the aid of a superposed cellophane template containing a dense net of small squares of known areal content. The area of numerous small water bodies had to be determined in this way. Creeks and canals constitute another of those unfavorable cases—long perimeter, small area—for direct measurement of their surface area with the planimeter. Only the larger ones, of which the banks are represented on the map by individual lines, are included in the compilation of the water surface. Their surface area was computed by sections of nearly equal width from measurements of width and length. Creeks and ditches shown on the map with a single line are included in the land area.

A uniform degree of validity of the results obtained from such measurements is not solely conditioned on the method employed and the care with which the measurements were made, but depends equally on a uniform degree of accuracy in the feature expression of the map. The forty years it took to complete the topographic survey of Delaware have been years of unprecedented progress and change. They have also put their imprint on the surface of land and water. The quadrangle sheets that appeared first are, therefore, far from being up-to-date in their contents. Changes wrought by nature and made by man have affected to some extent the actual areas and relative proportions of land and water within the confines of the state. Boundary modifications for the minor civil divisions of the counties, as well as for the exterior boundary of the state itself, have been made. In addition,

the mapping method has changed markedly with the use of aerial photography.

Aerial photography did not exist at the time the topographic survey was started. The first airplane photograph was taken in the United States in 1911. It is an oblique view of College Park, Maryland.¹⁸ Aerial photography for mapping purposes is a post-war development. Although rapid progress has been made, only the later topographic quadrangle sheets of Delaware show the influence of aerial photography in their refinements of detail.

Delaware has been photographed twice from the air with a time lapse of about 13 years. The first aerial photographs were taken for the Delaware State Highway Department in 1926, and the second for the United States Agricultural Adjustment Administration—New Castle and Kent Counties in 1937, and Sussex County in 1938. A comparison of the photographs with the earlier quadrangle sheets reveals a good many changes that affect the land and water area. Some of the outstanding ones are: the widening and partial relocation of the Chesapeake-Delaware Canal; a marked change in outline and increase in area of Pea Patch Island in the Delaware River; changes in the banks and decrease in the water surface in the lower part of Nanticoke River on account of dredging; new shorelines have been produced as a result of the closing of the old inlet to Rehoboth and Indian River Bay and opening of a new one farther south; and the draining of old ponds and the building of new ones.

These are some of the actual changes that took place in the time interval between ground survey and aerial survey. There are other discrepancies which must be considered as due to the mapping method. They are particularly noticeable in marshy shorelines, in the course of creeks, and the occurrence of ponds within marshy or swampy areas, which, from the nature of the land, made

¹⁸ Baisley, Capt. H. K., *Aerial Photography*, Smithsonian Report for 1936, Washington, D. C., 1937, PP. 383-390.

these features difficult of access for ground survey; consequently they could not receive in the old surveys the refinement in outline and apprehension of detail possible to record with aerial photography.

To bring the older topographic maps as far as feasible up to par with the later ones, important corrections, as revealed by the aerial photographs, were entered on the maps before measurements were taken.

Changes in political boundaries are not less in evidence than changes in land and water areas, but in contrast with the latter, political boundaries cannot be detected on aerial photographs except where they are known to coincide with such distinctly visible features as streams, creeks, shorelines, and roads.

The state boundary between Maryland and Pennsylvania on the one side and Delaware on the other is well established and marked on the ground, but the New Jersey-Delaware boundary has only recently been established more definitely by a Supreme Court decree of June 3, 1935.

The New Jersey-Delaware boundary was first mentioned in 1664 in the grant, relating to New Jersey, by the Duke of York to Lord Berkely and Sir Carteret wherein the boundary was described as the "Low water mark on the eastern side of the River Delaware, within the twelve-mile circle from New Castle; and the middle of the bay below said circle."¹⁹ The Supreme Court decree recognizes the boundary as described within the circle, but departs from it below the circle. To quote from the decree: "Within the twelve-mile circle (that is, within the circle the radius of which is twelve miles, and the center of which is the building used prior to 1881 as the courthouse of New Castle, Delaware, certain arcs of which are hereafter described and determined), the Delaware River and the subaqueous soil thereof up to mean low water line on the easterly or New Jersey side is adjudged to belong to the State of Delaware, and the true boundary line between the States within said twelve-mile

¹⁹ Douglas, Edward M., *Idem*, P. 116.

circle is adjudged to be mean low water mark on the easterly or New Jersey side of the Delaware River.

"Below said twelve-mile circle the true boundary line between the States of New Jersey and Delaware is adjudged to be the middle of the main ship channel in Delaware River and Bay.

"The real, certain and true boundary line separating the States of New Jersey and Delaware, in Delaware River and Bay thus determined is shown upon the annexed composite map"

The description of this boundary in the text and its position on the map accompanying the text decree is within the twelve-mile circle identical in location with the old boundary as shown on the topographic quadrangle sheets, with the exception of a minor adjustment across Salem Cove and a rather marked shift in position of the southern arc of the circle from the New Jersey shore to the ship channel in the river. No cognizance is taken, either in the text of the decree or on the map, of an artificial change in the position of the mean low water mark, which took place with the construction of the bulkhead bar dike and the Killcohook dike enclosing the "Hydraulic Fill" area in the Delaware River adjoining the Killcohook Meadows in New Jersey. The Hydraulic Fill and the Killcohook Meadows constitute what is known as the "Killcohook Disposal Area" acquired by the United States through purchase and State cession (1925 Laws of Delaware 6), and is primarily under the jurisdiction of the War Department. Executive Order No. 6582, February 3, 1934, established the area as the "Killcohook Migratory Bird Refuge," and as such it is also subject to regulation by the United States Department of the Interior. At present only about one-fifth of the Hydraulic Fill area of $570 \pm$ acres remains under water all the time, and no part of the fill area is affected by the ebb and flow of the tide.²⁰ Although there seems to be

²⁰ The information concerning the "Hydraulic Fill" has been courteously supplied by the District Engineer, United States Engineer Corps, Philadelphia.

some doubt of the ultimate disposition of the Hydraulic Fill, whether the area will belong to Delaware or New Jersey, present indications are that it is located in Delaware, and consequently it has been included in the area of New Castle County in our computation.

The boundary south of the twelve-mile circle consists now of straight-line sections following the middle of the ship channel in the lower Delaware River and Delaware Bay proper. Its location is now tied to permanent navigation signals, and provides a definite dividing line of jurisdiction between Delaware and New Jersey of that portion of the Delaware River and all of Delaware Bay.

County boundaries are well established on the land but seemingly end at the shore of Delaware Bay. However, in order to be able to assign definite portions of the bay area to counties, a dividing line must be used. The New Castle-Kent County boundary is extended on the topographic maps out into the bay to intersect the state line, and was used in determining the water surface area of these counties. The Kent-Sussex County line stops at the mouth of the Mispillion River. To obtain a dividing line that connects visible points, a straight line was drawn between the bayward-end of the northern Mispillion breakwater and Brandywine Shoal Light to the intersection with the state line. There was also need of a definite line separating the waters belonging to Delaware in Delaware Bay from those of the ocean. Following the same principle, the outer boundary of the Delaware portion of the Cable Area, marked by buoys, and connecting Cape Henlopen with Cape May, served the same purpose.

The Cable Area boundary may be considered also as a geographic line separating Delaware Bay from the Atlantic Ocean. For the same reason, to give areal definition to Delaware River and Delaware Bay, a line of separation is drawn on the map accompanying the Supreme Court decree which approximately links Liston Point on the Delaware side with the mouth of Hope Creek in New Jersey. Although they are two quite distinct geographic entities, Delaware River and Delaware Bay merge into

each other without any clearly perceptible natural indications in the contour of the shorelines as to where one ends and the other begins. A number of sites have been mentioned as the terminus of the river and entrance of the bay, but none of them has received lasting acceptance. The Duke of York referred to the river within the twelve-mile circle, and to the bay below said circle (see P. 105). According to Scott; "All that part south of Reedy Island, to the Atlantic Ocean, which is about 60 miles, is called the Bay of Delaware . . . Reedy Island is the rendezvous of outward bound vessels in autumn and spring from the ports of Philadelphia and Wilmington. Vessels of every description, find at all times a safe harbour at Reedy Island, where piers are erected. The navigation is easy and safe. Vessels are about 24 hours in ascending to Philadelphia."²¹ This was before 1807. In 1881, Gannett extended the "Delaware River as far south as Cohansey Creek" (see P. 95). Now that the Supreme Court has drawn a line, it has been used to tabulate under separate headings the water area of the river and of the bay belonging to Delaware.

DETERMINATION OF BOUNDARIES OF REPRESENTATIVE DISTRICTS

The representative district boundaries are in some parts of Delaware the least distinct of the boundaries that had to be recognized. Representative districts have developed from the old townships called "Hundreds," with their boundaries identical in most places. The hundreds are an old institution; they began to be established in colonial times. "The first mention of the term 'Hundred' was in 1690 when on April 9th of that year the Provincial Council instructed the magistrates and grand juries of the Counties to divide them into hundreds. The term 'Hundred' is supposed to be derived from a suggestion made by William Penn, that the land be divided between ten families in accordance with an old English

²¹ Scott, *Idem*, P. 163.

custom, assuming that each family was ten in number making one hundred."²² Neither the representative district boundaries nor the hundred boundaries have ever been properly surveyed and marked on the ground.²³ The nearest approach to a survey of the hundreds boundaries is found in Beers' Atlas of the State of Delaware, which is composed of maps of the hundreds as they existed at that time.²⁴ Although the representative districts are now the political subdivisions of counties, the hundreds are still referred to and used by the people. In fact, rural election districts of the representative districts are described in every case as portions of hundreds, or in cases where they are coextensive with a hundred, they are identified with the name of the hundred.²⁵

For the two northern counties, the boundaries of representative districts are almost completely delineated on the topographic quadrangle sheets, but changes have occurred since the maps were issued. Wilmington City has expanded its corporate limits, and has thus altered the representative district boundaries. Changes in water channels, with which the boundary of a representative district is identified, have also affected in some instances the location of these boundaries.

In Sussex County, the representative district boundaries are not indicated on the topographic maps. Other maps showing these boundaries do so with notable discrepancies in their location. To a large extent, these boundaries are identified with roads, rivers, and creeks. These features provide visible evidence of their location all along the line, and do not admit a great deal of misinterpretation. The discrepancies are found, therefore,

²² Conrad, Henry C. History of the State of Delaware from the Earliest Settlement to the Year 1907, Wilmington, Del., 1908, Vol. II, P. 684—See also Scharf, Idem. Vol. II, P. 611 for letter of William Penn on the Subject to the Justices of Peace in Sussex County dated Chester, the 25th of Tenth Month, 1682.

²³ Revised Code of Delaware, 1915, P. 10, Section 9.

²⁴ Beers, D. G. Idem.

²⁵ Registration, Primary and General Election Laws of the State of Delaware. Compiled by the Secretary of State, 1936. PP. 102-151.

principally where boundaries run across the country. To establish their location in such doubtful places, actual field investigation was necessary.

At a number of points, where highways and hundred boundaries intersect each other, the Historic Markers Commission has set a laudable precedent in erecting markers. These markers not only fix the boundary location at these points, but contain also pertinent historical annotations. In between such points, the boundary in use, fixed by custom and tradition, may not follow the straight line indicated on the existing maps. Local residents along the boundaries point out certain landmarks, such as old trees or stumps, ditches, etc., which are used as boundary signs separating the voters of adjoining districts. Evidence of this kind had to be accepted to determine the location of the boundaries in these doubtful places, and to delineate them on the maps. Definite representative district boundaries had to be drawn also in Indian River and Rehoboth Bay to allot the riparian water areas to the respective districts.

As a rule, representative district boundaries do not follow property lines. In this respect they are not unique, however. The state boundary between Maryland and Delaware exhibits the same disregard for land ownership. And how could it be otherwise? Straight political boundary lines, about 34 and 82 miles long, drawn after the land was settled, cannot be expected to coincide with property lines.

As the determining factor of the area, boundary lines, natural and political, necessarily had to receive first attention as a preliminary step, before the measurements of land and water areas were taken.

RESULTS OBTAINED

Tabulation of the results of measurements was done by unit areas—quadrilaterals of 5 minutes square—in which the component parts of land and water areas were arranged in distinct columns, supplemented by headings

for the bay and river areas and the outside complements. In this way the results were balanced with the control, and provided an automatic check to guard against tabulation errors. In condensed form, the results are shown in Table 1.

TABLE 1—Land and Water Areas by Counties, State of Delaware.

	Acres	Square Miles
Land area of New Castle County	274,114	428.30
Land area of Kent County	378,930	592.08
Land area of Sussex County	602,460	941.34
<hr/>		<hr/>
Total Land Area	1,255,504	1961.72
Total Interior Water Surface	33,128	51.76
Delaware River Area	34,087	53.26
Delaware Bay	212,791	332.49
<hr/>		<hr/>
Total Area	1,535,510	2399.23

The data for the total area of the State of Delaware as shown in Table 1, do not include the area of territorial waters along the Atlantic Coast. The so-called territorial waters are usually not considered as being part of the country on which they border, although by common consent of the nations, the country may claim jurisdiction over the contiguous ocean area 3 nautical miles wide from the low-water mark on the shore. In the case of Delaware—having a nearly straight shoreline—a fairly close estimate of the area involved can be had from multiplying 23.62 statute miles, as the distance of the shore between the Cable landing point at Cape Henlopen and the Maryland-Delaware boundary, by 3 nautical miles, and adding to the product the area of the triangle formed by Overfalls Lightship, Cable Landing at Cape Henlopen, and the intersection of the outer Cable boundary with the Delaware-New Jersey State line. The area above defined contained about 53,740 acres, or 83.97 square miles, which may be considered as the territorial waters of Delaware.

The areas of the districts and a summary for each county are presented in Tables 2, 3, and 4.

TABLE 2—Land and Water Areas by Representative Districts,
New Castle County, Delaware.

Districts	Land Acres	Interior Waters Acres	Land Square Miles	Interior Waters Square Miles
1-5 (Wilmington)	6,462	375	10.10	0.59
6	20,086	66	31.38	0.10
7	20,964	400	32.76	0.62
8	27,704	21	43.29	0.03
9	15,395	63	24.05	0.10
10	24,120 ²⁶	173	37.69	0.27
11	29,177	367	45.59	0.57
12	14,405	337	22.50	0.53
13	43,022	726	67.22	1.13
14	35,993	605	56.24	0.95
15	36,786	684	57.48	1.07
TOTALS	274,114	3,817	428.30	5.96
Total land area	274,114		428.30	
Interior waters (ponds, reser- voirs, rivers, canals and in- shore tidal waters)	3,817		5.96	
Delaware River	34,087		53.26	
Delaware Bay	3,523		5.51	
TOTAL land and water area of county	315,541		493.03	

²⁶ The area of the "Hydraulic Fill," 570 acres, is provisionally included in district 10, although not entirely above water at present. (See page 106).

TABLE 3—Land and Water Areas by Representative Districts,
Kent County, Delaware.

Districts	Land	Interior	Land	Interior
		Waters		Waters
	Acres	Acres	Square Miles	Square Miles
1	38,772	2,339	60.58	3.65
2	50,957	1,225	79.62	1.91
3	39,054	61.02	...
4	40,690	49	63.58	0.08
5	6,300	106	9.84	0.17
6	52,357	46	81.81	0.07
7	21,366	214	33.39	0.33
8	30,221	416	47.22	0.65
9	55,488	42	86.70	0.07
10	43,725	613	68.32	0.96
TOTALS	378,930	5,050	592.08	7.89
Total land area	378,930		592.08	
Interior waters (ponds, reservoirs, rivers, canals and in-shore tidal waters)	5,050		7.89	
Delaware Bay	131,943		206.16	
TOTAL land and water area of county	515,923		806.13	

TABLE 4—Land and Water Areas by Representative Districts, Sussex County, Delaware.

Districts	Land	Interior Waters	Land	Interior Waters
	Acres	Acres	Square Miles	Square Miles
1	68,347	671	106.79	1.05
2	72,563	65	113.38	0.10
3	64,575	421	100.90	0.66
4	44,435	376	69.43	0.59
5	58,872	305	91.98	0.48
6	81,740	1,250	127.72	1.95
7	55,677	7,305	87.00	11.41
8	49,954	8,244	78.05	12.88
9	30,616	47.84	...
10	75,681	5,624	118.25	8.79
TOTALS	602,460	24,261	941.34	37.91
Total land area	602,460		941.34	
Interior waters (ponds, rivers, creeks, canals, and inshore tidal waters)	24,261		37.91 ²⁷	
Delaware Bay	77,325		120.82	
TOTAL land and water area of county	704,046		1,100.07	

CONCLUSION

The relative probable maximum error of ± 0.2 per cent of the foregoing areal measures applies to the unit areas—quadrilaterals of 5 minutes square—which are comparable in size to the smaller rural representative districts in New Castle County, but does not apply to larger areas. From the method employed in the mensuration of these areas, errors are not cumulative but compensative where larger areas are involved. The slight errors of measurement along district boundaries within a

²⁷ This includes Rehoboth and Indian River Bays with about 13 and 12 square miles, respectively.

county cancel each other when the county as a whole is considered, i.e., a minus error on one side of the boundary is compensated by a plus error of equal magnitude on the other side, and consequently cannot affect the county total. What is true of errors in district areas as related to county totals is equally true of errors incurred along the separating county boundaries as related to the state total. Probable errors are confined to the outside quadrilaterals and even then they are compensative, for it would be contrary to the experience to suppose that all are positive or all are negative. For larger than unit areas the relative error decreases with the increase in the size of the area.

As an index of accuracy, the error of direct areal measurements expressed as a percentage of actual area is as much dependent on the method of measurement as it is conditioned on the precision in outline of the areas measured. As has been pointed out, a uniform degree of precision in the areal expression of the topographic maps of Delaware is as yet not completely attained, even with the incorporated corrections on the older sheets. The unmarked location of representative district boundaries inject an element of uncertainty in some cases. The county boundaries and even the state boundary are so far legally incomplete, and permit only a tentative apportionment of the water area of Delaware Bay to the counties, and only a tentative separation of the Delaware area of the bay from the ocean. All these are limitations that preclude a definite statement as to the probable error in the area of districts, counties, and the state total.

Although the results of these measurements cannot be considered as being correct to the last acre, they represent about the closest approach to reality obtainable at the present time. Future remeasurements will, no doubt, produce some variations. In fact they must be expected because changes in shorelines and interior water bodies as well as in the boundary lines of representative districts will occur in the future as they have occurred in the past and will affect the areal measure accordingly.

Greater precision in areal measures of this kind would require a systematic cadastral survey of the land in the entire state, based on a plane coordinate system similar to those adopted in the neighbor States of New Jersey (Ch. 116, P. L. 1935) and Pennsylvania (Act 310, 1937) as well as New York and North Carolina, and has been introduced for legislative approval in six other states. Such land surveys are on a much larger scale, have closer-spaced horizontal control points, which admit a corresponding greater precision in location and delineation of detail, and, therefore, provide not only a base for a more exact determination of the area of political divisions, but also for a computation of acreage of individual holdings with the refinement needed in land titles, for land tax assessment or the appraisal of land values as mortgage security. Probably a good many years will pass before such a systematic land survey is available. It will also probably take years to eliminate boundary uncertainties. When this is accomplished, a final revision will produce some changes in the present figures but is unlikely to yield results that vary from the present ones by thousands of acres for the land area of the counties and state total as the old ones did, discounting, of course, actual changes in the land area. As a faithful translation of the graphic areal expression on existing maps into the numerical idiom of the economist, the present areal figures provide a reliable base for statistical analysis and study of the economic land resources of Delaware.