

The Mason-Dixon Mile

by B. K. MEADE

THE historical Mason-Dixon line, the east-west boundary between Maryland and Pennsylvania, was laid out in a survey by Mason and Dixon during the period 1765-1767. Prior to this survey, Mason and Dixon established the north-south boundary between Delaware and Maryland in 1764. In the survey of the north-south boundary, monuments were placed at intervals of one mile by Mason and Dixon.

Results from a resurvey of the Maryland-Delaware north-south boundary, performed by the U.S. Coast and Geodetic Survey (USC&GS, now the National Geodetic Survey (NGS), NOS, NOAA) in 1961-62, indicated that the monuments established by Mason and Dixon were spaced at average intervals of 5,292 ft. The east-west boundary between Maryland and Delaware, laid out by colonial surveyors in 1751, was resurveyed by the National Ocean Survey in 1974. Results from this resurvey show the unit of measurement used by the colonial surveyors was in close agreement with the Mason-Dixon value, that is, the unit used in the colonial and Mason-Dixon surveys was about one part in 400 greater than the present value of 5,280 ft. per mile.

The units of measurement used in these surveys are summarized in this report. Before giving details of the survey results, it is important here to outline the various sections of the boundaries as defined in the final agreement which was signed by Lord Baltimore and the Penn heirs on the 4th day of July, 1760.

Before the 1760 agreement was reached, various attempts had been made to settle the boundary disputes which had been going on for more than 80 years. On the 15th of May, 1750, Lord Hardwicke, high chancellor of the English Crown, issued a decree

reinforcing provisions of earlier agreements made in 1685 and 1732. The boundary, as defined in the final agreement of 1760, was essentially the same as the provisional agreement of 1732. By this agreement the Penns succeeded in obtaining all their claims from the Baltimores.

The provisional agreement of 1732 and the final agreement of 1760 provided for the following boundary surveys:

1) A due west line from Cape Henlopen at the Atlantic Ocean across the peninsula to the Chesapeake Bay (the Transpeninsular Line);

2) A line from the middle point of the Transpeninsular Line north and tangent to a circle of 12-mi. radius from New Castle (the Tangent Line);

3) A line along the New Castle circle north to the meridian passing through the tangent point, then north along the meridian to the parallel of latitude 15 mi. south of the southernmost limits of the City of Philadelphia (the Arc and North Line); and

4) A parallel of latitude, 15 mi. south of the southernmost limits of Philadelphia, extended westward from the North Line (the East-West Line).

Before 1750, disputes arose from time to time concerning the definition of the 12-mi. circle from New Castle and the location of Cape Henlopen. On November 14, 1750, commissioners from the two provinces met in New Castle and decided that the New Castle Courthouse would be the center of the 12-mi. circle. A map was appended to the provisional agreement of 1732 which placed Cape Henlopen on Fenwick's Island, about 15 mi. south of the cape now known as Cape Henlopen. Lord Baltimore claimed the map was forged and was advantageous

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to the Penns. This issue was settled by Lord Hardwicke's decision that Cape Henlopen would be taken at the point shown on the map appended to the agreement.

Transpeninsular Line

Following Lord Hardwicke's decree of 1750, the line from Cape Henlopen westerly to the Chesapeake Bay was laid out by colonial surveyors of the two provinces in 1751. This survey was started in the early part of 1751, but operations were discontinued because of bad weather after the line had been extended about 10 mi. Later in 1751 the line was extended to the Chesapeake Bay. This survey was accepted by commissioners of the two provinces. The following quotation taken from the agreement of 1760 is of interest:

That the said Spot or Point, or Place for beginning such due West Line was and is, and shall at all Times forever hereafter be established, held, taken and adjudged to be, where the said Commissioners so agreed upon, fixed and determined the same to be, Namely, at a Point on the Verge of the Main Ocean, being at the distance of one hundred and thirty-nine Perches due East from a stone fixed by the said Commissioners, on the Northern Part of the land called Fenwick's Island, That the said spot or point, or place of beginning such due West Line was and is, and shall at all Times forever hereafter be esteemed, held, taken, and adjudged to be the Point of the Cape of Hinlopen mentioned in the said Articles of Agreement of the tenth day of May, one thousand seven hundred and thirty-two, at which the East and West Line across the said Peninsula mentioned in the same Articles, was meant and intended to begin. . . . That the true Length and Extent of the said West Line was and is, and shall at all times for ever hereafter be esteemed, held, taken, and adjudged to be sixty-nine miles and two hundred and ninety-eight Perches, neither more nor less. That consequently the exact Middle of such West Line, (from whence the other Line is to begin, which is to run up the said Peninsula till it makes a Tangent to the Western Part of the Periphery of the said Part of Circle, at the distance of twelve English Statute Miles horizontally, measured from the Court House in the said Town of Newcastle), was and is, and shall at all times for ever hereafter be esteemed, held, taken and adjudged to be at the exact distance of Thirty-four of the said miles and three hundred and nine perches so measured, West from the afore said Spot

or Point, or Place of beginning of the said West Line, as the same were so measured aforesaid.

Monuments set in the 1751 survey were at Fenwick's Island (No. 0, which was set 139 perches, 2,293 ft., west of the ocean) and at 5, 10, 20 and 25 mi. from the ocean. The 30-mi. monument and the marker placed at the middle point of the line were set in 1760. The agreement of 1760 states that the middle point of the line is at a distance of 34 mi. and 309 perches (5,098 ft.) from the ocean. Distances obtained from the NGS survey of 1974 and the average number of feet per colonial mile are given in Table I.

Tangent Line

Trial runs were made to lay out this line by colonial surveyors in 1751 and again in 1760-1762. These colonial surveys were not acceptable to the commissioners of the two provinces and Charles Mason and Jeremiah Dixon arrived in this country on November 15, 1763, to assist in running the lines agreed on in the original Articles. Bayliff (p. 15) wrote that "the Pennsylvania Commissioners informed the Maryland Commissioners that they had lately received a letter from the Proprietor of Pennsylvania dated August 10th, 1763, acquainting them that they and Lord Baltimore had agreed with two Mathematicians or Surveyors to come over and assist in running the Lines agreed on in the original Articles,"

This line was completed by Mason-Dixon in 1764 and monuments were placed at 1-mi. intervals from *Middle Point* on the Transpeninsular Line to Tangent Point. Tangent Point, at a distance of 12 mi. from New Castle Courthouse, had been established by colonial surveyors in 1762.

Distances obtained from the USC&GS survey of 1961-1962 and the average number of feet per Mason-Dixon mile are tabulated for a few sections of the boundary (Table II).

Radius of New Castle Circle

The distance from the New Castle Courthouse spire to *Tangent Point* is 12 mi. as determined by colonial surveyors in 1762.

TABLE I

From	To	Colonial miles	NGS feet	NGS feet per Colonial mile
Ocean	0		2293*	—
0	5		24225	—
Ocean	5	5	26518	5303.6
5	10	5	26511	5302.2
10	20	10	52928	5292.8
20	25**	5	26490	5298.0
25	Mid. Pt.	9.9656***	52810	5299.2
Ocean	25	25	132447	5297.9

* From agreement of 1760.

** Monument reported moved during highway construction previous to 1974 survey. In the NOS reconnaissance survey of the boundary, it was reported that the monument was moved about 13 ft. directly to the south. Also, that a pin was set underground to mark the original position of the monument. The distance between the reset monument and the pin, as determined from the 1974 survey, was 13.6 ft.

*** Middle Point assumed to be set a distance of 34 mi. and 309 perches, as stated in the agreement. Therefore, the distance from 25 to Middle Point is 9.9656 mi. Then, if the average number of feet per mile is taken, Ocean to 25, and convert 9.9656 mi. to feet, the result is 52,797 ft. This computed result, only 13 ft. less than the distance determined in the 1974 survey, indicates the middle point monument was set very close to the half-way point between the Atlantic Ocean and Chesapeake Bay.

Assuming that the middle point monument was set at the 5-mi. interval or 35 mi. from the ocean, then the total distance of 185,257 ft. divided by 35 gives an average value of 5,293.1 ft. per colonial mile.

TABLE II

From	To	M-D miles	C&GS feet	C&GS feet per M-D mile
16	21	5	26,458.5	5291.7
30	33	3	15,875.4	5291.8
58	63	5	26,462.5	5292.5
69	78	9	47,625.3	5291.7
0*	82*	81.9914*	433,924.8	5292.3

* Most references give this distance, *Middle Point to Tangent Point*, as 81 mi., 78 chains, and 31 links. This is the result of measurements made in 1764. The total length of the line was remeasured in 1768 and an error of one chain was found on the measurement between the 42nd and 43rd mile, (Mason, pp. 169, 205). The values above are, therefore, based on the total distance of 81 mi., 79 chains, and 31 links.

These points were used in a survey of the circular boundary between Pennsylvania and Delaware by the Coast and Geodetic Survey in 1892. Distances from the surveys are shown in Table III.

The Arc and North Line

When the boundary was originally defined, the relationship of the circle of 12-mi. radius from New Castle and the meridian through *Tangent Point* was not known. As determined by Mason and Dixon, the circle extends to the west of the meridian at a maximum distance of 115.8 ft. at the center of the arc. Mason and Dixon set four

monuments along the arc and another at the intersection of the arc with the meridian. The line was then extended to the north along the meridian to the all-important parallel of latitude 15 mi. south of the southernmost limits of the City of Philadelphia.

As reported in the *Mason-Dixon Journal* (Mason, 1969, pp. 91, 92) "From the *Tangent Point* to the said Parallel on a due north course is 5 miles, one chain and 50 links horizontal measure. On December 10th and 11th, 1766 Messrs. Darby and Cope remeasured this line and found it 5 miles, two chains and 43 links." In the

TABLE III

From TAN. PT.	To C.H.**	Colonial miles 12	C&GS feet 1892 63,460.7	C&GS feet per Colonial mile 5288.4
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** There could be some uncertainty in this result. The question that needs to be resolved here is whether or not the point used in the 1762 survey was the same as the position of the Courthouse determined in 1892.

remeasurement of the total line to determine the length of a degree of latitude, the Mason-Dixon Journal dated March 19, 1768, gives the distance as 5 mi., 3 chains, and 18 links.

In a resurvey of parts of the Mason-Dixon line by Graham of the U.S. Engineers in 1849-1850, boundary monuments at the *NE Corner of Maryland* and at the intersection of the circle with the meridian north of *Tangent Point* had been destroyed. Assuming that Graham reset the monument, *NE Corner Md.*, at the intersection of the north and east-west lines, the distance from *Tangent Point* to *NE Corner* is in agreement with the Darby and Cope remeasurement of 1766. This measurement is 93 links (61 ft.) greater than the first distance reported by Mason and Dixon. Also, it appears that Graham reset the *Intersection Stone* at a distance of 93 links greater than the distance of 116 chains, 10 links north of *Tangent Point* as reported by Mason and Dixon (Mason, 1969, p. 90).

Boundary monuments placed on the New Castle circle by Mason and Dixon are shown in Figure 1.

The Mason-Dixon arc stones, with relation to the computed Graham circle, are as follows:

Arc Stone	East or West of Graham Circle
1 (M-D)	3.8 feet east
2 (M-D)	2.1 feet east
3 (Graham)	0.6 feet west
4 (M-D)	4.1 feet east
5 (M-D)	2.5 feet east

The four monuments along the arc which were set by Mason and Dixon are at an average distance of 3.1 ft. east of the Graham circle. At the center of the arc between *Tangent Point* and *Intersection Stone*, the computed distance from the Graham circle to the chord is 119.5 ft. From the Mason-Dixon circle to the chord the distance is given as 115.8 ft. This dif-

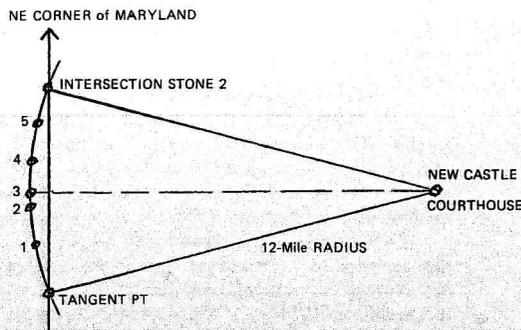


FIGURE 1. 1, 2, 4, and 5 are arc stones set by Mason and Dixon in 1765-1766. Arc stone 3 was placed at the center of the arc as determined by Graham in 1849. The Journal of Mason-Dixon states that the center of the arc is due west of New Castle (Mason, 1969, p. 91).

ference is due to the fact that the chord distance used by Mason-Dixon was 61 ft. less than Graham's value.

The East-West Line

This part of the boundary, identified as the Mason-Dixon Line, was completed in October 1767 after being extended over a distance of 233 mi., 17 chains, and 48 links. After Mason and Dixon established the parallel of latitude defining this boundary; that is, at a distance of 15 mi. south of the city limits of Philadelphia, a few miles along the eastern part of the *East-West* line were laid out in 1764 before the *Tangent Line* was started.

The last resurvey of this line was done by the Coast and Geodetic Survey during the period from 1900 to 1903. The primary purpose of the resurvey was to report on the condition of existing markers and to replace the monuments which had been destroyed.

Geographic positions of several monuments along this boundary have been determined from various surveys in the extension of the national network of horizontal

control. Distances obtained by inverse computation between some of these monuments and the average number of feet per Mason-Dixon mile are given in Table IV.

It should be noted here that some of the monuments used in these computations may not be in exactly the same position as that determined by Mason and Dixon. The C&GS distances are based on positions determined from modern surveys; however, the average number of feet per mile over the 84-mi. section, 46 to 130, is in close agreement with results over the *Tangent Line*.

Establishing a Parallel of Latitude 15 Miles South of Philadelphia

After arriving in this country on the 15th of November, 1763, Mason and Dixon wasted little time in starting operations on the work which had been outlined in their instructions. Of interest here is a letter from Mason and Dixon to Thomas Penn (Cummins, 1962, p. 1).

Sir

We arrived here the 15th of November and immediately wrote to Governor Sharp signifying our Arrival. On the 30th of November the Commissioners from Maryland came to this city and, they in Conjunction with those of Pensilvania, have given us instructions to the following purpose.

1st to settle the Latitude of the southernmost Point of the City of Philadelphia by the Sector, (which we are now about).

2nd to find a Point by the Sector, 30 or 35 miles west from this Place, having the same Latitude as the southernmost Point of this City.

3rd From this point so found to measure 15 miles horizontally due south, which done, to observe the Latitude of the South End of the said Line p Sector, and so proceed to run the Parallel of Latitude thro this last Point which is to be the North Boundary of Maryland and South Boundary of Pensilvania.

4th On the 15th of June next, (if we receive no further orders from the Commissioners), we are to begin the Tangent Line, as those already run for Tangent are so very irregular differing from each other in the Middle about 200 feet.

5th When we judge we are within 10 days of finishing the said Tangent, we are to inform the Commissioners that they may meet us at the Tangent Point or thereabout.

As our instruments are in very good Order, and not in the least damaged by the Voyage, we hope by the end of next Summer, to give a Satisfactory Acct. of all the above Work mentioned in our instructions.

We are

Sir

Your most obedient and
humble Servants

CHARLES MASON
JEREMIAH DIXON

Philadelphia

December the 14th, 1763

Observations for latitude at the southernmost part of Philadelphia were completed on January 4, 1764, and the latitude was found to be, $39^{\circ} 56' 29.1''$ North. The Sector was then moved to a point about 31 mi. to the west and observations were started to determine a point which would be on the same parallel of latitude as that determined for the southernmost part of Philadelphia.

The point 31 mi. west of Philadelphia was identified by Mason and Dixon as John Harland's Garden in "Ye Forks of Brandiwine." Observations at this point showed the latitude to be $10.5''$ south of the parallel through the southern limits of Philadelphia.

A distance was then measured, approximately 15 mi. due south, and the Sector was set up again to determine the latitude. After latitude observations were started, the 15-mi. line was remeasured and it was found to be about 500 ft. shorter than the first measurement. Later measurements, made in 1768, to determine the length of a degree of latitude verified the second measurement. The point, "where the Sector stood," at the south end of the 15-mi. line was in Mr. Bryan's field.

The latitude of the Maryland-Pennsylvania boundary, determined by Mason and Dixon to be 15 mi. south of Philadelphia, was computed as shown below.

Latitude (Southernmost Part of Philadelphia)	$39^{\circ} 56' 29.1''$
	$- 10.5$
Latitude (Mr. Harlan's at Brandywine)	$39^{\circ} 56' 18.6''$
<i>Lat. diff. by Sector</i>	$- 12' 55.8''$
Latitude (Mr. Bryan's field)	$39^{\circ} 43' 22.8''^*$

Offset due to error in 1st measure

	- 5.2
Latitude (Md.-Penn. Boundary)	<u>39° 43' 17.6"</u>

* Additional observations made by Mason and Dixon in 1768 show this latitude to be 23.45 sec. However, the Maryland-Pennsylvania boundary was established from the previously determined value of 22.8 sec.

Summary of Feet per Mile on Each Section of the Boundary

<i>Colonial Surveys</i>	<i>Miles</i>	<i>Avg. per mile</i>
Transpeninsular Line, Atlantic Ocean to Middle Pt.	35	5,293.1*
New Castle Circle, New Castle CH to Tangent Pt.	12	5,288.4
<i>Mason-Dixon Surveys</i>		
Tangent Line, Middle Pt. to Tangent Pt.	82	5,292.3
Arc & North Line, Tangent Pt. to NE COR. MD.	5	5,289.3
East-West Line, Mon. 46 to Mon. 130	84	5,293.9

* This value is based on the assumption that the Middle Pt. monument was set at 35 mi. from the Atlantic Ocean.

Maryland-Pennsylvania Boundary

In accordance with the agreement of 1760 between the Penns and Baltimores, the east-west boundary between Maryland and Pennsylvania was to be at a distance of 15 mi. south of the southernmost limits of the City of Philadelphia. After the first measurement of the 15-mi. line, performed by Mason and Dixon, April 2-12, 1764, latitude observations were taken at the southern terminal of the line. This latitude was intended as the parallel which would define the east-west boundary between Maryland and Pennsylvania. However, a second measurement by Mason and Dixon, made May 14-18, 1764, was 522 ft. less than the first measurement. As a result, due to an assumed error in the first measurement, the boundary was offset to the south 5.2 sec. of latitude (522 ft.).

Using the Mason-Dixon 1-mi. unit of measurement, determined from modern surveys by the National Geodetic Survey, the computed result of a 15-mi. line is in close agreement with the first measurement made by Mason and Dixon. The 1-mi. unit and the computed result are as follows:

	<i>NGS feet per M D mile</i>
Tangent Line (82 mi.)	5292.3
East-West Line (84 mi., Mon. 46 to 130) mean	5293.9
	5293.1
15 mi., at 5293.1 ft. per mile	<i>feet</i> 79,396.5
	<i>chains</i> 1202.98
	<u>-16.23*</u>
Computed distance, from Mason-Dixon unit	1186.75
First measurement by Mason-Dixon	1186.71

* Distance from parallel through southernmost part of Philadelphia to Mr. Harlan's at Brandywine (equal to 10.5 sec. of arc).

This result indicates the latitude of the observatory in Mr. Bryan's field was at the required 15 mi. from the Philadelphia parallel; therefore, the latitude observed there should have been the boundary parallel.

After a preliminary version of this report was presented to the Annual Spring Convention of ACSM, February 1976, Washington, D.C., a report by Mason and Dixon, "Observations for determining the length of a degree of latitude in the Provinces of Maryland and Pennsylvania" (London, 1769), was brought to this author's attention. A copy of the 1769 report was obtained from the Library of Congress and some comments follow.

Mason-Dixon Report of 1769

In the 1769 report, reference is made to the measurements made during the boundary surveys from 1764 through 1767. These results were given in the Mason-Dixon Journal before they returned to London. According to page 277 of the 1769 report: "These measurements, expressed in English statute miles and parts of the same, were made with a chain, established from a brass statute yard, which was proved and corrected, in the course of the work, by another statute chain (kept only for that purpose) made from the said brass yard. They were only designed for dividing the provinces of Maryland and Pennsylvania: the same lines were re-measured afterwards with wooden rectangular levels, for the purpose of determining the length of a degree of latitude."

A complete documentation is made of

the remeasurements, made in 1768, and the following comments regarding these measurements are given on pages 53 and 54 of the 1769 report.

Supposing the levels exactly = 20 feet each; then in the line NP a mile per chain measure = a mile and 9.44 feet by the levels; and in the line CD a mile per chain measure = a mile and 9.86 feet by the levels. In the line AB, what the levels make more than the chain, between the mile posts, is as follows:

[Here, a table is given which shows differences along the boundary from *Tangent Point* (A) to *Middle Point* (B). The average difference over the 82 mi. is 13 ft. per mi.]

We took notice of these differences as we measured from B to A, always finding the miles greater by the chain measure, by the quantity above, which shews that the chain was continually extending itself by use; as we had direct proof of, being obliged to contract it every day, and re-adjust it to its proper length by means of the standard chain.

Some of the statements given in the 1769 report tend to confuse the issue. The quotation from page 277 states that the chain was proved and corrected in the course of the work by comparing with a standard. This statement also occurs in many places throughout the Mason-Dixon Journal. If the chains were always measuring too long and were compared with the standard and readjusted to the proper length, then it must be concluded, that the chain unit used was different from that of the levels. In any case the measurements of 1768 also confirm the error made in establishing the Maryland-Pennsylvania boundary.

With reference to the chain measurements, and the brass statute yard which was used for calibrating the chain, the following note is from the Mason-Dixon Journal, page 22 (Mason, 1969, p. 231). "In April 1767 William Lukins (Surveyor General of the Province of Pennsylvania) told me that our statute yard was the thickness of a piece of Parchment shorter than theirs, with which they measured the Tangent Line." The question then arises, how and when was the unit of measurement with the levels determined?

The line identified as NP in the 1769 report is from the point at Brandywine where latitude observations were made to the parallel defining the Maryland-Pennsylvania boundary. If we use results given in the 1769 report, based on measurements made

in 1768 with levels, the error in the Maryland-Pennsylvania boundary parallel can be confirmed.

Distances given in the 1769 report are as follows:

NP = 78,290.7 ft.
One degree of latitude at a mean latitude of $39^{\circ} 12'$
= 363,763 ft., or 101.045 ft. per sec. of arc.
Converting NP to arc seconds, $78,290.7/101.045$
= 774.8"

Latitude (Mr. Harlan's at Brandywine)	= $39^{\circ} 56' 18.6''$
NP (arc minutes and seconds)	= $- 12' 54.8''$
Latitude (Md.-Penn. Bdry. from 1768 measurement of 15-mile line)	= $39^{\circ} 43' 23.8''$
Latitude (Observed 1768, Mr. Bryan's field)	= $39^{\circ} 43' 23.45''$
Latitude (Observed 1774, Mr. Bryan's field)	= $39^{\circ} 43' 22.8''$
Latitude (Bdry. parallel as established by Mason-Dixon)	= $39^{\circ} 43' 17.6''$

Further, if the distance of 15 mi. as computed from the Mason-Dixon 1-mi. unit determined from modern surveys is used, the latitude of the boundary is as follows:

15 mi. at 5293.1 ft. per mile = 79,396.5	
Converting the 15-mi. distance to seconds of arc, $79,396.5/101.045 = 785.8''$	
Latitude (Southernmost part of Philadelphia)	= $39^{\circ} 56' 29.1''$
15-mi. distance (converted to minutes and seconds)	= $- 13' 05.8''$
Latitude (Md.-Penn. boundary from M-D unit)	= $39^{\circ} 43' 23.3''$

These results further confirm the fact that the first measurement of the 15-mi. line was correct and the latitude of Mr. Bryan's field should have been used as the parallel defining the boundary between Maryland and Pennsylvania. As a result of the offset made in the boundary survey, the *Mason-Dixon Line* was placed at a distance of 522 ft. too far to the south.

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