REPORT

OF

THE SUPERINTENDENT

OF THE

COAST SURVEY,

SHOWING

THE PROGRESS OF THE SURVEY

DURING

THE YEAR 1853.

WASHINGTON:
ROBERT ARMSTRONG, PUBLIC PRINTER.
1854.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

ERRATA NOTICE

One or more conditions of the original document may affect the quality of the image, such as:

Discolored pages
Faded or light ink
Binding intrudes into the text

This has been a co-operative project between the NOAA Central Library, the Office of Coast Survey and the National Geodetic Survey. To view the original document, please contact the NOAA Central Library in Silver Spring, MD at (301) 713-2607 x124 or www.reference@nodc.noaa.gov.

Please Note:
This project currently includes the imaging of the full text of each volume up to the "List of Sketches" (maps) at the end. Future online links, by the National Ocean Service, located on the Historical Map and Chart Project webpage (http://historicals.ncd.noaa.gov/historicals/histmap.asp) will includes these images.

LASON
Imaging Contractor
12200 Kiln Court
Beltsville, MD 20704-1387
January 13, 2003

ABSTRACT OF CONTENTS OF REPORT.

CONTENTS OF APPENDIX.

GENERAL LISTS.

COAST SURVEY REPORTS AND CORRESPONDENCE.

SPECIAL SCIENTIFIC MATTERS.

MISCELLANEOUS MATTERS.

LIGHT-HOUSE MATTERS.

33D CONGRESS, 1st Session. | [HO. OF REPS.] | EXECUTIVE, No. 12.

LETTER

FROM THE

SECRETARY OF THE TREASURY,

TRANSMITTING

The report of the Superintendent of the Coast Survey.

DECEMBER 31, 1853.—Laid upon the table, and ordered to be printed.

JANUARY 3, 1854.—*Resolved,* That 10,000 copies of the letter of the Secretary of the Treasury communicating the report of the Superintendent of the Coast Survey for the year 1853, in addition to the usual number, be printed—6,000 copies thereof for the use of the House, and the remainder for distribution by the Coast Survey Office; and that the same be printed and bound, with the plates, in quarto form, and that the plates be printed under the direction of the Superintendent of the Coast Survey.

TREASURY DEPARTMENT,
December 27, 1853.

SIR: I have the honor to submit, for the information of the House of Representatives, the report made to the department by Professor A. D. Bache, Superintendent of the Coast Survey, showing the progress of said work during the year ending November 1st, 1853, with the accompanying map, prepared at the Coast Survey Office, in accordance with the provision of the act of Congress approved March 3, 1853.

Very respectfully, yours, &c.,

JAMES GUTHRIE,
Secretary of the Treasury.

Hon. LINN BOYD,
Speaker of the House of Representatives.

Blank page retained for pagination

REPORT.

MT. BLUE STATION, FRANKLIN COUNTY, MAINE,
November 27, 1853.

SIR: In conformity with law and the regulations of the Treasury Department, I have the honor to present a report of the progress of the Coast Survey, under my superintendence, during the past year. This amount of work will bear comparison with that of any preceding year, taking into consideration the expenditure made and the results obtained.

Progress has been made in every State of the seacoast of the Union, on the Atlantic, the Gulf of Mexico, and Pacific, in field operations, or, where they are completed, in the office work resulting from them. The two Territories on the Pacific have also received a proper share of attention.

My report on these various operations will be arranged as follows:

1. General statements and remarks.

2. A condensed account of the progress of the survey during the past year, arranged according to geographical sections and to localities.

3. The estimated progress for the next fiscal year, with the estimates for securing that progress.

4. A detailed account of the work done in the field and afloat between November 1, 1852, and the same date in 1853, divided into sections, which correspond with the geographical sections of the coast.

A brief summary of the subjects treated precedes the details in each section, and the operations are classed as they succeed each other in the survey. The work of each of the officers is there noticed, and the statistics given as reported by him.

5. The office work is next stated, following the order of succession of its different parts.

6. In the appendix are given lists, reports, and other data referred to in the body of the report, and classified, for convenience and reference, under several general heads.

7. Sketches of progress in the several sections, and sub-sketches where more detail is necessary, accompany the report, lettered from A onwards—those belonging to the same section bearing the same letter, and the successive sketches in each section being numbered.

8. Sketches are given of important parts of the coast, harbors, channels, shoals, rocks and ledges, diagrams of the Gulf Stream and of tides, &c., resulting from the work of the year.

A rough estimate of the comparative progress of the work, in different years, may be had from the fact that in 1844 the work was going on in nine States, in 1846 in fifteen; in 1847 it had been extended to eighteen, and now embraces all the States on both Eastern and Western coasts. In 1844 four sketches of octavo size sufficed to show the progress; in 1846 nine were required, in 1850 twenty-six, and now fifty-four are necessary for the same general purpose. There are few localities of our extended coast, from the St. Croix to the Rio Grande, and from San Diego to Fraser's river, which have not been embraced at least in the preliminary operations of the survey, the information obtained from which is incorporated in the sketches of the yearly report.

It needs but a cursory examination of these to show that the advance towards completion is decided and regular, requiring merely to be steadily followed up to insure its completion within a reasonable time—the system admitting, if it is desired to take the opportunity of our unexampled prosperity to push the survey more rapidly to completion, of ready enlargement to adapt the progress to increased appropriations. While increased means would be used economically and effectively, the estimates are limited to the same total amount as that approved by the department for the last year, and based upon the scale of operations repeatedly sanctioned by the Executive and Congress. I deem it but right to say, that the economy of nearly forty per cent., which was shown in my report of 1850 to have attended the previous enlargement of the work, would receive some increase from a further extension; but as a considerable portion of the work must necessarily be in the southern sections, where the expenses of every kind are higher than in the northern, a proportionate gain could not be expected. It would chiefly be in furnishing in a complete form, to commerce and navigation, the great aid of maps and charts, at an earlier day, that such an extension would be beneficial.

I proceed to state some of the most interesting and important results of the year, and to make such remarks upon them as are suggested by their connexion with the work generally.

The most difficult piece of hydrography on our coast has been completed during the past season. The area of broken ground east and south of the island of Nantucket is nearly seven hundred square miles in extent, and is spread with dangers, some real and some only apparent. The work which has been prosecuted there perseveringly for some seasons has made the position of the dangers fully known, and has in turn employed the resources and taxed the perseverance of some of the most able hydrographers of the survey. It was commenced in 1846 by Lieut. C. H. Davis, U. S. N., has been continued since 1849 by Lieut. C. H. McBlair, and has this year been completed by Lieut. H. S. Stellwagen. The breaking of the water over these sunken shoals and banks, so admirably explained in his theory of tides and waves by Professor Airy, and which, under the name of "Rips," occurs extensively over this region, serves, no doubt, to increase the terrors of the spot, though indicating in reality a change of depth, and not absolute shoalness. The outliers of this ground, Fishing Rip and Davis's Bank, have twenty-five and a half feet upon them, while on Great Rip, the Rose and Crown, Old South, and Davis's shoal, there are, respectively, but four, seven, six, and eight feet. The arrangement of these shoals led us to suppose that there must be dangers south of Davis's shoal, and several attempts have been made to look them up. The explorations of Lieutenant Commanding Stellwagen this year have completed the search over the space south of Davis's shoal to deep water, without any indication of another tier of banks. The hydrography of such ground as this is truly difficult; it must be surveyed with the minuteness of a harbor, without the facilities which neighboring land affords. The land cannot be seen from the deck of a vessel from Davis's shoal, and yet it must be traversed closely with the sounding-line, and the positions of the soundings be closely determined. It is necessary to establish bases from those on land by floating objects, which, like vessels, can be seen at a sufficient distance, and to preserve temporarily the positions of these floating stations by buoys. The first severe storm not only stops the actual sounding work, but is apt to break up the system entirely by removing or changing the position of these marks. The weather fit for surveying on that peculiarly stormy part of the coast is but a small fragment of each summer, and the harbors which must necessarily be sought as a refuge on the coming up of storms, which cannot be weathered in such exposed situations, are distant. It is no small source of congratulation that this difficult work is well through with, and without accident to those who have so faithfully encountered the very dangers which they seek in order to instruct others how to avoid them. The excitement caused by the mere rumor this summer that one of the Atlantic steamers was upon these shoals, shows the well-founded dread which the greatest commercial and navigating community of our country has of them—an excitement which was hardly allayed by the accompanying assurance that the steamer seen was one of the surveying steamers, whose departure to the shoals had been duly published, and whose business it was, therefore, to be just there, and at that time, where and when no passenger steamer should be. The preliminary sketch of these shoals, issued last year from the Coast Survey Office, will be speedily brought up to date and published. If a permanent light could be placed on the Old South shoal, it would, in a great degree, deprive this region of its danger to large vessels bound into New York.

The completion of the primary triangulation of another of the sections of the coast, (the third section,) and the rapid progress of the hydrography of the same section, which now embraces nearly the entire entrance of the Chesapeake bay, are gratifying results of this year. Two shoals have been determined off the Chesapeake entrance, which, if obscurely reported before, were not sufficiently known to be placed upon the charts, and public notice of the determinations has been given to mariners.

One of the most interesting hydrographic results ever obtained in the survey, and which opens a rich field of investigation, and has most important theoretical and practical bearings, is the carrying of soundings for some two hundred miles (with a small interval only) southeast from Charleston, directly off the coast, and the finding of soundings after crossing the Gulf Stream, from St. Simon's, (coast of Georgia,) St. Augustine, and Cape Canaveral, (Florida.) The character of the bottom which this work reveals is still more interesting—ranges of mountains and hills, with a general trend resembling that of the coast, and with heights and bases like those above the water in the far interior. The relation of the form of the bottom of the ocean, and especially that of these sections, to the peculiar features heretofore discovered in the Gulf Stream, is well determined by the observations of the year, particularly to those curious divisions of the warm water of the Gulf Stream by intrusive cold water, confirmed by so many observations, and now traced as far south as St. Augustine, in Florida. The discovery of the soundings on the other side of the Gulf Stream was made independently, and within three days of each other, (June 7th and June 10th,) by the parties of Lieuts. Comg. J. N. Maffitt and T. A. Craven, U. S. N., the one sounding across the Gulf Stream from Charleston, the other from Cape Canaveral. On the Charleston section, Lieut. Comg. Maffitt struck soundings in three hundred fathoms, then at eleven miles in six hundred, and again at twelve miles in three hundred and seventy fathoms. The first and second of these soundings represent a mountain eighteen hundred feet in height and eleven miles in base on the off-shore, and very steep on the in-shore side. The development of this subject, as far as it is appropriate to this report, belongs to another part of it; but I may here refer to the profile of the bottom of the sea there given, (Sketch Gulf Stream, No. 2,) as showing the relations of the configuration to that of the land. Lieut. Comg. Craven, in a distance of a mile and a quarter, passed from a sounding of four hundred and sixty to one of one thousand and sixty fathoms across the Stream from Cape Canaveral. A glance at the diagram just mentioned will show the connexion between the intrusive cold water first discovered by Lieut. Comg. G. M. Bache on the sections from Sandy Hook, Cape Henlopen, and Cape Henry, in 1846, and the figure of the bottom, in reference to which further remarks will be made, as illustrated by diagrams of Lieut. Comg. Craven's work. The existence of "ripples," apparently connected with the irregularities of the bottom, was noticed by Lieut. Comg. Craven.

The observations of this season clearly establish the existence of the polar current below the Gulf Stream, and its proximity to the shore where the depth permits, even where the surface water may be quite warm. They further render it very probable that there are counter-currents corresponding to the cold streaks in the Gulf Stream, which, if established, must be useful in navigation. It can hardly be doubted that this cold water off our Southern coast may be rendered practically useful by the ingenuity of our countrymen. The bottom of the sea fourteen miles ENE. from Cape Florida, five hundred and fifty fathoms in depth, was in June last at the temperature of 49° Fahrenheit, while the air was 81° Fahrenheit. A temperature of 38° (only six degrees above the freezing point of fresh water) was found at one thousand and fifty fathoms in depth, about eighty miles east of Cape Canaveral. The mean temperature of the air at St. Augustine for the year is 69°.9 Fahrenheit, and for the three winter months 57°.5. The importance of the facts above stated, in reference to the natural history of the ocean in these regions, is very great, but, of course, requires to be studied in connexion with other physical data. It has also a bearing upon the important problems of the tides of the coast. This exploration of the Gulf Stream will be steadily prosecuted to its close, the different problems being taken up in turn, or in connexion, as may be found practicable. Too much credit cannot be given to the officers who have by their assiduity and ability developed so far the problem of the temperatures, not only at the surface but to the greatest depths, from the section across the Stream from Cape Cod to that from Cape Canaveral. The limits of the Gulf Stream as now known to us are traced on the map ordered by Congress, showing the progress of the several operations of the Coast Survey, and on the sketch accompanying my report. (Sketch Gulf Stream, No. 1.)

The relation of the tides on shoals at sea, off the coast, to those on the immediate shores, must be a determination of great importance. For several years I have sought for observations of this kind, and they have been frequently attempted, but without success. This year the efforts of Lieut. Comg. Almy have been rewarded by the approximate results which were necessary to connect the soundings at sea, and the tidal reductions of the shore, and which will be detailed in their appropriate place.

The reconnaissance of the coast of parts of North Carolina, South Carolina, Florida, and Louisiana, to determine the plan of work there, has been a valuable result of the last season. With that of the Gulf coast, where existing charts have been made from comparatively loose information, has been connected the approximate determination of astronomical positions, enabling us to give more accuracy to our own progress sketches, and to furnish important geographical data for general use.

The hydrographic reconnaissance of the Western coast, so essential to commerce and navigation there, has been completed from San Francisco north, having been finished this summer. A new edition of the charts based upon it is in progress. The work there is beginning to assume its regular form. Reconnaissances and preliminary surveys have been made in a rapid way, and sketches have been published to meet the immediate wants of the country; accurate surveys and complete maps will in turn speedily take the place of these. The officers on that coast, from the first commencement by the late lamented McArthur to the present time, have labored most assiduously to give the work the turn required by the wonderful development of the country. The history of such surveys does not present a case of rapid execution and publication of results which will compare with these which we owe to the Coast Survey parties in California and Oregon, and the office organization on this side.

The more thoroughly the coast is examined, the more effectually do those difficulties to a continuous triangulation, which were so fully believed in the earlier stages of the survey to exist, disappear. By far the largest extent of the coast, as I have shown in my report of 1849,* presents great facilities for the work, by high hills near the coast, by islands lying off it, and by sounds of various breadths, only separated from the ocean by narrow strips of land. No portion yet examined, from Passamaquoddy bay to the St. Mary's, from the Capes of Florida to the Tortugas, from Cedar Keys to Atchafalaya bay, and from Galveston to the Rio Grande, though including many places where it was argued that the system would fail, presents any insurmountable obstacles, or requires the system of triangulation to be departed from for methods which are still available when the other fails. The triangulation extends from Cape Small, in Maine, to Old Topsail inlet, North Carolina, (Beaufort,) a distance of fourteen hundred and fifty miles, measuring along the sides of the triangles, with a gap of but twenty-four miles, which we are certain, from the examination of Assistant Cutts and of Major Prince, can be filled up, and which the ordinary progress of the work is gradually closing. The same plan of extension from the bases, in the different sections, will have the same results. Each section rests upon its own base and astronomical determinations, while detached; its survey is complete in itself, as far as it goes; the charts are published as the results come in, and when the triangulations join, the bases will serve to verify each other. In the smaller triangulations the bases will be more numerous, but the principle of the work remains the same. The general reconnaissance, which has made important progress during the last season, will be continued until we know, through its instrumentality, the facilities and difficulties for work along the entire coast, and two or three years, at most, will suffice, at the present rate of progress, to close up the intervals which now exist.

I have appended to the report of this year a list of tidal data for the use of navigators. These results require not only laborious observations to collect, but still greater labor to compute. After trying several different plans for securing, with regularity, the necessary tidal reductions, with but partial success, I have now obtained the desired result by organizing a party expressly for this work, combining the observations and reductions under my own immediate direction. The gradual progress of the observations and their immediate reduction are thus secured. The results are not yet in condition to present as scientific data, but the rapid progress made in bringing them into that shape warrants the belief that they may soon be thus prepared, and in the mean time the tables presented in the Appendix No. 26 have a practical value which induces their publication. The only systematic effort made to determine the progress of the tide-wave along our coast was under the direction of a distinguished foreigner, the master of Trinity College, Cambridge, the Rev. Mr. Whewell. The progress of the hydrography of the coast not only requires such investigation, but the determination of the tidal phenomena peculiar to the principal ports.

It is an interesting fact that the tides of our Atlantic coast, of parts of the Gulf of Mexico, and of the Western coast, are of three different types. Those of the Atlantic coast are of the ordinary type of tides—twice in the twenty-four hours—

* Ex. Doc. No. 5, 31st Congress 1st session, Senate, pp. 2 and 3.

having, however, a distinct, though small, difference in height and time between the morning and afternoon tides, known as the diurnal inequality. The Gulf tides are single-day tides, and, until the Coast Survey developments established the contrary, were believed to depend upon the winds which have the character of trade-winds, and, therefore, considerable regularity along that coast. The tides of our Pacific coast ebb and flow twice in the twenty-four hours, but with so large a diurnal inequality in height that the plane of reference of mean low water, commonly used on the charts, would, if employed, be a snare to navigators. A rock in San Francisco bay, which at one low water of the day might be covered to the depth of three and a half feet, might at the next be awash. The observation of the tides on the Atlantic coast having been made in close connexion with the other parts of the hydrography, the stations still wanting will be filled up as we advance. A few stations are still required on the Gulf of Mexico to complete the general determination of its tides from Cape Florida to the Rio Grande. We have already found nearly the dividing position, Cape St. George, Apalachicola, where the tides resemble on one side, eastward, those of Cedar Keys, Key West, and Tampa bay, ebbing and flowing twice each day, with a large diurnal inequality, and on the other, westward, resemble the tides at Mobile entrance, the Delta of the Mississippi, Galveston, and the Rio Grande entrance, ebbing and flowing, as a general rule, but once in twenty-four hours. Those only who have encountered the vexations incident to imperfect observations—the failure to obtain results from the indifference, want of skill, or neglect of observers, not to speak of worse cases—will fully enter with me into the praise bestowed on one of the worthy men to whose patience and accuracy we owe so many of the tidal results in the Gulf of Mexico. On the Western coast I have been able to take up the tidal problem in a more general way than on the Eastern, and expect the best results from the arrangements there made. Already we know that at three important points self-registering gauges of comparison have been established, and that all the zeal and energy of an able officer is devoted to carrying out the plan of continued observations at these stations, with more temporary ones at intermediate points for their connexion. The working up of the observations as they come in goes steadily forward, and the accumulation of results is such that provision should be made for their publication in the most ample detail. The memoirs which I submit from time to time to the judgment of our scientific men in the meetings of the American Association for the Advancement of Science, and which are published in its proceedings, and the table of results accompanying the charts and my report, do not by any means supersede the official publication, which is essential in every public work of this sort, and which must be of a much more detailed character, giving the particular observations from which the general results are deduced.

The tables of geographical positions which were published with my report of 1851* have since received important additions, which are given in the Appendix to the present report (No. 7.) The first list contained the positions of 3,240 points, and the present addition is of some 600. In the monthly reports made to me of the different divisions of the office, in the replies to the numerous inquiries addressed to the division, in the plans for work, results obtained, and reports made, I cannot but recognise that the computing department of the office has obtained a position of efficiency worthy of all praise, and of special mention in enumerating the prominent results of the work, though this has been due not to the efforts of one but of many years, combined with remarkable zeal and assiduity, directed by clear intellect and ample knowledge.

* Ex. Doc. No. 3, 32d Congress 1st session, Senate, pp. 162 to 442.

The reductions of the last chronometer expedition for determining the difference of longitude between a point on our coast and one in Europe have advanced towards completion, the discussion being of the most thorough sort.

The discussion of the problem of deducing longitudes from observed moon culminations, interrupted by the lamented decease of Professor S. C. Walker, has been undertaken by one of our most eminent mathematicians, and promises to lead to very satisfactory methods of reduction, at once original and practical. This will enable the immediate use of our observations of moon culminations, without the necessity of waiting for the receipt of corresponding results, often productive of much delay; and it will also prevent the loss of valuable observations for the want of actual correspondences of observation, as now constantly happens.

The feature of the reorganization of the survey under the act of Congress of 1843, which secured a close connexion between the science of the country and the work, was most judicious. The tendency of such works is undoubtedly to adopt a routine and to adhere to it, so that sometimes they fall behind the progress of the science of the day. System is so very desirable that its excess, constituting a blind routine, is always a danger to be avoided. When closely in contact with the scientific movement of the country, this becomes impossible, the judgment of men of science being prompt to detect any faltering in the forward course of operations which they understand, and in every improvement which they fully appreciate.

The act just referred to, giving a wise discretion to the Treasury Department, and the regulations established in conformity with it in 1844, have sufficed for the present development of the work with scarcely a necessary supplement.

The advantage of bringing together civilians, officers of the army, and officers of the navy, in one organization, as was done by the act just referred to, under the Treasury Department, which alone could unite them, has been so often dwelt upon in former reports, that I feel it would be out of place here to repeat my observations. I believe, indeed, that it is so generally admitted as not to require any further remark. I therefore simply refer to the reports of 1848, 1850, and 1851,* in which the subject is fully discussed.

In execution of the "Directions" for the Coast Survey, approved by the Secretary of the Treasury in June last, instructions have been issued by me to the several chiefs of parties in relation to the work required from them. A list of the field parties, specifying the several localities of work and the operations in which they were engaged during the past year, is given in Appendix No. 1. My own service, as chief of a party, will be found in the same list.

By monthly reports from the parties a supervision of the operations is maintained, providing for their due progress and connexion, and for contingencies arising during the season. I have personally inspected the operations of several of the parties, and when the operations of several were to be combined to effect an immediate purpose, have personally made the necessary arrangements. I was enabled generally to combine the inspections made in Sections III, IV, V, and VI, with my service on the commissions for the improvement of the James and Appomattox rivers, for Cape Fear entrance and river, and for the Savannah river, which had been requested by the War Department, and received the sanction of the Secretary of the Treasury. During the surveying season I visited the parties on the James river, at Raleigh, on the Cape Fear, Winyah bay, the Stono, Savannah river, and the St. John's, and gave personal directions to the parties in Section I, on the way to, and while at, my stations in Maine.

* Ex. Doc. No. 13, House of Reps., 30th Congress 2d session, pp. 4, 5; Ex. Doc. No. 12, House of Reps., 31st Congress 2d session, pp. 6, 7; Ex. Doc. No. 3, Senate, 32d Congress 1st session, pp. 9, 10.

I visited New York, by request of the Common Council, in relation to the regulation of the water-line of the harbor.

The number of officers of the army attached to the Coast Survey is at present sixteen, namely: of the Corps of Engineers, four; Topographical Engineers, two; of the line, ten. Under the rules for details, adopted by the Secretary of War, in October, 1853, the service of at least four additional officers will be obtained. These rules will make the number of military and civil assistants equal, as required by the plan of reorganization of 1843, and will permit these officers to remain a sufficient period on the survey to acquire the necessary experience for usefulness in its operations. This result we were approaching in 1846, when the Mexican war swept off all the officers but two from the Coast Survey. The number of army officers has been steadily increased, as the War Department was willing to detail them to meet our applications. A list of the officers of the army attached to the work in March and in September is given in Appendix No. 2.

The number of officers of the navy attached to the Coast Survey is sixty-four, whose names are given in Appendix No. 3. Besides the sea officers, thirteen engineers are attached to the steam-vessels in commission. I have necessarily dwelt, in my successive reports for the last three years, upon the rapid rotation in the naval parties, and other circumstances by which the efficiency of the hydrography was very much impaired. Justice to the work required that I should point out the facilities which had been withdrawn, and the expenses which the Treasury Department had been required to assume. I have now every reason to expect that the former relations with the Navy Department will be restored, and that full efficiency will be once more given to the hydrographic parties.

A list of developments and discoveries made by the Coast Survey was published in my report of 1851,* and continued in that of 1852†. Very few portions of the coast are closely examined without yielding discoveries important to navigation. The charts furnished by the surveys are its most important practical results, showing not only the character of the bottom in the sailing tracks of the coast, or the pilot tracks of harbors, but over every portion of the extent of coast and harbor. In the course of the minute investigations required for this purpose, facts of a striking kind are ascertained. During the past year, for example:

1. A ridge connecting Davis's New South shoal and Davis's Bank (Nantucket shoals) has been found.

2. A small bank or knoll, with but five fathoms on it, about five miles east of Great Rip, with twelve fathoms between it and Davis's Bank and Fishing Rip, the water gradually deepening outside of it to the northward and eastward beyond the limits of the series of shoals.

3. A rock, not on any chart, in the inner harbor of Gloucester, Massachusetts, which should be marked or removed.

4. A bank ninety miles eastward from Boston, with about thirty-six fathoms of water upon it—probably a knoll connected with Cashe's ledge, but having deep water between it and the ledge.

5. The inlet at the north end of Monomoy island has diminished considerably in extent since 1848, and in the course of a few years will probably close entirely, a new one being open to the north of Chatham light, which is now the principal entrance to Chatham harbor.

6. Two shoals near the entrance to the Chesapeake—one, four and three quarters nautical miles SE. by E. from Smith's Island light-house, with seventeen feet on it;

* Ex. Doc. No. 3, Senate, 32d Congress 1st session, pp. 126, 127.

† Ex. Doc. No. 58, Senate, 32d Congress 2d session, p. 80.

and the other, E. by S. nearly, seven and three quarters miles from the same light-house, with nineteen and a half feet on it.

7. The remarkable discovery of continuous deep-sea soundings off Charleston, and of soundings in the depth of between four and five hundred fathoms beyond the Gulf Stream.

8. The discovery of cold water at the bottom of the sea, below the Gulf Stream, along the coast of North and South Carolina, Georgia, and Florida.

9. The well-ascertained influence of prevailing winds in the movement of the bars at Cape Fear and New Inlet entrances, and the gradual shoaling of the main bar, the latter fact being replete with interest to the extensive commerce seeking this harbor.

10. The changes at the entrance to Winyah bay, Georgetown harbor; the washing away of Light-house Point, at the same entrance.

11. The removal of the East Spit of Petit Bois island in the hurricane of 1852, opening a new communication between the Gulf and Mississippi sound, and the rendering of Horn Island Pass more easy of access by the removal of knolls.

12. The diminution, almost closing, of the passage between Dauphine and Pelican islands, at the entrance of Mobile bay.

13. The accurate determination of Ship shoal, off the coast of Louïsiana, in connexion with the site for a light-house.

14. The changes at Aransas Pass, coast of Texas, as bearing upon the question of placing a light-house or light-boat there.

15. The determination of the position and soundings on Cortez Bank, near the island of San Clemente, coast of California.

16. The changes at Humboldt harbor, California.

17. The depth of water on the bars at the entrance of Rogue's river, and of Umquah river, Oregon.

18. The changes in the entrance to Columbia river.

19. The determination of several anchorages on the coast between San Francisco and the Columbia river.

The calls for information from the archives of the Coast Survey have very much increased of late years. During the one just passed eighty-seven applications for copies of maps and charts, and statements founded upon them, have been received and answered under the authority of the Treasury Department, and in pursuance of one of its general regulations. Of these, forty-three copies or tracings of maps were for the use of the officers of the United States government, forty-one were furnished to individuals or associations, and three to State or local authorities. The liberal regulations of the department places the information from the archives of the Coast Survey at the disposal of those who desire it, at the mere cost of copying. A list of the tracings, &c., furnished from the office, is given in Appendix No. 6.

One hundred and forty-eight maps, charts, and preliminary sketches are now in progress, or have been published; a list of which, showing the class of each, its relative progress, whether in the hands of the draughtsman, engraver, or electrotypist, or published, is given in the Appendix No. 5.

The following maps and sketches, fifty-four in number, will accompany my report:

1 to 10. Progress sketches in the several sections, marked from A to K, inclusive; Section No. 1, A; Section No. 2, B, &c.

11. Alden's rock, Portland harbor.

12. Minot's ledge, off Boston harbor, (light-house survey.)

13. Nantucket shoals, (hydrography from 1846 to 1853, inclusive.)

14. Sow and Pigs ledge, Cuttyhunk, Massachusetts, (light-house survey.)
15. Romer shoals and Flynn's knoll, New York harbor, (light-house sketch.)
16. Changes at Sandy Hook, New York harbor.
17. Seacoast of Delaware, Maryland, and Virginia, No. 2.
18. Metomkin inlet, coast of Virginia; Wachapreague inlet, coast of Virginia; Hog Island harbor, coast of Virginia.
19. Cape Charles and vicinity, coast of Virginia.
20. Cherrystone inlet, coast of Virginia.
21. Pungoteague creek, Virginia, (light-house sketch.)
22. Progress of the survey of Cape Fear river and reconnaissance southward.
23. Cape Fear entrance and New inlet, North Carolina, (preliminary chart.)
24. Chart showing the progress of the survey of the Gulf Stream.
25. Diagrams of the Charleston, St. Simons, and Cape Canaveral sections of the Gulf Stream.
26. Cape Roman shoals, South Carolina.
27. North Edisto entrance, South Carolina.
28. Progress of the survey of Savannah river and Tybee entrance, Georgia.
29. St. John's River entrance, Florida.
30. Sub-sketches of progress of survey of Florida reef.
31, 32. Diagrams of tides at Key West.
33. East and West entrances of St. George's sound, Florida.
34. Horn Island Pass, Mississippi, from a resurvey.
35. Pascagoula river, Mississippi, (light-house survey.)
36. Barataria bay, coast of Louisiana.
37. Timballier bay, coast of Louisiana.
38. Isle Dernière and Ship shoal, (light-house survey.)
39. Sabine River entrance, (light-house survey.)
40. Galveston entrance, Texas.
41. San Luis Pass, Texas.
42. Aransas Pass, coast of Texas.
43. Reconnaissance of the coast of California from San Diego to San Francisco.
44. Cortez Bank, off San Clemente island, coast of California.
45. San Diego bay, California.
46. Santa Barbara, coast of California.
47. Progress of the survey of San Francisco bay.
48. Diagrams of tides at Rincon Point, San Francisco bay.
49. Progress of the survey of the Columbia river.
50. Shoal-water bay, Washington Territory.
51. Reconnaissance from Gray's harbor, Washington Territory, to Admiralty inlet.
52. Cape Flattery, Washington Territory.
53. False Dungeness, Washington Territory.
54. Self-registering tide-gauge.

During the past year the following notices have been issued from the Coast Survey Office, under the authority of the Treasury Department—

No. 1. Of geographical positions on the Western coast.
No. 2. Of the tides in San Francisco bay.
No. 3. Of the position of Cortez shoal, off San Clemente island, coast of California.
No. 4. Of two shoals off Smith's island, coast of Virginia.
No. 5. Of the deep-sea soundings off the coast of South Carolina, Georgia, and Florida, and the discovery of soundings beyond the Gulf Stream.

No. 6. Of the hydrographic reconnaissance of the coast of California and Oregon Territory, embracing notices of Mendocino, Humboldt bay, Crescent City bay, Ewing harbor, Rogue's river, Point St. George, Cape Blanco, Umquah river, and Columbia river.

No. 7. Of a bank south of Cashe's ledge, with thirty-six fathoms on it.

Examinations have been made, under the law of 1851 and 1852, for the Light-house Board, with minute surveys in cases requiring them, of York harbor, Maine; of Minot's ledge and the Cohasset rocks, off Boston harbor; of Deep-Hole rock, Cotuit, Massachusetts; of the Sow and Pigs reef, off Cuttyhunk, entrance to Buzzard's bay; of Romer shoal, New York harbor; of the Florida reef, in reference to signals or sea-marks; of East Pascagoula entrance, Mississippi; of Ship shoal, off Last island, (Isle Dernière,) Louisiana; of Sabine entrance and of Aransas Pass, Texas; of Point Bonita and Humboldt bay, California, and of Umquah River entrance, Oregon.

Examinations for placing surf-boats have been made on the coast of Maine, New Hampshire, and Massachusetts, by request of the Treasury Department.

The reports made on both the foregoing classes of work are given in the Appendix.

Congress at its last session directed that a map should be prepared, showing, as nearly as practicable, the configuration of the coast, the probable limits of the Gulf Stream, the limits of soundings off the coast, and exhibiting, by colors, the progress made in the several operations of the survey, as reconnaissance, triangulation, topography, and hydrography, and in the publication of the maps and charts resulting from the work. Such a map has been compiled from the archives of the survey, as far as they furnish the information, and from other authorities where the Coast Survey has not yet reached. The progress sketches accompanying my reports have shown, year by year, all the details of the field-work in a form suited to engraving, and the engraved sketches have, in part, been prepared in the Coast Survey Office, and generally by the apprentices to the art of engraving there, so as to be ready for publication as early as my report. Besides these, the Congress map, in colors, on a scale of $\frac{1}{1,500,000}$, has been prepared in the office to accompany the present report. The very fortunate result of our attempts to explore the Gulf Stream the past year has enabled me to give, from our own data, a very large portion of the hydrography of that remarkable peculiarity of the American coast. The explanations which will accompany the Congress map will dispense with remarks here in regard to its details.

Certain topics in regard to the organization and economy of the Coast Survey, which might be expected to find a place in my report, have been so often discussed by me that a reference to former reports will perhaps be more suitable than any extended notice here. Such subjects are the organization of the parties for different operations, explained in the report of 1845;* the advantages of the division of the coast into sections in the report of 1846,† and again further developed in 1847,‡ and in 1849;§ the order of succession of the operations of the survey explained in 1847,[1] and again in more detail in 1848;[2] the advantages of the triple organization of civilians, army and navy officers, noticed in 1848,[3] 1849,[4]

* Ex. Doc. No. 38, House of Reps., [13;] Senate, 29th Congress 1st session, p. 2.
† Senate, [3,] 29th Congress 2d session, pp. 3, 4.
‡ Ex. Doc. No. 6, Senate, 30th Congress 1st session, pp. 2, 4.
§ Ex. Doc. No. 5, Senate, 31st Congress 1st session, p. 3.
[1] Ex. Doc. No. 6, Senate, 30th Congress 1st session, p. 4.
[2] Ex. Doc. No. 13, House of Reps.; No. 26, Senate, 30th Congress 2d session, p. 2.
[3] Ex. Doc. No. 13, House of Reps.; No. 26, Senate, 30th Congress 2d session, pp. 4, 5.
[4] Ex. Doc. No. 5, Senate, 31st Congress 1st session, p. 3.

1850,* and 1851;† the comparative gain by increasing the scale of the work, 1850;‡ the relative cost of the topography and of the land surveys in 1848§ and in 1850;[1] the relative cost of our own and of foreign surveys, 1849;[2] the cost of the different operations showing that scientific accuracy is gained at small cost, 1848;[3] the plan of working deemed appropriate to the Western coast, 1850[4] and 1851.[5]

In April last, Bvt. Maj. I. I. Stevens, of the Corps of Engineers, the assistant in charge of the Coast Survey Office, was appointed Governor of Washington Territory, and his new duties, upon which he entered with his characteristic zeal, soon drew him entirely away from us. The gain to the country in his appointment, and especially to that new region to which he has been called, will no doubt be great, but our loss is proportionably great. An administrative ability of a high order was joined to unceasing activity and great force of character; varied general and professional knowledge, to great clearness in discerning ends, and fixedness of purpose in pursuing them; remarkable knowledge of men, and easy control of those connected in business with him, to personal qualities, which rendered official intercourse agreeable to those about him. The system with which he followed up plans, complicated as well as simple, insured success in his administration, and was felt in every department of the office, of which he had thoroughly mastered the details as well as the general working. The experience acquired by such an officer is invaluable to the work, and not soon to be replaced, whatever may be the resources of his successor. In the officer detailed by the War Department to succeed Maj. Stevens, Capt. H. W. Benham, of the Corps of Engineers, it is certain that the qualities will be found, necessary to the charge of the office even in the present varied and extended condition of its operations.

I would here again call the attention of the department to the recommendation made in my former reports in relation to Capt. A. A. Humphreys, U. S. Topographical Engineers, formerly assistant in charge of the Coast Survey Office. This officer was placed in charge when the augmentation of the scale of the Coast Survey was begun, and devoted himself, with untiring assiduity and most remarkable success, to the difficult task imposed upon him. His health suffered so seriously from the accumulated labors which he undertook, that he was finally obliged to leave the work. His services were so fully shown by the condition to which he had brought the office during his charge of it, that I simply discharged a duty in recommending him for a brevet on retiring. The varied and complicated duties of the several departments of office-work require not only professional knowledge of a high order, but intense application, and very considerable administrative power. The new form of organization to be given to the different parts of the office rendered Capt. Humphreys' duty one of even greater than ordinary difficulty, and he discharged it with success, regardless of the gradual undermining of his health. As this duty is imposed by law on the officers of the army, I respectfully submit, that for distinguished execution of it he should have the reward appropriate to the officer, a brevet, and would ask that application may be made representing

* Ex. Doc. No. 7, Senate; No. 12, House of Reps., 31st Congress 2d session, p. 6.
† Ex. Doc. No. 3, Senate, 32d Congress 1st session, p. 6.
‡ Ex. Doc. No. 7, Senate; No. 12, House of Reps., 31st Congress 2d session, p. 5.
§ Ex. Doc. No. 13, House of Reps.; No. 26, Senate, 30th Congress 2d session, p. 3.
[1] Ex. Doc. No. 7, Senate; No. 12, House of Reps., 31st Congress 2d session, p. 5.
[2] Ex. Doc. No. 5, Senate, 31st Congress 1st session, p. 4; also, Ex. Doc. No. 26, Senate, 30th Congress 2d session, p. 4.
[3] Ex. Doc. No. 26, Senate; No. 13, House of Reps., 30th Congress 2d session, pp. 3, 4.
[4] Ex. Doc. No. 7, Senate; No. 12, House of Reps., 31st Congress 2d session, pp. 2, 52.
[5] Ex. Doc. No. 3, Senate, 32d Congress 1st session, pp. 4, 5, 83.

the case of Capt. Humphreys to the honorable Secretary of War for favorable consideration.

The Coast Survey has again, during the past year, suffered severe loss by the death of valued officers. Professor S. C. Walker, who died on the 30th of January last, was in the first rank among those men of science in our country who devote themselves to mathematical and practical astronomy. He had been connected for nearly ten years with the Coast Survey, at first giving a portion of his time to the collection of observations and to computations of longitudes from astronomical observations, after which he was more closely connected as an assistant in charge of the subject just named, and of the telegraphic operations for differences of longitude. While engaged in this duty he invented the application of the galvanic circuit to the recording of astronomical observations, which, under various ingenious modifications, is known as the American method. His researches in physical astronomy are among the most elaborate which our country has produced, and have justly been regarded as models of the practical application of some of the most refined processes of modern analysis. The longitude problem in his hands was in a fair way for solution, the discrepancies having been clearly pointed out and traced in a general way to their origin, when his impaired health gave warning that he must soon cease from his labors, and after a brief struggle with disease he was taken from us. The feelings of his brethren in the Coast Survey are shadowed in the proceedings of the meeting which they held on his decease. (Appendix No. 43.) The loss of such a man is truly irreparable to the work and to the country. He had made a special department of researches his own, and his death leaves a marked vacancy in the ranks of American science.

Lieut. Joseph Swift Totten, U. S. Army, who died in May last, had twice been connected with the survey, his first connexion having shown his adaptation for the work, and having only been given up for service in the Mexican war. He was in bad health when he rejoined us, and though for a time the duty seemed to improve his condition, it was but for a time. He undertook the triangulation of Georgetown harbor when most men would have yielded to the pressure of disease, and almost literally died at his post, only relinquishing the charge of his party a few weeks before the close of his life. The officers of the survey have testified their regard for his memory in the resolutions which accompany my report. (Appendix No. 44.)

Benjamin F. West was one of the most promising of the younger members of the survey. He returned from Texas last spring unwell, but not seriously so. Going north during the summer, on his return from duty at Mt. Washington he became the victim of the disease which carried him off just as he had arrived at his majority. He had been promoted by the Treasury Department as a sub-assistant after his return from the south. The officers of my party, to which he had usually been attached, have united in expressing their regrets at his untimely fate, and their condolence with his parents, who saw him first on his return from his tour of service in Texas after death had marked him for its victim. (Appendix No. 45.)

Daniel L. Bryan, M. D., Passed Assistant Surgeon U. S. Navy, who had been at different times on duty in the survey, arrived in Pensacola in the schooner Morris during the prevalence of the epidemic there, took his position in the Naval Hospital, where his services were much needed, and was himself attacked by the disease and died there. He was an officer of distinguished merit in his profession, and his services were highly prized by the parties with which he was connected.

Second Assistant Engineer Washington H. Nones and Third Assistant Engineer George E. Shock, who also had been on duty in the Gulf of Mexico in the steamer Walker, and were attached to the survey waiting orders, were also both victims of the disastrous epidemic—the one at Pensacola and the other on the coast of Mississippi. Both officers had rendered acceptable service in the hydrographic parties of the Coast Survey.

Before passing to the estimates, there are two points on which I beg leave to offer remarks: the first is in regard to the policy of publishing the records of the work; and the second in regard to the power now vested in the Treasury Department to regulate the salaries of the assistants and others.

The arrangements of the survey of the coast from the beginning, with ample means to insure a reasonable degree of progress year by year, and with resources in persons, instruments, equipments, and other appliances, such as are now possessed by the work, is a very different problem from that which has been presented for solution. In such a case, it would have been easy to divide the coast into sections of nearly equal extent of shore-line, or with an extent so proportioned to the facility or difficulty of survey as to advance each one equally, and so to arrange the field parties that their labors would be devoted, during the most profitable portion of the year, in each section, and the office work, that it would keep exact pace with the results produced in the field. The sections of our work were necessarily commenced in turn as means could be procured, and it is only very recently that most of them have been put under survey. It requires a careful study of their relative progress year by year, and the regulation of operations to suit it in the different sections, to bring them ultimately on the same line of advance. It would be unduly expensive to keep up an organization for a limited extent of coast, which is capable of embracing a large portion of it; hence the prominence which I have given for some years to the argument for pushing the survey of the coast of Florida, and for publishing the results and observations made in the progress of the work. The unequal division of the parts of the coast suitable for field work during the summer and winter is a difficulty requiring much time to meet. The very different periods at which the work was begun in the different sections is another difficulty. These are independent of the difficulties strictly professional, presented in the course of the work, and which are of themselves sufficient to employ the resources of all engaged in it. I am satisfied by a careful revision of the progress in each of the sections, made with the sketches and maps before me, that the progress in each is tending to a more just advance, and is in general very satisfactory. These sections and operations, when full means have been furnished, have gone forward in such a way as to convince the most skeptical of the capabilities of this mode of surveying. I need only instance the third section—Delaware, Maryland, and Virginia—in which the whole primary triangulation, the secondary connected with it, and that of the outer coast, have been nearly completed in less than ten years, and the topography and hydrography have kept close upon the triangulation, permitting, now that the main part of the section is finished, its gradual completion with the others. While this section illustrates the position just taken, it also shows the correctness of that in relation to unequal progress, for, while the sections further south were untouched for want of means, this one was in progress. At one period, the means furnished permitted the extension of the work but in one direction, and at a later day but in two directions. At present, on the Atlantic and Gulf coast seven sections are in full activity. Taking the work on the Atlantic and Gulf of Mexico together, I estimate that it is nearly one half done, and that its present rate of progress is between four and six per cent. of the whole work. A small increase of means for the office work, and to push forward sections six and seven, the Florida reefs, keys, and coast, would enable me to be positive of the period of the completion of the Eastern coast. As matters stand, I will do my best to accomplish the result of the uniform and speedy completion of the work, recommending the measures necessary to insure it, and taking advantage of all means that may be furnished. The history of such works shows that the observations accumulated during their progress, and which must be published for permanent reference and to give them authenticity, are brought out very slowly. Those who have taken part in them are dispersed, and questions arise which require their aid to answer. However perfectly in theory a work is organized, such questions will arise. The interest in the results is lost, with the responsibility for their accuracy. The present time, when the organization is complete, and the observers are still connected with the work, is the proper time, on every account, to publish the observations. The economy of present publication would be very considerable. I am sustained in these views by the judgment of the scientific men of the country generally. It is my duty to present this subject to the department and to Congress, that the responsibility of the delay, and of the other difficulties which I foresee unless these publications be soon commenced, may not rest with me.

In this connexion I must further observe that, in a temporary work of this sort, the principle of compensation in proportion to the zeal, assiduity, and talent shown—in other words, the services rendered—is a cardinal one. The Treasury Department, by law, now regulates the compensation of the employees of the work, and it is, in my judgment, essential to its progress that such should be the case. That this power has been carefully exercised, the comparison of compensations from date to date for the last ten years will show; in fact, at a period when compensations out of the public service are increasing, and where increased expenses of living must be met, the economy has been found to be too stringent, as the resignations of many in the employ of the survey, and their advancement in the positions which they seek, fully prove. I make these remarks with the more freedom, that the subject does not affect me personally. My own compensation has remained entirely stationary since I first received my appointment, and is now fixed by law. The extension of the Coast Survey has at least quadrupled my duties as Superintendent, and I have continued to discharge the duties of Superintendent of Weights and Measures, and have been at the call of the Government whenever it thought my services were important, without any remuneration, even for the necessary expenses of travelling; and this relation I have no desire to change. My remarks apply to the compensation of the Assistants and other employees of the survey, and are founded on an experience which cannot be deceptive. To take away the power of regulating the salaries of the Coast Survey officers from the Treasury Department would be vitally injurious to the efficiency of the work. A temporary work should be organized, as such; and when other principles are applied to it, the work under them must take shape accordingly. The legislation which confirmed the re-organization of 1843 wisely looked to the Coast Survey as temporary, and its advance has shown the wisdom of the measures founded on that principle. A cardinal feature of that policy is the regulation by the Treasury Department of the salaries of the employees.

The following is a condensed statement of the progress of the survey in the different geographical sections of the coast, the operations being referred to in the general order of their succession. The particulars of the work, and their relation to the parties and persons employed, are given in the subsequent division of my report.

SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.*—Sebattis Hill, near Lewiston, and Blue Mountain, in Franklin county, Maine, have been occupied as primary stations, the first being also an astronomical point. The line of stations observed upon to the eastward of Mt. Blue extends from the

Camden Mountains, at the mouth of the Penobscot, to Peaked Mountain, in Amherst. The reconnaissance has been carried to the range of points next the St. Croix. The heights of important points in New Hampshire, and near the southern boundary of Maine, have been measured. The topography of York harbor, Maine, and its vicinity, has been executed, and that of Portland commenced; that of the coast of Massachusetts has been extended from Essex northward towards Newburyport; that of Plymouth harbor, Massachusetts, and its approaches, and of Monomoy Point, Cape Cod, has been completed; that of Cuttyhunk and Gay Head has been finished. The hydrography of Portland harbor has been completed, including a minute survey of Alden's Rock; also, of Plymouth harbor, Massachusetts. Monomoy shoals, north of Nantucket, have been surveyed. The hydrography of the shoals, east and south of Nantucket, has been completed to the inner limits of the deep-sea work; that of the south side of Martha's Vineyard has been executed; that of Gloucester harbor has been commenced. Minute surveys have been made of Minot's ledge, off Boston harbor, and of the Sow and Pigs reef, off the entrance of Buzzard's bay, for the sites of light-houses; and of Deep Hole Rock, for placing a beacon. The regular tidal stations at Boston, Portsmouth, and Portland have been kept up, and temporary stations have been added at Siasconsett, Great Point, and Hyannis, Massachusetts. Views were taken for charts of Salem, Newburyport, and Portsmouth harbors, and examinations have been made in reference to placing surf-boats, for the Treasury Department, on the coast of Massachusetts, New Hampshire, and Maine. The computations of the chronometer expedition between Liverpool and Cambridge have been nearly completed. The computations of the season's work, generally, have been kept up. The chart of Wellfleet harbor, and sketches of Alden's Rock, Portland harbor, Davis's shoals, and other dangers near Nantucket, (6th edition,) and Sow and Pigs reef, between the entrances to Martha's Vineyard sound and Buzzard's bay, have been published within the year. Charts are in progress of Portsmouth, Newburyport, Annisquam, and Ipswich, Salem, Boston, Muskeget channel, and Eastern series Nos. 1, 2, and 3; and a sketch of Minot's ledge, Boston harbor.

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware.*—The triangulation of the Hudson has been continued to about six miles above Newburgh; and the topography and hydrography have been extended from above New York city to beyond Sing Sing, to Teller's Point. The Romer shoals and their vicinity, New York harbor, have been surveyed in reference to beacons, and to ascertain if any change has taken place in the adjacent channels. Sandy Hook shore-line has been retraced to register the changes there. The Jersey flats have been surveyed. Tidal observations at Governor's island have been continued. The off-shore chart, from Gay Head to Cape Henlopen, the chart of the mouth of the Connecticut river, sketches of Romer and Flynn's shoals, and of the changes in Sandy Hook, have been published; and the three sheets of Long Island sound are nearly ready to be issued. The charts of south side of Long Island, Nos. 2 and 3, and a comparative map of Romer shoals and Swash channel, New York harbor, are in progress.

SECTION III. *Coast of Delaware, Maryland, and Virginia.*—Telegraphic observations for differences of longitude have been made at Washington for the connexion with Raleigh, and thence to Charleston. The main triangulation of Chesapeake bay has been completed to the Capes. A line of the outer coast triangulation has been measured, and an azimuth determined for verification. Magnetic observations have been made in connexion with the azimuth station. The secondary triangulation of the Chesapeake is nearly complete; that of the James river, from Richmond to Harrison's bar, nearly so; that of the Rappahannock has been carried from Fredericksburg to Port Royal nearly, and is in progress. The topography of the ocean shore of Maryland and Virginia has been continued; that of the Chesapeake has been extended from Back river to Newport-news Point, and to include the shores of Hampton Roads. The shore-line of the James river has been traced from Richmond to Harrison's bar, below the mouth of the Appomattox; that of the Rappahannock, from Fredericksburg to Port Royal, has been commenced. The verification work on the Patapsco is nearly completed. The hydrography of the outer coast of Maryland and Virginia has been completed to Cape Charles; that of the entrance to the Chesapeake, including both Capes, has been nearly finished; that of the bay, near the entrance, has been in progress. The hydrography of the James river, from Richmond to Harrison's bar, has been completed, and that of the Rappahannock is in progress. The tidal station at Old Point Comfort, Virginia, has been continued, and the tides of James river have been observed from Richmond to City Point. Charts have been published within the year of the seacoast of Delaware, Maryland, and Virginia, No. 1, and sketches of Cape Charles and vicinity, of Watchaprigue, Metomkin, Pungotigue and Cherrystone inlets, and of Hog Island harbor, Virginia. Charts are in progress of Chesapeake bay, Nos. 1, 2, and 3, Patapsco river, Appomattox river, and part of James river. A manuscript map of the Appomattox for the city of Petersburg is nearly completed.

SECTION IV. *Coast of Virginia and North Carolina.*—Washington and Raleigh, North Carolina, and Raleigh and Charleston, have been connected for difference of longitude and connexion of Washington and New Orleans. The secondary triangulation has been extended northward of the Virginia and North Carolina line, in Back bay, Currituck sound, also over Core Bank and sound, southward beyond Beaufort harbor, North Carolina, the reconnaissance extending still further south towards New river. The triangulation of Cape Fear river has been made from New inlet to the head of Eagles' island, above Wilmington. The topography of Currituck sound has been carried on at the same time with the triangulation; so also that of Core sound and its vicinity, and of the Cape Fear river. The hydrography of Cape Fear entrance, New inlet, and Cape Fear river, to a point above Wilmington, has been executed. The Gulf Stream has been explored in sections perpendicular to it, from Cape Hatteras and Cape Fear. The tidal observations at Smithville have been continued, and stations for the Cape Fear River tides have been occupied. Charts and sketches have been published within the year of Beaufort harbor, Hatteras inlet (4th edition,) Ocracoke inlet, Cape Fear river, and New inlet; charts are in progress of Albemarle sound, Nos. 1 and 2, and of the same in one sheet on a smaller scale.

SECTION V. *Coast of South Carolina and Georgia.*—A general reconnaissance has been made from Cape Fear entrance to the Santee river, South Carolina. Astronomical observations have been continued at the Charleston observatory, which has been connected, for difference of longitude, with Raleigh, North Carolina. The primary triangulation between the Edisto base and Charleston has been continued by the opening of lines and the occupation of stations, and the secondary connected with it has been carried along the Stono and across James's island. The triangulation, determination of shore-line, and hydrography of Winyah bay and Georgetown harbor, have been made. The triangulation of the Savannah river has been carried from the base on Union causeway to the entrance. Additional examinations of Charleston bar have been made. The exploration of the Gulf Stream has been continued on a section perpendicular to its direction from Charleston light, and from near Savannah entrance, (St. Simon's,) Georgia. Tidal observations have been kept up in Charleston harbor. Charts have been published within the year of Cape Roman shoals and North Edisto entrance and river, South Carolina; and charts are in progress of Charleston harbor, Winyah bay, and Georgetown harbor, of Tybee entrance, and of Savannah river.

SECTION VI. *Coast, keys, and reefs of Florida.*—The survey of the St. John's entrance and Fort George inlet, including the triangulation, topography, and hydrography, and the necessary observations of tides and currents, has been made, and furnished to the engineer in charge of the improvement. The triangulation of the Florida keys and reef has been extended from Point Elizabeth, near Carysfort, to Key Tavernier, and from Key West eastward. The topography has been extended from Soldier Key to Old Rhodes Key, and from Key West eastward over Boca Chica, and the marking of the keys required by the Land Office has also been made. The hydrography has been carried from Triumph reef to Turtle reef. The Gulf Stream has been explored in sections from St. Augustine and Cape Canaveral, and in other positions from Cape Florida northward. A report on screw-pile signals for the reef has been made. A preliminary sketch of St. John's river entrance and Fort George inlet, and sketches of the west coast of the Florida peninsula, Channel No. 4 Cedar Keys, have been published, and additions have been made to the chart of Key West, scale $\frac{1}{100,000}$. A chart of this harbor on a larger scale is in the hands of the engravers, and the chart of Florida Keys and Reef No. 1 is commenced.

SECTION VII. *Coast of Florida.*—Special reconnaissances, with astronomical points determined, and hydrography, have been made of the east and west entrances into St. George's sound, harbor of Apalachicola, and a general reconnaissance of St. Andrew's and St. Joseph's bays, and of the coast westward. Tidal observations at Pensacola have been made. Sketches of Cedar Keys and of St. Mark's harbor, and of the east and west entrances to St. George's sound, and of the reconnaissances of St. Joseph's and St. Andrew's bays, with the coast westward, and those resulting from the past season's work, are in progress.

SECTION VIII. *Coast of Alabama, Mississippi, and Louisiana.*—The reconnaissance for extending the primary triangulation from Lake Borgne to the Delta of the Mississippi has been made. A general reconnaissance of the coast has been made, with the determination of astronomical positions for a sketch of the coast, from the mouths of the Mississippi to Atchafalaya bay. Special reconnaissances for furnishing preliminary charts have been made of Barataria and Timballier bays, Louisiana. The stations of the secondary triangulation have been established and the lines opened for connecting Lake Borgne and New Orleans, and for extending the work to near Madisonville, on Lake Pontchartrain. The topography has determined the shores of Lake Borgne. A complete survey for the location of a light-house, including triangulation, topography, and hydrography, has been made of Last island, (Isle Dernière,) Louisiana, and of Ship shoal in its vicinity. A hydrographic examination of Nassau Roads and Horn Island Pass has been made, to ascertain if changes had occurred from the hurricane of 1852; also, of the reported break across Ship island, and of the passage between Little Pelican and Dauphine islands, Mobile bay entrance. The regular hydrography has been carried westward in Mississippi sound, and Pascagoula river entrance has been examined for the site of a light-house. Hourly observations of the tides have been made at the Southwest Pass of the Mississippi and at Last island. The chart of Horn Island Pass, (2d edition,) preliminary sketches of Mobile bay on a small scale with additions, and of Ship shoal, have been published; also, sketches of Grand Pass into Barataria bay, entrance to Timballier bay, and Cat island tidal diagrams. Charts are in progress of Mobile bay, Nos. 1 and 2, Mississippi sound, Nos. 1 and 2, and sketches of Nassau roads, Chandeleur island, Louisiana.

SECTION IX. *Coast of Louisiana and Texas.*—Astronomical and magnetic observations have been made at two of the primary stations, determining the latitude and the azimuth of certain lines. The reconnaissance for the secondary triangulation has been carried to Matagorda bay, and the work itself has advanced to the head of the bay. The topography has been carried from the Brazos river to Cany creek, near the limits of the triangulation. The hydrography of Galveston upper bay and of San Luis entrance and bay has been completed. Aransas Pass and the entrance to the Sabine have been examined in reference to sites for light-houses. The hydrography of the Rio Grande entrance and of part of the river has been executed. Hourly tidal observations have been made at Galveston, and at the Rio Grande and Matagorda entrances. Charts of Galveston entrance and San Luis Pass, a preliminary chart of Galveston bay on a small scale, and sketches of Aransas Pass, from a resurvey, and of Sabine Pass, Texas, have been published within the year.

SECTIONS X AND XI. *Coast of California, and of Oregon and Washington Territories.*—The geographical positions of Punta de los Reyes, Bodega bay, Haven's anchorage, Mendocino city, Shelter cove, Humboldt city and harbor, Trinidad bay, Port St. George, Port Orford, and the mouth of the Umquah, have been determined by preliminary observations in connexion with the general hydrographic reconnaissance of the coast. A preliminary base has been measured at Pulgas, San Francisco county, and the main triangulation of the coast has been commenced. The triangulation of the bays adjacent to San Francisco bay has been completed. A preliminary base has been measured near San Pedro, and the triangulation for connecting the Santa Barbara islands with the main, and furnishing bases for the work on those islands, has been commenced. The triangulation of Humboldt harbor, and the coast near Mendocino city, near Crescent City, under Port St. George, and at the mouth of the Umquah, has been executed, and the preliminary topography made in connexion with it. The topography of San Francisco bay proper has been completed, and that of the adjacent bays is in progress. The topography of the coast near San Pedro, and towards Point Año Nuevo, has been executed. The topography of Bonita Point has been completed in reference to the site of a light-house there. A hydrographic reconnaissance has been made of the coast north from San Francisco to the Columbia river, and the hydrography of Humboldt harbor, of Mendocino, Trinidad bay, Point St. George, and the mouth of the Umquah, has been executed. A survey has also been made of Columbia river entrance, and the hydrographic reconnaissance of Washington Territory has been extended. An examination of Cortez Bank, near San Clemente island, has been made, and the hydrography of the Santa Barbara islands has been commenced. Tidal stations have been established at San Diego, Monterey, San Francisco, Columbia river, &c. The following maps, charts, and sketches have been completed, and either published within the year or are ready for publication: Reconnaissance chart from San Francisco to San Diego; San Francisco city; Santa Barbara; Points Conception and Coxo; Catalina harbor; Cape Mendocino. Reconnaissance from Gray's harbor to Admiralty inlet, Straits of Fuca, Cape Flattery and Neé-ah harbor, Shoalwater bay, and False Dungeness harbor, Washington Territory; and Cortez Bank, SW. from San Clemente island. Charts are in progress of San Francisco bay and harbor, of Columbia river, of San Diego bay, and sketches of Umquah river and of Ewing harbor.

The foregoing statement does not include the work done in the computing department of the office, nor in the maps of record and assemblage for the use of the survey, nor the sketches of progress in the different sections, which accompany my annual report, and are in themselves quite numerous.

I proceed next to give an estimate of the progress of the work, which can be executed, under its present organization, with the means shown in the same estimate. If it is desired to hasten the work to completion, there will be no difficulty in so doing by adding to these estimates. I have, however, adopted the scale heretofore approved by the Executive and by Congress. The expenses of the work on the Western coast are not necessarily as great as in past years. I have made a reduction adapted to the present circumstances there. I have already given the reasons why the survey should be pressed in Section VII; and without increasing the total sum asked for the survey of the Atlantic and Western coasts, I have provided for this section. The very pressing matter of a publication of our records, discussed in this and previous reports, and recommended heretofore by the Treasury Department, I have provided for by an estimate, which is of moderate amount.

The estimates follow the order of the geographical sections of the coast, and of the different operations constituting the field and office-work.

They suppose the same aid which is now furnished, under the law, from the Navy and War Departments, by the detail of officers for the hydrography and land-work respectively.

ESTIMATE FOR THE FISCAL YEAR 1854-'55.

General expenses for all the sections, namely: rent, fuel, postage; materials for drawing, engraving, and printing; carpenter's work and materials; blank books, stationery, printing and ruling forms; binding; transportation of instruments; maps and charts, and miscellaneous office expenses; purchase of new instruments, books, maps, and charts . .	$16,000
SECTION I. *Coast of Maine, New Hampshire, Massachusetts, and Rhode Island.* FIELD-WORK.—To extend the primary triangulation in Maine, and the astronomical and magnetic observations connected with it eastward, to the Penobscot, and to complete the reconnaissance to the boundary, including the selection of a site for the base of verification; to continue the secondary triangulation of *Casco bay*, and across to the *Kennebeck*, and determine the heights of stations; to continue the topography of the coast between *Portsmouth* and *Portland*, and to complete that of *Portland harbor* and its approaches; to continue the topography of the coast of *Massachusetts* from between *Essex* and *Newburyport* northward; to complete the off-shore hydrography near the *Nantucket shoals;* to continue that of *Nantucket sound* and the eastern entrance to *Martha's Vineyard;* to commence that of the outer coast of *Cape Cod;* to complete that of the coast of *Massachusetts* between *Boston* and *Cape Ann;* to complete that of the harbors of *Chatham* and *Gloucester, Massachusetts*, and of *Saco* and *Kennebunk, Maine;* and to commence that of *Casco bay, Maine;* to continue observations of tides and currents at stations on the coast; and to take the views required for the chart of *Portland.* OFFICE-WORK.—To make the reductions and computations for the section; to make drawings of harbor charts of *Plymouth* and *Gloucester, Massachusetts*, and of *York* and *Portland, Maine;* to make a finished drawing of the *Nantucket shoals;* to complete the engraving of charts of the harbors of *Gloucester, Annisquam*, and *Ipswich, Massachusetts*, and to commence that of *York* and *Portland, Maine;* to continue the engraving of coast charts, Eastern series Nos. 1, 2, and 3, coast of *Rhode Island* and *Massachusetts*—will require	37,000

SECTION II. *Coast of Connecticut, New York, New Jersey, Pennsylvania, and Delaware.*—To continue the triangulation, topography, and hydrography of the *Hudson*, and to execute verification work in the section; to continue observations of tides and currents; to continue the engraving of the third sheet of the south side of *Long Island*, and of preliminary sketches in the section—will require	$7,000
SECTION III. *Coast of Delaware, Maryland, and Virgina.* FIELD-WORK.—To make the astronomical and magnetic observations required at stations on the *Chesapeake bay* and rivers; to continue the triangulation of the *James* and *Rappahannock* rivers; to continue the topography of the lower part of *Chesapeake bay*, and of the *James* and *Rappahannock* rivers, and of the outer coast of *Maryland* and *Virginia;* to commence the off-shore hydrography of the section; to continue that of the *Chesapeake bay* and of the adjacent bays near the entrance; to continue that of the *James* and *Rappahannock* rivers. OFFICE-WORK.—To make the computations and reductions required by the work of the section; to commence the drawing of the seacoast of *Maryland* and *Virginia*, sheet No. 2; to complete that of sheet No. 1, and that of the second series, south of the *Potomac*, and to continue that of the *James* and *Rappahannock* rivers; to continue the engraving of the upper series of the *Chesapeake*, Nos. 1 and 2, and of a portion of the rivers, and to complete that of the general chart of the bay; and to engrave, in part, No. 2 of the outer coast series—will require	25,000
SECTION IV. *Coast of Virginia and North Carolina.* FIELD-WORK.—To continue the primary triangulation of *Pamplico sound;* to make the connexion with the *Chesapeake* by the secondary triangulation, and to follow with the topography, and to continue that of the coast and the topography between *Beaufort* and the *Cape Fear* river; to continue the in-shore hydrography between *Cape Henry* and *Cape Hatteras;* to continue that of *Pamplico sound;* to extend the hydrography south from *Beaufort* and north from the *Cape Fear;* to continue the tracing of the *Gulf Stream;* to make the necessary tidal observations. OFFICE-WORK.—To make the computations and reductions required by the work of the section; to make the drawings of the preliminary sketches required by the season's work; to complete the drawing of *Cape Fear river* to the head of *Eagles' island;* to continue the engraving of the charts of *Albemarle sound*, Nos. 1 and 2, of *Cape Fear entrance* and river, and of the preliminary sketches—will require	24,000
SECTION V. *Coast of South Carolina and Georgia.* FIELD-WORK.—To continue the primary triangulation, and the secondary triangulation connected with it, eastward between *Charleston* and *Bull's bay*, and to make the necessary astronomical and magnetic observations; to extend the secondary triangulation south of *Tybee entrance*, and over *St. Mary's entrance* and river, and *Brunswick harbor;* to extend the topography east from *Charleston harbor*, and south from *Tybee*, following the triangulation; to continue the hydrography of the ocean coast between *Charleston* and *Savannah entrances*, from *Georgetown entrance* south, to include *Roman shoals*, and of *St. Mary's harbor;* to continue the exploration of the Gulf Stream in this section, and to continue the tidal observations at *Charleston*, *Savannah*, and along the coast of the section. OFFICE-WORK.—To complete the drawings of *Winyah bay* and *Georgetown harbor*, of *Savannah river* entrance, of	

St. Mary's harbor, and of the sketches required by the season's work, and to commence the drawing of the seacoast of *South Carolina*, south of *Charleston entrance;* to complete the engraving of *Charleston harbor;* to commence that of *Winyah bay* and *Georgetown harbor*, and of *Savannah entrance* and river—will require $25,000

SECTION VI. *Reefs, keys, and coast of Florida.*—(See estimate for usual appropriation for that special object.)

SECTION VII. *Coast of Florida.* FIELD-WORK.—To make the triangulation of *St. Andrew's* and *St. Joseph's bays*, and the necessary astronomical and magnetic observations connected with it; to continue that of *Apalachicola harbor* and of *St. Marks*, and the adjacent coast, and to commence that of *Pensacola;* to complete the topography of the *Cedar keys* and adjacent coast, and to commence that of *St. Andrew's bay* and *St. George's sound;* to complete the hydrography of the *Cedar keys* and *Crystal river offing;* to commence that of *St. Andrew's bay*, *St. George's sound*, and *St. Marks.* OFFICE-WORK.—To make the necessary drawings of preliminary sketches, and to engrave them; to complete the drawing and commence the engraving of the coast sheet, including the *Cedar keys* and *Crystal river offing;* to commence the drawings of the harbors and parts of the coast—will require . . 23,000

SECTION VIII. *Coast of Alabama, Mississippi, and Louisiana.* FIELD-WORK.—To complete the general reconnaissance of this coast; to continue the primary triangulation towards the Delta of the *Mississippi;* the secondary of the coast from the entrance to *Lake Borgne*, southward along the group of *Chandeleur islands*, towards the *Mississippi;* to complete the telegraphic connexion of *Washington*, *Mobile*, and *New Orleans*, for difference of longitude; to make the astronomical and magnetic observations required in connexion with the triangulation; to continue the preliminary surveys of the more important bays west of the *Mississippi;* to continue the topography of the coast and shores of *Lake Pontchartrain*, and of the *Chandeleur islands;* to complete the hydrography of *Mississippi sound*, and to continue that of *Louisiana bay;* to continue the in-shore and off-shore work south of the islands bounding *Mississippi sound;* to continue the hydrography of the approaches of the *Mississippi*, and to make the necessary tidal observations on the coast of *Louisiana.* OFFICE-WORK.—To make the computations and reductions required by the work of the section; to make the drawings of *Mississippi sound*, No. 2; to commence one of the sheets of *New Orleans* and its approaches; to complete the engraving of the chart of *Mobile bay;* to continue that of *Mississippi sound*, No. 1; to complete the engraving of sketches of *Atchafalaya*, *Côte Blanche*, and *Vermilion bays*, and of the sketches required by the season's work—will require 27,000

SECTION IX. *Coast of Louisiana and Texas.* FIELD-WORK.—To make particular reconnaissances for the main triangulation; to extend the main triangulation southward and westward, and to make the astronomical and magnetic observations connected with it; to execute the secondary triangulation and topography of *Matagorda* and *Lavaca bays*, and to complete the triangulation, topography, and hydrography at the mouth of the *Rio Grande;* to execute the hydrography, in-shore and off-shore, from *Galveston* southward and westward; to commence that of *Matagorda bay.* OFFICE-WORK.—To make the reductions and computations required for the section; to complete the drawing of *East* and *West bays* in connexion with the chart of *Galveston bay;* to commence the drawing of the coast sheet south of *Galveston;* to make the drawing of the *Rio Grande entrance;* to engrave the preliminary sketches required; to continue that of *Galveston*, and *East* and *West bays*, and to commence that of the *Rio Grande entrance*—will require $22,000

SECTIONS X AND XI.—*Western coast, California, Oregon, and Washington.* (See estimate provided for, as last year, by special appropriation.)

Total, exclusive of *Florida reefs* and *keys*, and of *Western coast* . . 206,000

The estimate for the Florida coast, reefs, and keys, and for the Western coast, is intended to accomplish the following named results:

SECTION VI. *Reefs, keys, and coast of Florida.* FIELD-WORK.—To continue the general reconnaissance of the coast; to continue the triangulation of the *Florida* reefs outside, and keys from *Tennessee reef* towards *Key West*, and of the *keys* east of *Boca Chica*, and to continue that of *Barnes' sound;* to extend the topography of the *keys* from *Key Rodriguez* westward; to continue the hydrography of the reef southward and westward; to execute that of *Key Biscayne bay* and *Card's sound*, and to continue the Gulf Stream examinations necessary. OFFICE-WORK.—To complete the computations and reductions required by the work of the section; to make the drawings and sketches of harbors and shoals from the previous season's work; to complete the drawing of *Key West* chart, (large scale,) and of sheet No. 1 *Florida keys* and *reefs;* to continue the engraving of *Key West* chart; to commence that of *Florida* reefs and keys No. 1, and to engrave the sketches and preliminary charts—will require 30,000

SECTIONS X AND XI. *California, Oregon, and Washington.* FIELD-WORK. To continue the determinations of geographical positions, absolute and relative, of capes, headlands, &c., and to determine the position of the forty-ninth parallel on the coast; to complete the triangulation of the *Straits of Karquines*, *Suisun bay*, &c.; to continue the main triangulation of the coast north and south of *San Francisco bay*, and to follow the triangulation with the topography; to continue the triangulation and topography of the several harbors; to continue the triangulation of the *Columbia river* and of *Puget's sound;* to complete the hydrography of *San Francisco entrance;* to continue that of *San Pablo* and adjacent bays; to continue the hydrographic reconnaissance of the *Straits of Fuca*, *Puget's sound*, &c., of the harbors of the coast, and of *Santa Barbara channel.* OFFICE-WORK.—To make the computations of geographical positions and others required by the work; to complete the drawing and engraving of revised reconnaissance and harbor charts; to commence the drawing of *San Francisco bay* and its appendices; of *Columbia river*, and of the *Santa Barbara islands;* to continue the engraving of *San Francisco bay* and of *Columbia river;* to commence that of the *Santa Barbara islands*, and new harbors and anchorages developed; to reduce and engrave the sketches resulting from the previous season's work, and from current work—will require 130,000

The total amount appropriated for the Eastern and Western coasts for the fiscal year 1853–'54 was the same which is now asked for these objects, the distribution being different for reasons stated. The additional sum of twenty thousand dollars is required for the publication of the records and observations of the survey.

The items are as follows:

1. For the coast of the Atlantic and Gulf of Mexico generally	$206,000
2. For publishing the records of the work and the observations made during its progress	20,000
3. For continuing the survey of the reefs, keys, and coast of Florida . .	30,000
4. For continuing the survey of the coast of California, Oregon, and Washington	130,000
5. For fuel and quarters, and for mileage or transportation for officers and enlisted men of the army serving on the Coast Survey, in cases no longer provided for by the Quartermaster's Department	10,000

The appropriations for the fiscal year 1853–'54 were—

1. For the coast of the Atlantic and the Gulf of Mexico generally . .	186,000
2. For the Florida reefs, keys, and coast	30,000
3. For the Pacific coast	150,000
4. For fuel and quarters, &c., for officers and men of army, as above . .	10,000

SECTION I.—FROM PASSAMAQUODDY BAY TO POINT JUDITH, INCLUDING THE COAST OF MAINE, NEW HAMPSHIRE, MASSACHUSETTS, AND RHODE ISLAND. (SKETCH A.)

Very satisfactory progress has been made in this section during the year. Besides the regular operations of the work, several special examinations and surveys for the Light-house Board have been made. Eight parties have been engaged during the season: one in primary triangulation; one in reconnaissance and secondary triangulation; one in secondary triangulation and measurement of heights; three in topography, one of which was a double party; and two in hydrography, both parties employing two vessels and a tender. Two points in the main triangulation, Mount Sebattis and Mount Blue, have been occupied, at the former of which astronomical and magnetic observations were made. The reconnaissance for the further extension of this triangulation has been carried to near the boundary, and one or two locations for a proposed base of verification have been examined. An interesting series of observations for the determination of heights by the different methods of levelling, barometrical measurements, boiling-point apparatus, and by the measurement of zenith distances, have been made; and, in connexion with them, others, having special reference to obtaining the co-efficient of refraction over cultivated fields, woodlands, and water. Several points on the sea-shore were occupied for the last purpose, all of which were referred, by the several means above mentioned, to the permanent tide-gauge at Portsmouth, New Hampshire. The topography of Portland harbor has been continued, and that of York harbor, Maine, executed; that of Essex and Ipswich harbors, of Gay Head and part of Martha's Vineyard, of Cuttyhunk, of Plymouth, and Monomoy Point, Massachusetts, has been executed. The important work of the survey of the Nantucket shoals has been completed to deep water, and unfinished portions of former hydrography filled in. Deep-sea soundings have been run out from Old South shoal, and the hydrography of the south side of Martha's Vineyard, of Plymouth, Gloucester, Marblehead, and Lynn harbors, Massachusetts, and of York and Portland harbors, Maine, has been executed. Minute surveys of York harbor, Maine, Minot's ledge, Cohasset rocks, Sow and Pigs, Cuttyhunk, and Deep Hole rock, Cotuit, Massachussetts, have been made for light-house purposes. The position of a shoal lying about ninety miles east of Boston has been determined. A ridge connecting New South shoal and Davis' Bank, a small bank to the east of Great Rip, and a rock in the harbor of Gloucester, have been among the discoveries of the season. Examinations and arrangements were made for the location of several life surf-boats along the coast. Views of Salem, Newburyport, and Portsmouth harbors, were taken. Tidal observations have been continued at Nantucket, Hyannis, Boston, Portsmouth, and Portland, and have been made at Gloucester. The efforts to obtain tidal observations on the seaward side of Nantucket have at last been successful, a pipe having been laid from deep water to the inner part of the beach, and a tide-gauge connected with it. The chart of Wellfleet, and sketches of Alden's rock, Portland harbor, Davis' shoals and other dangers near Nantucket, and Sow and Pigs rocks, Cuttyhunk, have been published; and charts of Portsmouth, Newburyport, Ipswich, Salem, Boston, Muskeget channel, (Eastern series, Nos. 1, 2, and 3,) and sketch of Minot's ledge, Boston harbor, have been in progress.

Reconnaissance.—The reconnaissance for the extension of the primary triangulation eastward was continued last October by Assistant C. O. Boutelle, accompanied by Bvt. Major Henry Prince, U. S. Army, assistant in the Coast Survey, and several schemes for the continuation of the work were presented.

During the past season Mr. Boutelle and Major Prince have pushed the reconnaissance eastward to near the boundary, and determined the practicability of the lines between Mount Desert, Humpback, Moose à bec, and Western ridge, in Cooper, forming a quadrilateral well adapted to the continuation of the work. I have selected from the various schemes developed by this reconnaissance that on Sketch A, No. 1, as best fulfilling all conditions. It requires but eight stations, besides those to connect with a base of verification, to reach the boundary. On the British side of the frontier two stations, Grand Menan and Chamcook Mount, near St. Andrews, are visible from the last range of points. While prosecuting this reconnaissance, which occupied from September 12 to October 6, examinations were made of two sites, with reference to the selection of a locality for a base of verification, but neither appeared satisfactory, and further reconnaissance for this object will be made during the next season. Mr. Boutelle and Major Prince were accompanied in this work by Sub-Assistant B. Huger, jr. On the 6th of October, after the selection of the points above given, Major Prince commenced preparations for continuing his reconnaissance in Section V, and making that in Section VI, between the St. Marys and Cape Florida, and on the western coast of the Florida peninsula, for which he is under instructions.

Primary triangulation.—In June last the party under my immediate charge, engaged in the extension of the primary triangulation eastward, returned to this section, and on the 18th of that month commenced the occupation of Sebattis mountain, Kennebec county, Maine. (See Sketch A, No. 1.) This station was finished on the 16th of August, during which time eleven horizontal angles were measured by six hundred and thirty (630) observations, with the thirty-inch theodolite, C. S. No. 1, (Troughton and Simms;) one hundred and thirty-nine vertical angles for difference of height, with the micrometer of the same instrument, and twenty-one for absolute elevation, with ten-inch theodolite, C. S. No. 63, (Gambey;) sets of four repetitions being used. This triangulation covers an area, estimated in the usual manner, of three thousand and eight (3,008) square miles: its longest triangle side is about ninety-three miles, and its shortest twenty-seven.

For azimuth and connexion with the triangulation, two hundred and forty-nine observations were made with the thirty-inch theodolite. The stars observed were Polaris, at upper and lower culminations and eastern elongation, and one thousand and seven (1,007) in the Greenwich twelve-year catalogue, at western elongation.

I was assisted in a part of these observations by Assistant J. E. Hilgard, who made the greater part of the observations for latitude and time, at the station, in connexion with the triangulation. These consisted, for time, of observations of sixty-five transits with the thirty-six-inch transit instrument, C. S. No. 9, (Wurdemann;) and for latitude, of observations with zenith telescopes Nos. 1 and 2, (Troughton and Simms,) of twenty-seven pairs of stars with both instruments, and observations upon eight pairs with instrument No. 1, independently, and upon seven pairs with No. 2. The whole number of observations amounted to two hundred and seventeen; and the average number taken with one instrument upon a pair of stars was three. Two determinations of the value of the micrometer were made for each instrument. Mr. Hilgard was assisted in these observations by Mr. J. G. Oltmans, making part of the observations, and Mr. S. Harris.

A meteorological register was kept by Mr. James Searles, jr., at this station, in which one hundred and twenty-three observations of the barometer and wet and dry bulb thermometers were recorded.

A curious fact of personal equation in the use of the zenith telescope was observed at this station, and will be followed up in future observations.

Remarkable local attraction at the immediate station at Mt. Sebattis prevented the observations for magnetic declination, dip and intensity, and they were consequently made at a station about half a mile distant. These were made by Assistant J. E. Hilgard, aided by Messrs. Oltmans and Harris, and consisted of observations on three days for declination, of two sets of experiments of vibration and deflection, for absolute horizontal intensity, with declinometer C. S. No. 2; of six sets of observations of dip, with a ten-inch Gambey dip circle.

Upon the completion of this station, on 19th of August, the party was transferred to Mount Blue, Franklin county, Maine, to occupy that point in the primary triangulation, and the station was ready for the observations on the 25th of August. These were not commenced, on account of the unfavorable state of the weather, until the 29th, and from the same cause were not completed when the operations were closed, on the 22d of November. At this time Mount Blue and the adjacent mountains were almost constantly, during the day time, surrounded by clouds, preventing the possibility of observing at any considerable distance. Up to that date twelve horizontal angles were measured by four hundred and two observations, with the thirty-inch theodolite, C. S. No. 1, (Troughton and Simms.) This triangulation covers an area, computed in the usual way, of eight hundred and twenty-nine square miles.

The height of the mountain was determined by the two methods—by levelling and barometrical measurement. Observations with mountain barometers were simultaneously made at the summit of the mountain and at its base, half-hourly for five hours, and then in connexion at Avon pond and Bates' tavern, in Avon township, the place at which Dr. Jackson set out in his determination of the same elevation in 1838 or '39, every ten minutes for one hour. Similar observations were made simultaneously at the self-registering tide station in Portland, and at the base of the mountain half-hourly for five hours. The barometers were compared at the base before the commencement of the above by half-hourly observations for five hours. The total number of these sets of observations was seventy-six, in connexion with each of which the temperature and evaporating point were observed. These observations were conducted with great care by Assistant George A. Fairfield and Lieut. A. W. Evans, U. S. Army, assistant—the latter making the observations at the base of the mountain, and Mr. Fairfield those at the other points.

The height of the mountain was also determined by Mr. Thos. McDonnell, by levelling from the summit rock to the spot where the above observations were made at the base, and from thence to the pond, the point there being marked on a prominent rock.

Meteorological observations were made at the base and summit simultaneously throughout the time of occupation of this station, in each of which were registered two hundred and forty-nine observations of the wet and dry bulb thermometers, and Alexander and aneroid barometers.

Mr. Dean assisted in all the geodetic observations, and had special charge of the station and instrument, involving much responsibility and hardship, which he cheerfully sustained.

Secondary triangulation.—Captain T. J. Cram, U. S. Topographical Engineers, assistant in the Coast Survey, who had been engaged during the winter in the reduction and computations of his triangulation of the season previous, resumed field work on the 20th of June, to continue the determination of the heights of several stations of his triangulation, by the different methods of observing reciprocal zenith distance by the barometer and by levelling. The extremities of these lines have been occupied in the observation of reciprocal, simultaneous and separate zenith distances, with a view to obtain the co-efficient of refraction for long, short, and medium distances across water. The extremities of one other line were occupied in a similar manner; the line levelled and distanced, and intermediate points occupied in a variety of ways, to obtain, if possible, data for the co-efficient of refraction over cultivated fields and woodland. Another scheme embraced a line upon a sand beach, covered at high and bare at low water. Seven stations were thus occupied; simultaneous and reciprocal observations being made upon each other, upon other stations in sight, and upon the sea horizon, at determinate stages of the tide, in several positions. One thousand one hundred and seventy-four (1,174) vertical angles and twenty-five horizontal angles were measured.

With two mountain barometers simultaneous observations have been made, at various heights above the level of the sea, in number amounting to one thousand two hundred and thirty-four, (1,234,) and of corresponding thermometric observations two thousand four hundred and sixty-eight, (2,468.)

Several points, as before remarked, have been connected with lines of levels, and Mt. Washington, the highest peak of the White mountains, and on the Atlantic coast, was levelled from the summit to the Atlantic and St. Lawrence railroad summit—a total elevation of five thousand five hundred feet. This range was divided into steps of five hundred feet: one of these steps was sub-divided into steps of one hundred, and one of these into steps of ten feet. On all these points observations were made with barometer, thermometer, and boiling-point apparatus. This last apparatus was used, besides, in the observations at Mt. Washington, at seven different harbors on the coast, and on sixteen different stations of the Coast Survey triangulation; the elevations of which have been determined heretofore by other methods. One hundred and twenty-four observations were made with this instrument.

In connexion with the above, special observations of tides have been made of four stations, with a view of obtaining the mean level of the sea simultaneously with the zenith distance observations. It is expected to deduce from this extensive and careful series of observations, important data for the co-efficient of refraction under different circumstances, and in relation to the relative advantages in accuracy, time, and other particulars of the different modes of measuring heights.

Since his return from the field, Capt. Cram has been engaged in the computation of the results of his season's labor.

Topography.—Assistant H. L. Whiting, after the close of his work of revision on the Patapsco, noticed in my report of last year, was engaged in inking several sheets of his previous field-work (in Sections I, III, and V) until the 24th of May, when he received instructions for the season's operations in Section I. These were commenced at Cuttyhunk (see Sketch A, No. 5) on the 4th of June, for the purpose of showing, in detail, the topography of the southern part of the island and the "Sow and Pigs" rocks, upon which it is proposed to erect a light-house, and to furnish the shore-line and positions to the hydrographic party charged with the minute examination of the rocks and selection of a site for the light-house. This work was completed on the 14th of June; after which, until the 24th of that month, the party was occupied in the re-establishment of points on the south side of Martha's Vineyard (see Sketch A, No. 1) for the use of the hydrographic party, rendered necessary by the rapid wear of the cliffs there by the ocean.

Mr. Whiting says, in regard to the Nashaquitsa (or Wequobsky) cliffs: "The highest cliffs on Martha's Vineyard are the 'Wequobsky cliffs,' called by Mr. Eakin 'Nashaquitsa cliffs,' on the highest point of which he put his triangulation station. This part of the south shore of the island is rather remarkable, from the fact that these cliffs draw in and form quite a *cove*, showing that the shore is washed away more at this point than any other, although the cliffs are one hundred and fifty feet high.

"When the signal was first put up in 1844 or '45, it was placed twenty-five feet from the edge of the cliff. Last year I went with Lieut. McBlair to show him where the signal was, and found it had been washed away. I noted a large rock, some ten or twelve feet back from the edge of the cliff, as a landmark at the time, and I now find this stone has been reached and has rolled down the cliff. My new station is about sixty feet inside the old point, and thirty-eight feet from the present edge of the cliff, making the encroachments of the sea upon these cliffs, of one hundred and fifty feet in height, some *fifty feet* (50) in *nine years*. This encroachment continues for some miles to the westward on the south side of the island. I found the beach washed in at 'Chilmark Pond station' about twenty or twenty-five feet, but this becomes less and less, until at the extreme southeast end of the island the shore seems to have increased, if anything; there is, however, not much change.

"As these and the Gay Head cliffs are quite known landmarks in this section of our coast, I thought these changes quite interesting facts."

It may be worth inquiry whether some effective means should not be adopted to preserve these landmarks.

Thence the party proceeded to the survey of the vicinity of Gay Head, (see Sketch A, No. 1,) which was finished on the 14th of July. On the height of Gay Head cliffs Mr. Whiting remarks:

"I find the Gay Head cliffs not so high as supposed. Prof. Hitchcock calls them one hundred and fifty feet, which they are generally considered, but they are only from one hundred and twenty to one hundred and thirty-five feet high. There is one small knoll, not on the edge of the cliff, which is one hundred and forty-five feet. The lantern of the light-house I make about one hundred and sixty-seven feet. All these heights are from mean low water. The highest land is near the middle of the Head, and is about one hundred and eighty-five feet."

Upon the completion of this work Mr. Whiting transferred his party to the vicinity of Cape Ann, resuming the topography from the limits of the last season, and carrying it northward as far as Rowley river, including part of the harbor of Essex and that of Ipswich. (See Sketch A, No. 1.) The operations of this party were closed on the 10th of October, this last work having occupied until that time from the 25th of July.

The statistics of Mr. Whiting's work of the season are given in the following table:

	Area in square miles.	Miles of shore-line.
Essex sheet	10	14½
Ipswich sheet	24	40
Gay Head, &c	15	
Total	49	54½

On the character of the topography of this region, Mr. Whiting makes some interesting remarks, which I give:

"The country surveyed this season has been quite varied. The rocky and broken character of Cape Ann seems to change very abruptly at about Essex river; the masses of rocks, with their pine and cedar growth, disappear entirely, and the country has a soft and fertile appearance; the hills are remarkably smooth and undulating, and are scattered in quite distinct peaks or mounds, sometimes separated by tracts of marsh or quite level upland. These hills, within the limits of my survey, range from about two hundred to one hundred and twenty feet in height. The immediate shore is also quite different from that of Cape Ann and Massachusetts bay, being more like our southern coast. The long beach and sand-hills of Plum island, with the sound and marshes behind it, is not unlike the coast of North Carolina, and with the same hydrographic characteristics, as the shifting bars of Ipswich and Essex rivers, with their shallow channels, plainly show."

About the middle of October this party was transferred from this section to Section III, to continue the work of revision on the Patapsco, in which it is now engaged.

The topographical sheet of Casco bay and of Portland harbor, Maine, upon which Assistant A. W. Longfellow was engaged in the latter part of 1852, and of which the statistics were given in my report of that year containing his work, joined on its southern boundary that of Richmond Island harbor, which was executed in 1850. It embraces the shore to the northward and westward of that sheet from the light-house on the eastern extremity of Cape Elizabeth to Spurwink river, four miles and a half; thence to the Portland light, situated on Portland Head, a distance of four miles; and thence two miles in a westwardly direction. (See Sketch A, No. 1.)

The character of the topography on this sheet, and of the region in its vicinity, is thus given by Assistant Longfellow in an extract from his report:

"The character of the topography is moulded directly upon that of the geological formation which characterizes this region and the coast of Maine generally. This is a slate formation, with a stratification so much inclined with the horizon as to become nearly vertical. Its prevailing character is micaceous, though of so highly metamorphic a type as to pass in many localities into talcose or chlorite slate and other modifications. It presents to the most casual observer, in its external character, the strongest indications of having been greatly altered by heat. The general direction of the strata is northeast and southwest, as shown upon the map in the shore section; and in the contours of the interior, equally numerous trap dikes intersect the strata, following the direction of its stratification, the most remarkable example being just to the southward of the Portland light, and so large as to be shown upon the map. This dike having been worn away by the weather and the sea, has left a canal with vertical walls, through which the sea rushes at high tide.

"From the varied character of the rocks results an inequality of hardness: the softer and more friable portions, yielding readily to the power of the elements, are worn down and washed away, leaving small valleys or depressions between; the harder rocks extending generally in the direction of the strata. These give the characteristic form to the relief of the ground, the rock being generally but thinly covered with soil, and in many places entirely bare. In these reaches the decomposed rock forms a rich and warm soil, which affords the best arable land on the cape.

"In the wooded and uncultivated parts, back from the shore, these depressions, not being drained, form swamps and morasses, generally covered with alder bushes.

"The prevailing forest growth on the Cape is the double or black spruce; some hickory and oak are found, and an occasional shrub of red cedar, which here reaches nearly its northern limit of growth."

Mr. Longfellow has, during the past season, been engaged in the topography of York harbor, Maine, including Cape Neddick and Boone island. This was commenced on the 13th of July, and continued until the 3d of September, when his immediate party was transferred to Portland harbor, leaving the completion of the York harbor sheet with Sub-Assistant A. S. Wadsworth. This was finished on the 1st of October, and comprises within its limits an area of nine (9) square miles, and an extent of shore line of thirty-three and a half (33½) miles.

Boone island was determined by a detached survey, in regard to which Mr. Longfellow says:

"Boone island, lying too remote from the shore to connect with the triangulation points on the main land, was determined by a detached survey. It is a mass of granite, destitute of soil, reaching, in its highest part, hardly twenty feet above the tide, which breaks over it during storms. There is a reef of rocks lying off its northwest end, and another extending out from its southeasterly point."

The shore-line determined by this party was furnished to the hydrographic officer, who immediately followed in the execution of that portion of the survey.

The work in Portland harbor was commenced by Assistant Longfellow upon his withdrawal from York harbor, and is now in progress.

Upon the completion of the reductions and computations of his work in Section VIII, during the winter, Assistant S. A. Gilbert was instructed to survey the harbor of Plymouth, Massachusetts, and Monomoy island, off the southern extremity of Cape Cod. (See Sketch A, No. 1.) The first of these surveys was commenced on July 5, and up to the 1st of October two sheets were nearly completed, embracing, of work done, an area of twenty-seven (27) square miles, and an extent of shore-line of thirty-five (35) miles. On these sheets are included Duxbury beach, the Gurnett, and Clark's island. The survey of Monomoy Point was commenced on the 24th of September, and up to the date of his report Mr. Gilbert had completed the survey of five square miles of area, and of fourteen miles of shore-line. In this survey the positions of the new light-house, of the light-vessel on Pollock rip and Shovelful shoals, and of the buoys on the several neighboring shoals, were determined. It was found that the inlet at the north end of the island had closed up, in a degree, since the former survey, and a new one opened to the north of Chatham light, which had become the principal entrance to that harbor. Since the completion of the above work, Mr. Gilbert has received instructions for the continuation of his triangulation in Section VIII, for which he is now making preparations.

Hydrography.—Two hydrographic parties have been occupied in this section during the past season, under the charge of Lieuts. Comg. H. S. Stellwagen and M. Woodhull, U. S. Navy, assistants in the Coast Survey. The former party had the steamer Bibb and a tender, and, during a part of the time, the steamer Corwin; the latter, the schooners Madison and Gallatin, and a tender.

The first work of Lieut. Comg. Stellwagen's party was the minute survey of Minot's ledge and adjacent rocks, Cohasset, near Boston harbor, (see Sketch A, Nos. 1 and 3,) for the purpose of the site for a light-house. To obtain the proper information, in an engineering point of view, in regard to the feasibility of erecting a light-house on these rocks, Captain H. W. Benham, of the Corps of Engineers, assistant in charge of the Coast Survey Office, accompanied Lieut. Comg. Stellwagen. An eligible position, selected by these officers, was indicated upon the chart forwarded to the department in my letter of 21st November, enclosing the report of Lieut. Comg. Stellwagen upon this survey, and which is given in Appendix No. 48. Next in succession was the filling up of the space of unfinished hydrography to the northeast and southwest of Davis' South shoal, (see Sketch A, No. 4;) next, of that unfinished portion to the northeast of Great Rip, extending the soundings out to twenty-six fathoms; these additions completing the hydrography of the Nantucket shoals to deep water. The party next proceeded to Martha's Vineyard, and carried out the hydrography from No-Man's Land to the eastern end of the island, (see Sketch A, No. 1,) and ran lines of off-shore soundings to a distance of fifteen miles from the beach. A line of deep-sea soundings was then run to the distance of seventy-five miles from the west buoy on Davis' South shoal (see Sketch A, No. 4,) until no bottom was had, with a line of one hundred and sixty fathoms. The course going out was south, by compass, and returning north by west. Additional lines of soundings were also run out a distance of forty miles southwest of Davis' shoal. These were finished on the 28th of September, since which time Lieut. Comg. Stellwagen has made a supplementary report of the completion of the survey of Gloucester harbor, and of the outside work from Cape Ann, Thatcher's island, to near Manchester, joining the work of Salem harbor. (See Sketch A, No. 1.) The hydrography between Marblehead and Lynn concluded the excellent season's work of this party, on the 28th of October, when they were driven in by storms, which were becoming so frequent and severe as to render it impracticable to continue longer, and having very nearly completed the entire work directed in the season's instructions.

In addition to the foregoing work, Lieut. Comg. Stellwagen has made examinations and selected locations for a portion of the life surf-boats provided by Congress for the coast east of Long Island sound. His report on these selections was transmitted to the department on the 18th of November, and will be found in Appendix No. 10 of this report.

During the work of this party several interesting discoveries and developments have been made. In sounding northeast and southwest of Davis' South shoal, a ridge was found between the southern end of Davis' bank and the New South shoal, having four and a half to five fathoms on it. In making the soundings northeast of Great Rip, a small bank or knoll was found with but five fathoms on it, about five miles east of Great Rip, and with twelve to thirteen between it and Davis' and Fishing Rips, the water gradually deepening outside to the northward and eastward beyond the limits of the series of shoals. In the survey of Gloucester harbor a small rock, coming to a pinnacle at about seven or eight feet from the surface at low water, was determined accurately in the inner harbor. This rock is not indicated upon any existing chart. While the party was at work in this harbor one of the vessels was despatched in search of the shoal reported to be about ninety miles east of Boston, and to which my attention was called by George W. Blunt, Esq., of New York, who gave me the approximate position of the shoal. This was found very little to the northward of the specified spot, and where deep water is shown on the chart. It is a small knoll between Cashe's ledge and Fippenies bank, and probably a part of one or the other of them. It lies about eight miles southwest of shoal water on the chart. There were found thirty-six fathoms on it, the charts placing ninety-five fathoms as the soundings in this locality. The report of the determination of the position of this shoal has been published, and is now appended to this report. (See Appendix No. 12.)

The statistics of the work of this party are given in the following table:

	Number of soundings.	Miles of soundingsrun.	Square miles of area sounded out.	Number of angles measured.
Minot's Ledge	6,000	40	4	200
Northeast and southwest of Davis' South shoal	934	156	142	160
Northeast of Great Rip	965	160	120	146
Martha's Vineyard	3,846	400	150	392
Gloucester	6,035	150	20	471
Marblehead to Lynn	4,325	85	30	241
Lynn harbor	1,702	16	6	47
Deep-sea soundings	178	250	....	....
	23,985	1,257	472	1,657

After the completion of the work in Section II, in the early part of the season, the party under charge of Lieut. Comg. M. Woodhull, U. S. Navy, assistant in the Coast Survey, proceeded to Section I to commence the season's work there, of which the first was the minute survey of the "Sow and Pigs" reefs, off Cuttyhunk, Massachusetts, for the purpose of selecting a site for a light-house. This was commenced about the middle of June, and completed on the 1st of July. A more extended notice of this survey is given in Lieut. Comg. Woodhull's report upon it in full, which was transmitted by me on the 3d of September, and is given in Appendix No. 50. Captain H. W. Benham, of the Corps of Engineers, assistant, was associated with Lieut. Comg. Woodhull on this duty, and these officers united in the selection of the site indicated on the sheet which was transmitted to the department, and is now shown on Sketch A, No. 4.

The survey of Monomoy shoals, (see Sketch A, No. 1,) and their vicinity, was commenced on the 5th of July. The work embraced within its limits covered the shoals known as the Shovelfull, Handkerchief, Dry shoal, Broken Ground, Pollock Rip, and the Great, and Little Round shoal; also the coast on both sides of Monomoy Point from Harwich Port, on the westward, to Chatham, on the east. The importance of this locality seemed to justify the immediate issue of a preliminary chart, which is now in the course of preparation. The value of the light-boat recently placed on Shovelfull shoal is acknowledged by Lieut. Comg. Woodhull, who mentions that Butler's Hole, in consequence of the facility afforded for entering by this vessel, is now much used as a harbor by vessels navigating the sound, bound either to or from the eastward. After this, the survey of Deep Hole rock, at the entrance into Deep Hole harbor, near Cotuit, Massachusetts, was made with a view to placing a beacon upon it. This operation is noticed more fully in the report communicated, with sketch, to the department on October 31, given in Appendix No. 49.

On the 14th of August the party was divided, the schooner Madison repairing to York harbor, Maine, (see Sketch A, No. 1,) to execute the survey there necessary to the selection of a site for a light-house. The Gallatin at the same time executed the hydrography of Portland harbor, Maine. (See Sketch A, No. 1.) The work in this excellent harbor has been very minute, embracing its numerous islands and channels necessary to form a complete chart.

In speaking of the advantages and capacities of Portland harbor, Lieut. Comg. Woodhull remarks:

"This harbor I look upon as one of the best on our whole coast, remarkable alike for the facility of ingress and egress, with its convenient and safe anchorage. The main entrance is deep and sufficiently wide for sailing-vessels under all circumstances, and the sailing limits so plain that there can be little or no impediment to navigating it with ease and perfect safety. Good ten fathoms of water can be carried from sea to Munjoy Point, and there are from four and a half to five fathoms within the harbor. I have been very particular and minute in sounding the harbor within the breakwater and fronting the city, as I hoped thereby to furnish such facts as would give the citizens of Portland full knowledge of this harbor, and prevent the errors that have been committed in some of our commercial ports, in forcing improvements beyond propriety and a due regard to the safety of the harbor. Already shoals are making, caused, I think, by the irregularity in length of the different piers now existing, behind which eddies are formed. I would urge and recommend that the longest pier be considered the utmost limits of such extension for the future, and that as speedily as convenient the remaining piers should be built out flush with that limit. This would have the effect of preventing eddies, make a uniform and direct flow and ebb of the tide, and thus keep the harbor thoroughly and regularly scoured. Back of the city, and just without the flats, there is good deep water. A little assistance would make this a most safe and excellent steamboat harbor. The depth of water is sufficient, and the channel is straight, wide, deep, and convenient for ingress and egress.

"I would recommend that a small sixth-order harbor light be erected on the extremity of the breakwater; also that a can-buoy be placed on the shoal to the northward of the breakwater: the one now down is too small to serve as a proper mark. I deem the light above mentioned very important; it is absolutely necessary to make a safe entrance into the harbor, and to guard against striking the breakwater itself, which is nearly under water at high tide, and is, therefore, on dark nights difficult to be seen so as to be avoided."

A minute survey and determination of the position of Alden's rock, lying at the entrance into this harbor, (see Sketch A, No. 2,) were made, and the results furnished, by authority of the department, to the Board of Trade of that city, who contemplate taking measures either for its removal or indication by a more appropriate mark than a mere buoy.

The survey of Plymouth harbor, Massachusetts, (see Sketch A, No. 1,) was commenced on the 25th of September, and finished on the 15th of October. This harbor was very closely sounded, embracing all its approaches; which being finished, the party returned to Monomoy Point and vicinity to complete a portion of the hydrography which had been left undone in the earlier part of the season.

In October Lieut. Comg. Woodhull made examinations of the localities for surf-boats on the coast of New Hampshire and Maine, provided for by Congress and referred by the department to this office. His report on the result of these examinations was transmitted to the department on the 24th of October, and is also given in the Appendix No. 9.

The schooner Madison, of this party, also gave transportation to Captain A. A. Gibson, U. S. Army, assistant in the Coast Survey, in taking views of several harbors along this coast.

After the completion of the above work, the party returned to New York harbor to determine the positions of several buoys in the harbor, which was done at the end of October, when the vessels were laid up and the officers returned to the office to reduce and plot the work of the season in which they are now engaged, having executed with great zeal and assiduity the large amount of work for which they were called upon.

The statistics of that work are given in the following table:

	Number of soundings.	Miles of soundings run.	Square miles of area sounded.	Number of angles measured.
Sow and Pigs	3,600	180	1½	234
Monomoy	18,500	700	120	970
Portland	11,000	600	65	720
Plymouth	6,500	270	20	868
York harbor	2,600	180		390
Deep Hole rock	3,000	120		
Total	45,200	2,050	206½	3,182

Light-house examinations.—The surveys of York harbor, Maine; of the Minot's ledges, Cohasset, Boston harbor; of the Sow and Pigs rocks, near Cuttyhunk; and of Deep Hole rock, near Cotuit, Massachusetts, were made at the request of the Light-house Board, and by direction of the Treasury Department, under the law of 1852. The results of these surveys have been transmitted to the department in reports, of which I append copies, (see respectively Appendix Nos. 48, 50, and 49,) each of which was accompanied by a sketch indicating the position selected for the aids to navigation contemplated.

Tides.—Tidal observations were continued at Portland, Portsmouth, Boston dry-dock, Hyannis, and Great Point, Nantucket—at the first and last two named places with a self-registering tide-gauge; and were made at Gloucester and Siasconsett, in addition to those temporary observations required for the correction of the soundings.

To obtain reliable tidal observations on the outside of the island of Nantucket, where the ebb and flow corresponds to that on the shoals, has been a baffling problem. The rise and fall is small, and the surf breaks frequently with very great violence on that very exposed part of the coast. By the perseverance and skill of Sub-Assistant G. A. Fairfield, a gauge was placed near Siasconsett, on the eastern side of the island, connected by a pipe with the sea below low water. This arrangement has worked well, and will probably stand as long as is necessary to obtain the tidal data desired. The difficulties encountered, and final arrangements made, are detailed in Mr. Fairfield's report, (Appendix No. 13.) With the experience thus gained he was readily enabled to place a second gauge of the same sort at Great Point, Nantucket, to compare with that at Hyannis, the observations of which of last season did not appear reliable. In this latter case the pipe was connected with a self-registering gauge, and the working of the apparatus was very satisfactory.

Views.—Early in October Captain A. A. Gibson, U. S. Army, assistant in the Coast Survey, made such views of the harbors of Salem and Newburyport, Massachusetts, and Portsmouth, New Hampshire, as were required for the charts of those harbors now in the hands of the engraver. This occupied about ten days, for which time the schooner Madison, of Lieut. Comg. Woodhull's party, was at his disposal to afford transportation from place to place, and the means of obtaining the proper points of view of each harbor.

SECTION II.—FROM POINT JUDITH TO CAPE HENLOPEN, INCLUDING THE COAST OF CONNECTICUT, NEW YORK, PENNSYLVANIA, AND PART OF DELAWARE. (SKETCH B.)

The surveys of the Hudson, of Sandy Hook changes, and of the shoals and channels in that vicinity, have somewhat increased the amount of field-work in this section; two triangulation, one topographical, and two hydrographic parties have been engaged during parts of the season, as their services could be spared from other sections. The triangulation of the Hudson river has been extended, and points determined at the entrance of Dona and Mahon's rivers for verification of the hydrographic points of the previous year. The topographical survey of both shores of the Hudson, from Fort Washington to Sing Sing, has been made, noticing the changes in the shore by improvements and other causes since the previous survey; Sandy Hook has been resurveyed, and its changes since the last and former surveys determined. The hydrography of the Hudson river has advanced from the limits of the former work to Croton Point, about twenty miles above Fort Washington, and a resurvey of the Romer shoal, Flynn's Knoll, East and West Swash channels, and a part of Gedney's channel, New York harbor, has been made, with a view to ascertain any changes which may have taken place in their positions or extent, and also to select a location for a beacon to be used in connexion with the present beacons by vessels entering the harbor. The Jersey flats from Constable's Point to Jersey City have also been sounded over minutely. The tidal observations at Governor's island have been continued.

The off-shore chart from Gay Head to Cape Henlopen, and the chart of the mouth of Connecticut river, have been published during the year, and sketches of Romer and Flynn's shoals, and changes in Sandy Hook, Long Island sound, Nos. 1, 2, and 3, south side of Long Island, and comparative map of Romer shoal and Swash channel, New York harbor, have been in progress.

Triangulation.—The triangulation of the Hudson river, under the charge of Assistant Edmund Blunt, has extended during the season to a station (see Sketch B, No. 1) on Constitution island, near West Point, New York. This was commenced in the first part of September, after the withdrawal of the party from the Chesapeake, and continued until November. The work of the season covers an area of forty-two square miles, in which twenty-one stations have been occupied, forty-five primary and one hundred and ninety-five secondary angles measured, in two hundred and twenty-nine series, by two thousand and ninety-eight (2,098) observations. These were made with twelve-inch theodolites C. S. No. 11, (Simms,) and C. S. No. 32, (Gambey.)

In addition to this triangulation above noticed, Mr. Blunt determined the position of the light-house at the entrance to Bridgeport, Connecticut, numbered 112 in the list of light-houses, and of that in Newark bay, at the mouth of the Passaic river, numbered 131. He also determined points and re-erected the necessary signals for the resurvey of Romer shoal and vicinity, New York harbor, (see Sketch B, No. 2,) and marked the points for the range beacons proposed by the late Assistant J. B. Glück, in his report given in Appendix No. 23 to my report of 1851. Mr. Blunt's report on this last operation is given in Appendix No. 51.

Lieut. A. H. Seward, U. S. Army, assistant, has been attached to this party during the whole season, and, upon the close of the Hudson river work, received instructions for the charge of a party triangulating along the inner Florida reef, for which he is now making preparations.

Lieut. D. T. Van Buren, U. S. Army, assistant, who had been attached to the party of Captain Palmer on the Rappahannock, joined Mr. Blunt in September, upon the suspension of the work for the summer in Section III, and continued with him until its resumption in October.

The position of Mahon's river light-house, and of the station at Dona landing, used in the hydrographic survey of last year of Dona and Mahon's rivers, (see Sketch B, No. 1,) by Lieut. Comg. Woodhull, were verified in January last by Assistant J. E. Hilgard, and the points given to the hydrographic party to plot that work. Three other lights were observed upon for the same object.

Topography.—Assistant F. H. Gerdes, who had finished inking the several sheets of his reconnaissances in the Southern sections, was detailed to make the resurvey of Sandy Hook, New York harbor, to note what changes had taken place since the survey of November, 1851. Six stone posts were placed in that year in positions for easy reference and comparison in future surveys. Most of these, however, have been removed or lost, and the Hook has changed somewhat, though not materially, in its outline. A comparison of its shore-line of this and former years is given in Sketch B, No. 3. The sheet of this year contains ten miles of shore-line, and three square miles of area. The great changes on the Hudson river since 1839, the date of the last survey, produced by the innumerable improvements along its whole extent, required that a new determination of its shore-line, and of the topography of its banks, should be made before executing the reduced drawing. Mr. Gerdes was therefore instructed to make this resurvey, which he has accomplished of both shores from Sing Sing to Fort Washington, (see Sketch B, No. 1.) This is embraced in three sheets completed, and a fourth nearly so, comprising an extent of shore-line of fifty-five miles, and an area of thirty-six square miles.

Mr. Gerdes inked these sheets as he advanced with the field-work, and has since handed them into the office; he also furnished points to the hydrographic party working on this river. The work was closed about the last of October, but will be resumed next year, and continued to embrace the lower portion of the river, and the shore-line of the city to the battery. Mr. Gerdes is now under instructions for the further prosecution of the reconnaissance of the Gulf of Mexico along the shores of Louisiana and Texas.

Hydrography.—The hydrography of the Hudson river was commenced during the season by the party of Lieut. Comg. R. Wainwright, U. S. Navy, assistant. The portion surveyed lies between Croton Point and Fort Washington, (see sketch B, No. 1,) a distance of about twenty miles. In its execution thirteen thousand four hundred and twenty-five (13,425) casts of the lead were made, two hundred and nineteen (219) miles of soundings run, thirty-four (34) square miles of area sounded out, and fifteen hundred and thirty-eight (1,538) angles measured. The above was accomplished after the withdrawal of the party for the summer from Section III, August 5th and October 18th. In connexion with this survey, two permanent tide-gauges were kept—one for a month and the other for a month and a half—six current stations occupied, and a flood and ebb tide taken at each. In addition to plotting this work, the inking and lettering of the entire season's survey of the James river was done.

The party is now at work in the Rappahannock river, Virginia.

A resurvey of the Jersey flats, from Constable's Point to Jersey City, (see Sketch B, No. 1,) was made in April last, by Lieut. Comg. M. Woodhull, U. S. Navy, assistant, and all the rocks, bars, &c., carefully determined. This was done between the 20th of April and 4th of May, in which time eight thousand five hundred (8,500) casts of the lead were made, one hundred and seventy (170) miles of soundings run, ten (10) square miles of area sounded out, and one hundred and ninety (190) double angles measured. In connexion with this, hourly observations of tides night and day, at Bedloe's island, were made.

I am indebted to B. Aycrigg, Esq., of Aquackanock, for calling my attention to the necessity for this work, and for putting his minute local knowledge at the disposal of the survey; the value of which Lieut. Woodhull acknowledges in his report.

A resurvey was made of Romer shoal, East and West Swash channels, of a part of Gedney's channel, and of Flynn's Knoll, in New York harbor, (see Sketch B, Nos. 1 and 2,) with a view to ascertain what changes had taken place since the last survey, and with special reference to the position of the Romer beacon, and of a new one to be used in connection with it, to guide vessels in passing the shoal and through the Swash channel. This survey was very minute, an area of twenty-five (25) square miles having been sounded with eight thousand (8,000) casts of the lead, two hundred and twenty-five (225) miles of soundings run, and three hundred and seventy (370) double angles measured. The result of this work is published in sketch accompanying this report, and numbered B No. 2.

After this work, Lieut. Woodhull proceeded to Section I, to execute that which has been already noticed under the head of that section.

Light-house surveys.—The survey noticed in the preceding paragraph was for light-house purposes.

SECTION III.—FROM CAPE HENLOPEN TO CAPE HENRY, INCLUDING THE COAST OF DELAWARE, MARYLAND, AND PART OF VIRGINIA. (SKETCH C.)

Twelve parties have been successfully engaged in this section during the whole or part of the season. One was engaged in astronomical observations and the determination of telegraphic differences of longitude; one in primary and secondary triangulation; three in secondary triangulation; four in topography; and two in hydrography. Astronomical observations, in connexion with those at Charleston and Raleigh in determining the difference of longitude between the former place and Washington, were made. Magnetic and azimuth observations were made at the time of the measurement of a base of verification for the outside triangulation. The main and secondary triangulation of Chesapeake bay, and of those adjacent and of the outer coast, have been finished. The secondary triangulation of the James river from Richmond to below City Point, and of the Rappahannock from Fredericksburg to Port Royal, has been executed. The topography of the outer coast of Virginia is nearly finished; that of the shores of Chesapeake bay advanced; that of the James and Rappahannock rivers has been under execution; work of revision on the Patapsco is nearly completed. The hydrography outside the entrance to the Chesapeake across to Cape Henry has been completed, and that of the bay within the capes has made good progress; that of the James river from Richmond to Harrison's bar has been executed, and that of the Rappahannock commenced at Fredericksburg. A successful series of off-shore tidal observations have been obtained, and the determination of the positions of two important shoals, not laid down in the charts, in the entrance of the bay, has been made and published for the benefit of mariners.

Within the year a chart of the seacoast of Delaware, Maryland, and Virginia, No. 1, and sketches of Cape Charles and vicinity, of Wachapreague, Metomkin, Pungoteague, and of Cherrystone inlets, and of Hog Island harbor, Virginia, have been published. Charts of Chesapeake bay, Nos. 1, 2, and 3, Patapsco river, Appomattox, and part of James river, have been in progress, besides a manuscript map of the Appomattox river for the city of Petersburg, which is nearly completed.

Astronomical observations.—In the determination of the difference of longitude between Washington and New Orleans by telegraph, Seaton station in this section was occupied to connect with Charleston, South Carolina, and afterwards with Raleigh. The observations were made at this station by Assistant L. F. Pourtales, from whose report I quote the following statement of the number of observations made, instruments used, and mode of observing:

"The instruments used were, transit instrument U. S. C. S. No. 6, the Hardy clock, with Mr. Saxton's break circuit apparatus, Bond's spring governor, and a Morse register. A main battery of forty grove cups was used, and a local battery of six jars on Mr. Mathiot's plan. The station communicated with the southern telegraph office by the wire belonging to the Coast Survey attached to the posts of the Magnetic Telegraph Company.

"The telegraphic arrangements were made by Mr. E. Colton, chief operator at the southern telegraph office. I was assisted in observing by Mr. R. T. Bassett.

"Preparations for working were made on eleven nights, between January 17th and February 18th, without success. During this time eighty-eight transits of stars were observed for instrumental correction and clock's rate.

"Having found it impossible to get a good circuit to Charleston, owing to imperfect insulation of the line, it was resolved to divide the distance, and in consequence Dr. Gould established himself at Raleigh, and was ready for work on the 15th of April.

"Four good working nights were obtained, viz: April 21st, 26th, 28th, and 30th. On those nights eighty stars were exchanged for difference of longitude, sixteen reversals of the transit instrument were made on circumpolar stars for determining the error of collimation, and thirty-one transits observed for clock's rate and azimuth correction. Observations for the same purposes were also made on the nights of April 15th, 18th, 20th, 22d, 27th, and May 2d. On those nights ten reversals on circumpolar stars and thirty-six transits for clock's rate were obtained.

"Before the campaign sixty-two stars were observed for the determination of the personal equation between Dr. B. A. Gould and myself, and eight for the same purpose between Assistant C. O. Boutelle and myself. After the campaign twelve more stars were observed by Dr. Gould and myself, for the same object.

"During the year ending October 1, twenty-nine culminations of the first limb of the moon, and seventeen of the second limb, and three hundred and seventy transits of stars in connection with them for comparisons with the Western coast, were observed at Seaton station, chiefly by Messrs. R. T. Bassett and R. P. Kerrison. During the progress of the telegraph operations the moon culminations were only observed when not interfering with them."

These operations are noticed more fully under the head of Section V.

Primary triangulation.—The primary triangulation, and the secondary connected with it, of Chesapeake bay and the adjacent bays, have been brought to a successful completion during the past season to Cape Henry (see Sketch C, No. 1) by Assistant Edmund Blunt, who has extended it from the base on Kent island. The first observation of the season was made on the 5th of July, the early part of the season having been occupied in the general setting of signals; and the last on the 4th of August. During that time twenty-five stations were occupied, three primary angles were measured, and three hundred and one secondary, with one thousand six hundred and ninety-seven observations, with one hundred and seventy-two repetitions. The area covered by the work was sixty-one square miles. The instruments used were twelve-inch theodolites, C. S. No. 11, (Simms,) and C. S. No. 32, (Gambey.) Mr. Blunt, with Lieut. A. H. Seward, U. S. Army, assistant in his party, repaired, on the completion of the above work, to Section II, to continue the triangulation of the Hudson river northward, which has been noticed under its appropriate head. Mr. Blunt is now engaged in marking thoroughly the several station points in this section.

Secondary triangulation.—As stated in my last report, Mr. Farley took the field early in October last, for the purpose of connecting the secondary triangulation of the outer coast of Maryland and Virginia with that of the Chesapeake, at Smith's island, near Cape Charles. (See Sketch C, No. 1.) A satisfactory line of junction was obtained between Smith's island east and Cape Charles station, and the observations completed on the 6th of November. The triangulation points, up the coast as far as Hardy's Hole station, were then marked with permanent monuments, and some of the topographical stations secured. This duty was terminated by the advance of the season, and from other causes, on November 26. Mr. Farley was occupied with the computations of his season's work during the winter and until March, when they were reported to the office; and he commenced preparations for the triangulation of James river, Virginia, from the limits of the work of last year by Lieutenant William P. Trowbridge. This was begun in April, and continued until the end of July, when it was suspended on account of the sickness of the party. A further account of this work will be given subsequently.

With a view to finally closing up the triangulation of the seacoast of Maryland and Virginia, it was determined to measure one of the sides of the triangulation, as a verification line; and Assistant J. E. Hilgard was detailed to assist Mr. Farley in the measurement of the base and the observation of the azimuth of one of the lines. This operation, which was commenced on the 6th of September, is thus reported by Assistant Farley:

"The measurement was made by Assistant J. E. Hilgard and myself, aided by Mr. Stephen Harris, and completed on the 26th of September.

"The site selected is on the beach, extending about one mile and a quarter northeast and southwesterly from station Dromedary, and opposite to the side Davis—Quilling, to which the measured length has been transferred, by the observation of angles at north base, south base, Davis and Quilling, with the ten-inch Gambey, No. 31, and the six-inch Brunner theodolite, No. 59.

"The base was measured with two four-metre rods, marked 3 and 4, and with the apparatus used by Mr. Boutelle at Georgetown, South Carolina.

"The number of bars measured is 977, and the length of the base 3908.5^{m}. The average number of bars measured in an hour was forty-five—the greatest number, ninety.

"Thirty-five angles, each by six repetitions, were measured, to transfer the measured line to the side Davis—Quilling. The work closes in a satisfactory manner.

"In connexion with this work, observations of azimuth and magnetic observations were made by Assistant J. E. Hilgard at station Davis.

"Twelve sets of six repetitions between Polaris and a mark were observed at both elongations of the star, and ten sets to refer the azimuth to the station Quilling, the instrument used being the ten-inch theodolite, C. S. No. 31, (Gambey.)

"The magnetic observations consist of three days of declination, three sets of dip, and one set of horizontal intensity observations."

The first field-work of the season by Mr. Farley's party was the continuation of the triangulation of the James river, Virginia, between Richmond and City Point. This work was carried on by Mr. Farley from the 20th of April to the 19th of May, when, on account of his sickness, Sub-Assistant J. R. Offley was detailed to assist him. The party continued working under single organization until the 15th of June, when it was found practicable to double it—Mr. Farley executing the lower portion, in the vicinity of City Point, and Mr. Offley the upper part, working towards each other.

The unhealthiness of the season on the river, both gentlemen becoming sick, rendered it advisable to close the work on July 26, after carrying it as far down the river as the line Longfield—Kingsland; leaving an interval between the triangulations of the two parties of about ten miles, which will be closed by one of them during the coming season.

The number of intersections in this work, by both parties, was one thousand eight hundred and thirty-nine, (1,839,) from seventeen stations occupied. The instruments used were the ten-inch theodolite, C. S. No. 15, (Gambey,) and the six-inch theodolite, C. S. No. 60, (Brunner.)

Mr. Farley, upon his recovery, commenced the measurement of a base, with the assistance of Mr. J. E. Hilgard, upon the eastern shore of Virginia, which has been reported under its proper head; Mr. Offley, meanwhile, being engaged in computing the results of the James river triangulation.

The triangulation of the James river, Virginia, was commenced last November by Lieut. Wm. P. Trowbridge, U. S. Engineers, assistant in the Coast Survey, who continued the work until the middle of January, when he was withdrawn for the purpose of making preparations for duty on the Western coast, in which he has been since engaged. A base line of 892.17 metres in length was measured near Richmond, and a triangulation extended from the city down the river to French station. (See Sketch C, No. 1.) A reconnaissance and plan for its further extension was made as far as Warwick. The work executed by this party includes an area of about four square miles, the occupation of ten stations, and the measurement of thirty-nine (39) primary angles, and thirty (30) secondary, by one hundred sets of six repetitions and sixty secondary observations.

The further triangulation of this river has been continued by Assistant John Farley and Sub-Assistant J. R. Offley, the results being as above reported.

The reconnaissance for the secondary triangulation of the Rappahannock river, from Fredericksburg to its mouth, (see Sketch C, No. 1,) was made in the autumn of last year, by Captain Wm. R. Palmer, U. S. Topographical Engineers, assistant in the Coast Survey. An appropriate scheme of triangulation was laid out for each of the three sections into which the river was divided: the first extending from Fredericksburg to Port Royal, the second from Port Royal to Tappahannock, and the third from Tappahannock to the Chesapeake. The report of this reconnaissance, containing interesting information in regard to the river, its shores, villages, &c., is given in Appendix No. 114.

On the 15th of April Captain Palmer commenced the triangulation of the first section of this river, assisted by Lieut. D. T. Van Buren, U. S. Army, on Coast Survey service. A base line of twelve hundred and forty metres was measured about the middle of the section, and the triangulation first carried up the river towards Fredericksburg. This was finished on the first of June and extended to Falmouth village, about a mile above Fredericksburg, when the party returned to the base and triangulated down the river nearly to Port Royal, discontinuing work at the line Hazelwood—Lewis (see Sketch C, No. 1) on the 6th of July, when the advance of the season required it.

The triangulation of the season extended a distance of eighteen miles directly, following the river shore of thirty miles; twenty-nine stations were occupied, and ninety-six angles were measured by one thousand two hundred and ninety-six

(1,296) observations upon thirty-one objects. The instrument used was the six-inch theodolite, C. S. No. 58, (Brunner.)

Captain Palmer completed the computations of the work after returning from the field, and Lieut. Van Buren joined Assistant Edmund Blunt in the triangulation of the Hudson river.

The party resumed work here in October, and is now, under the former organization, engaged in extending it into the second section towards the mouth of the river.

Topography.—The topography of the peninsula of Maryland and Virginia has been extended by the party of Assistant George D. Wise. On the 10th of June Mr. Wise accompanied Lieut. Comg. Almy and furnished him the shore-line from Sand Shoal inlet to Cape Charles, (see Sketch C, No. 1,) which completes the shore-line from Cape Henlopen to that point. This finished, the topography of the shores was extended as far as Sand Shoal inlet, comprising, up to the first of October, an extent of shore-line of one hundred and five miles, and an area surveyed of fifty-one square miles.

The topographical party of Sub-Assistant John Seib commenced the survey of the James river, Virginia, in the early part of the past season. The intention was to have taken the field in April, but the accidental grounding of the schooner Wave, the vessel employed by the party, caused a short delay, and they did not reach the field until May 16th; the work was then taken up, and actively prosecuted until June 27th, when the requisite amount of shore-line was completed and furnished to the hydrographic party at work in that river. This was contained in four sheets, and extended from Warwick, the limits of Sub-Assistant Wainwright's work, to Cogain's Point, below Harrison's bar, (see Sketch C, No. 1,) embracing an extent of shore-line of eighty-one and a half miles.

Having made a copy of the James river work and sent it to the office, Mr. Seib repaired to the Chesapeake to take up the topography of the unfinished portion of the main shores of that bay. This portion is included in plane-table sheets 53 and 54, to which was added work on sheet No. 56, embracing part of Hampton Roads and the mouths of the James and Nansemond rivers, (see Sketch C, No. 1.) Mr. Seib thus describes the limits and progress of each sheet, and the whole amount of work in this vicinity:

"No. 53 includes Pocsin river and a part of Back river; only a small portion of it is done on the northern shore of Back river.

"No. 54 includes part of Back river and of Hampton Roads, with Old Point Comfort, Mill creek, Hampton creek and town, Willoughby's Point, Mason's creek, Sewell's Point, and the lower part of Tanner's creek, at the mouth of the Elizabeth river. This sheet was commenced last year, and is now completed.

"No. 56 includes a part of Hampton Roads, the mouths of Nansemond and James rivers. On this are executed the shore and topography from the limits of sheet No. 54 to Newport-News Point, and the shore with a small portion of the topography from Crany island to within a short distance of Pig Point, at the mouth of Nansemond river.

"The country thus gone over and surveyed is low and even, the highest point above high-water mark scarcely exceeding ten feet; it is much intersected with creeks, coves, and branches, with considerable woodland and marsh, as will be seen from the following statement of the amount of work executed:

"Shore-line of bay, river, and creeks - - - - - - -	101 miles.
"Shore-line of ponds - - - - - - - - - - -	16½ "
"Total shore-line - - - - - - -	117½ "

"Area of country,	cultivated land	11 square miles.
Do.	woodlands	11½ "
Do.	sand and marsh	4 "
	"Total area	26½ square miles."

The work in this neighborhood was suspended upon the completion of plane-table sheet No. 54, about October 5th, when the party was transferred to the Rappahannock river to execute the shore-line corresponding to Captain Palmer's triangulation, in which it has been since engaged.

Before taking the field in the spring, Mr. Seib was occupied in inking the sheets of his previous season's work on the Appomattox river, which were finished and turned into the office.

The topographical party of Sub-Assistant S. A. Wainwright was detailed for the purpose of furnishing shore-line and points to the hydrographic party making the survey of the James river, Virginia. This was done during the month of May, executing about fifteen miles of shore-line from Mayo's Bridge, above Richmond, to Warwick bar, (see Sketch C, No. 1.) Mr. Wainwright also made a survey of Trent's Reach, in this river, to furnish points to the party sounding on the bar there.

When the above work was finished, Mr. Wainwright repaired to the office to finish the inking of his sheets of Georgetown harbor, South Carolina, which has been done, and they have been turned into the office.

Hydrography.—The hydrography of the outer shore of Virginia was resumed, during the past season, by Lieut. Comg. J. J. Almy, U. S. Navy, assistant in the Coast Survey, from the limits of the last year's work, at a line running from the northeast point of Prout's island, and was extended to Cape Henry light, a distance of thirty-three miles, (see Sketch C, No. 1,) making thus admirable progress. The hydrography of the entrance to the Chesapeake was included within the limits of the sheets, soundings on which were carried off the north point of Prout's island to a distance of fifteen nautical miles, and off Cape Henry to a distance of twenty nautical miles, extending in a line between these outer points, and including an area of five hundred and sixty square miles. One thousand one hundred and seventy-six (1,176) nautical miles of soundings were run; eighteen thousand one hundred and six (18,106) soundings were made in from one to fifteen fathoms water; four thousand four hundred and ninety-eight (4,498) angles were measured with a theodolite, and one thousand two hundred and eighty (1,280) with a sextant. Five current stations were occupied, and one hundred and seventy-three (173) observations taken; seventy-eight high and seventy-seven low tides were observed, and the number of observations made were three thousand five hundred and forty-six, (3,546,) and thirty-seven specimens of bottom were obtained.

The same vessels were attached to this party during this season as the last—the steamer Hetzel and schooner Graham. In speaking of the currents as observed, Lieut. Comg. Almy says: "Upon the sketch will be observed the tracks of three bottles which have been thrown overboard and picked up this season. Their courses, as you will perceive, were nearly due north—the reverse of the courses of the bottles thrown overboard the two previous seasons. The prevailing winds, through almost the entire season, have been from the southward, and there has been very little northerly wind. Not even once during the season has there been what might be called a regular 'northeaster,' which we have frequently had during the two previous seasons. This would seem to show that the current upon the seacoast of Virginia is influenced almost entirely by the winds."

One of the most important results of the season's work of this party has been the determination of the positions of two dangerous shoals lying at the entrance into Chesapeake bay, and which were not laid down upon any existing map. The outer of these two shoals lies at a distance of seven nautical miles, and bearing E. by S. ¼ S. from Smith's Island light-house, with three and one-fourth fathoms of water upon it at low tide, and seven fathoms between it and the land. The inner shoal lies SE. by E., distant four and three quarter nautical miles from the light-house, with seventeen feet upon it, and five fathoms between it and the land. The notice of the determinations of these positions was published, by authority of the department, for the benefit of navigators, and is now appended to this report. (See Appendix No. 16.)

A tripod was placed on a shoal at sea, two nautical miles from the tide-staff at Sand Shoal inlet, (see Sketch C, No. 1,) and seven high and seven low waters observed for comparison. As is almost invariably the case in such observations, the differences of time and height of high and low water on the shores and at the inlet were irregular; but the final average result showed a difference much smaller than the irregularities of the phenomena themselves. These observations, though difficult to make, will be resumed on a favorable occasion. Lieut. Almy's report on them is given in Appendix No. 15.

In a supplementary report, Lieut. Comg. Almy gives the result of his work inside the capes in Chesapeake bay. This extends from the limits of last year, at New Point Comfort, northward to Wolf Trap, thence across the bay, and further north to beyond "Sandy Point." (See Sketch C, No. 1.) The statistics of the work, which was commenced 26th of September, and finished on November 1, when the advance of the season required its discontinuance, are given as follows:

"Four hundred and twenty-seven nautical miles have been run in soundings; twenty-three thousand nine hundred and fifty-one (23,951) soundings have been taken, in from one to seventeen fathoms water. The number of angles taken by the theodolite for hydrographic positions is one hundred and twelve, and the number taken by the sextants for the same purpose is one thousand and eighty-three. The number of tides observed is fifty-five high tides and fifty-two low tides, and the number of tidal observations is fourteen hundred and seventy-five. The number of specimens of the bottom taken has been eleven."

This party is now engaged in the office, reducing and plotting the season's work.

On the 22d of April the party of Lieut. Comg. R. Wainwright, U. S. Navy, assistant in the Coast Survey, with the schooner John Y. Mason, resumed the hydrography of James river where it had been suspended in the winter, about five miles below Richmond, and completed it, by the 1st of July, to the junction with the reconnaissance of Harrison's bar made in 1852. (See Sketch C, No. 1.) In the execution of this work, two hundred and thirty (230) miles of soundings were run, twenty-five thousand (25,000) casts of the lead made, one hundred and sixty-four (164) stations were occupied, and two thousand seven hundred and one (2,701) observations made. Two permanent and nine temporary tide-gauges were established, in connexion with the hydrography, and borings were made in twenty-eight positions, varying in depth from one to ten feet below the surface, near Richmond. Upon the close of this work, in July, the party was transferred to the Hudson river, where their operations have been noticed. Since the completion of that, they have been engaged in the hydrography of the Rappahannock river, Virginia, below Fredericksburg.

SECTIONS IV, V, and VI.—GULF STREAM.

The general plan of exploration of the Gulf Stream, laid down in 1845, was to observe the phenomena on sections perpendicular to its axis from well-determined points on the coast. In pursuance of this design, sections were run from near Montauk Point, Sandy Hook, Cape Henlopen, Cape Henry, and Cape Hatteras, previous to 1848. The circumstances of the work did not permit a successful prosecution of the observations from that date until the season just past, though instructions were given and preparations were made more than once for the purpose. The direction of Congress to show on a map, to accompany the report of this year, the state of our knowledge in respect to the Gulf Stream, induced me to push the operations even more rapidly than I should in the regular progress of the exploration, and to employ two parties in it during a part of the season. Lieut. Comg. Craven was directed, in returning from the Florida reef, to run four sections across the stream from near Cape Canaveral, St. Augustine, St. Simons, and Charleston; and Lieut. Comg. Maffitt, after closing his work at Georgetown, South Carolina, to run three sections respectively from Charleston, Cape Fear, and Cape Hatteras. In each section the number of positions was to depend upon the more or less rapid changes met with, and the temperatures were to be observed at the surface at five, ten, twenty, thirty, fifty, seventy, one hundred, one hundred and fifty, two hundred, three, four, five, and six hundred fathoms, with deeper casts in some cases to reach far into the cold polar current shown to underlie the stream. The Hatteras section having been made in 1848, the new work was connected with the former by retracing this section, taking the former positions as nearly as they could be reached. The Charleston section was to be run by the same two parties, and it was expected that the positions occupied by the one first passing over the section could be communicated to the other in time to join the two sets of observations at nearly the same points.

Great credit is due to both parties, whose chiefs I have already named, for the manner in which the work was executed. The difficulties caused by the use of a sailing-vessel (the Crawford) were entirely overcome by the zeal and perseverance of the officer in immediate charge, Acting Master J. P. Jones. The Crawford began the Charleston section on the 2d of June and finished it on the 11th, making sixteen positions, the furthest of which was two hundred and seven miles from Charleston light. (See Sketch Gulf Stream, Nos. 1 and 2.)

The Corwin steamer, Lieut. Comg. Craven, made the Canaveral section on the 9th and 10th of June; the St. Augustine on the 10th and 11th; the St. Simons on the 12th and 13th; and the Charleston on the 16th; not carrying the latter quite as far as her commander intended, from the giving out of the boilers. Including some positions not on these sections, thirty-nine positions were made. The Crawford ran the Cape Hatteras section between the 12th and 16th of July, (both inclusive,) and the Cape Fear between the 19th and 26th, making in both together twenty-six positions.

On the Charleston section, bottom was carried from ten fathoms in position A, (see Sketch Gulf Stream, No. 2,) thirty-eight nautical miles southeast from Charleston light, to one hundred fathoms in position I, sixty-five miles from the light. The bottom was not reached in position II at five hundred fathoms, nor at III in six hundred fathoms. In position V, ninety-seven miles from Charleston light, after crossing the warmest water of the Gulf Stream, bottom was struck in three hundred fathoms, on the 7th of June, at 8 p. m., and was kept at variable depths from five hundred to three hundred and seventy fathoms to position X, two hundred and seven miles from the coast. The details are shown on diagram Gulf Stream, No. 2.

The bottom was brought up in every case, and is preserved at the office. The interesting observations of Assistant L. F. Pourtales, in regard to the physical and natural history characters of these and the other specimens of the bottom of the stream, collected during the cruises of this year, are given in Appendix No. 30.

The Corwin's section, just north of this one, and in a direction somewhat inclined to it, gives remarkably accordant determinations for the depths, as will be seen by examining diagram Gulf Stream, Nos. 1 and 2.

After crossing the Gulf Stream on the Canaveral section, on the 10th of June, at 8 a. m., Lieut. Comg. Craven struck soundings at four hundred fathoms in position XII, (see diagram Gulf Stream, Nos. 1 and 2,) sixty-nine miles from the coast, and kept them at position XI, six miles from the former. It appears thus that the existence of soundings of from three hundred to four hundred fathoms, after crossing the Gulf Stream at these two points of our coast, was discovered independently by the two officers whose work I am noticing, within two days and a half of each other. In the subsequent sections run by the Corwin, soundings were struck one hundred and twenty-five miles off St. Simons in five hundred fathoms, and off Charleston in four hundred and eighty fathoms.

The form of the bottom on the Charleston and Canaveral sections is well shown on diagram No. 2, Gulf Stream, shoaling gradually from the shore to fifty-three and thirty-six miles respectively, then suddenly falling off to below the depth of six hundred fathoms. On the Charleston section, ninety-six miles from the coast, is a range of hills steep on the land side, and having a height of eighteen hundred feet and a base of about eleven miles on the seaward side; a second range one hundred and thirty-six miles from the coast, fifteen hundred feet high and twenty-eight miles base towards the shore, and six hundred feet high, with a base of about seventeen miles, on the outer side. Beyond this is a more gradual rise. On the Canaveral section the inner range is sixty-eight miles from the coast. Of course, it may readily be concluded that if the positions at which the soundings were taken had been nearer to each other, a more diversified surface would have been presented. In fact, at position XI, on the Canaveral section, after sounding at the depth of one thousand and sixty fathoms, the steamer drifting about a mile and a quarter, the line showed bottom at four hundred and sixty fathoms. Both are stated to have been good up and down casts. These first observations, while they are merely a foundation to build upon, are undoubtedly in the highest degree interesting and important in their connexion with the phenomena of the Gulf Stream.

On the sections from Cape Fear and Cape Hatteras, after leaving the shoals near the shore, the depths increase very rapidly.

Lieut. Comg. Craven noticed ripples in connexion with the irregularities of the bottom on the Charleston section. Similar ripples were observed on the Sandy Hook section by Lieut. Comg. Geo. M. Bache in 1846, and on the Montauk section by Lieut. Comg. Charles H. Davis in 1845, who compared them to the "Rips" on the Nantucket shoals. These are, however, probably a secondary effect of the irregularities by the changes of current produced.

For the temperature observations, the parties were furnished with Six's self-registering thermometers for moderate depths, and with Saxton's metallic thermometers for greater depths. More difficulty was had with the instruments than usual, and there are more anomalous observations; but after examining them with care, I think it more probable that the anomalies were real than that they were errors of observation. I have also satisfied myself that they do not interfere materially with the general results. The whole of the computations which I have yet made are, however, only approximate, to indicate the route to be followed in deriving numerical results, but sufficiently near the more exact ones to guide in future observations.

The results of all the new sections confirm those given by the old ones, namely, that there are alternations of temperatures across the Gulf Stream, cold water intruding and dividing the warm, making thus alternate streaks or streams of warm and cold water. In fact, the Gulf Stream is merely one of a number of bands of warm water separated by cold water. The observations of Mr. Jones on the Hatteras, Cape Fear, and Charleston sections, show a counter current where the cold streaks are found; and as these observations and those for temperature are entirely independent of each other, the coincidence in result is very striking. This fact is of too great importance not to be very carefully followed up. It would appear, from general reasoning, that this was not unlikely to be the case.

The southern sections present, on a small scale, the same phenomena which we formerly traced over a large expanse in the more northern ones. Examining the Canaveral section, which is the furthest south, we see the cold wall almost as plainly as on that from Sandy Hook; the curve, showing the mean results between seventy and one hundred fathoms, (diagram Gulf Stream, No. 2,) rises some seventeen degrees, from 57½° to 74½° Fahrenheit, in the distance of twenty-three nautical miles. The warm water, overlying the cold, is deeper in its overflow towards the shore—that is all. After passing through the warmest water, which, in June last, was only 80½° Fahrenheit at two fathoms and a half, there is a fall of temperature of several degrees, followed by a rise. On the St. Simons section (see diagram Gulf Stream, No. 2) the cold wall is again well shown, and is the first of those distinct bands of minimum temperature dividing four maxima, of which the greatest body of warm water of the Gulf Stream is the second from the shore. These are particularly distinct in the lower curves of the diagram. Near the surface the first and fourth maxima are the highest; at fifteen fathoms the first and second; at one hundred and fifty fathoms the successive maxima rise as they recede from the shore. The Charleston section presents, as a general feature, between twenty-five fathoms and two hundred and fifty fathoms, four minima and three maxima. Within the cold wall minimum is a decided warm belt, and probably further on in-shore is a cold one. The rise in the curve, showing the mean of the temperatures at twenty and thirty fathoms, is eleven degrees Fahrenheit, namely, from 64° to 75°. There is an intrusive band of cold water between positions III and V, which does not continue to show itself as low down as the curve *p*. The advantage of not relying on surface temperatures, or those near the surface, where the distribution is so much less regular and marked than below, will be recognised in all these results, and was early provided for in my instructions.

The underlying cold water from the northern regions is as plain in these southern sections as it was in the more northern. Four hundred fathoms vertically below the warmest water of the Gulf Stream, on the Cape Henlopen section, in August, 1846, the temperature was 49° Fahr., and in the same position off Cape Canaveral, in June, 1853, it was 48½°. The latitude corresponding to the first temperature was about 37° 20′, and to the last about 28° 20′. Lieut. Charles H. Davis, in October, 1845, found a temperature of 40° at one thousand fathoms, in latitude 39° 25′, and longitude 69° 01′, and Lieut. George M. Bache 40° at two thousand one hundred and sixty fathoms, in latitude 34° 13′, longitude 68° 05′. Lieut. S. P. Lee, in August, 1847, found 37° below the Gulf Stream, at the depth of one thousand fathoms, in latitude 35° 26′, longitude 73° 12′; and again 48° beyond the Gulf Stream, at the same depth, in latitude 30° 10′, and longitude 68° 09′. Lieut. Richard Bache, in July, 1848, found a temperature of 42° at one thousand fathoms, in latitude 35° 06′, and longitude 74° 07′, below the surface of the Gulf Stream.

The fact that the side limits of the polar current recede from the shore as the depth increases, is clearly marked on all the sections. Directly down below the maximum surface temperature we soon plunge into this cold current, the warmer water receding from the shore, and at four hundred fathoms reach temperatures, the differences between which at the north and south are of an order corresponding to the variations of the ocean waters in different years and at different seasons. For example, at the depth of four hundred fathoms, on the Sandy Hook section, in 1846, vertically below the crest of the Gulf Stream the temperature was 51° Fahr.; on the Henlopen section, at the corresponding point, 51°; on the Cape Henry section, 54½°; in 1848, on the Cape Henry section, 52½°; and on the Hatteras section, 52°; in 1853, on the Hatteras section, 51°; and on the Cape Fear section, 54°; all the foregoing observations being made in July and August of the several years. In June of this year, the temperature at the point and depth before noted, on the Charleston section, was 55°, and near Cape Florida, fourteen miles ENE. from the light, was 51°, varying from 54° to 46° in the intermediate localities. The low temperature of 46° was observed on the Canaveral section. The temperature at four hundred fathoms, near Cape Florida, is the same as was observed on the Sandy Hook section in July, 1846.

I remarked that these differences came within the annual changes near the surface. Not to complicate the examination with surface irregularities, if we compare the maximum temperatures at twelve or fifteen fathoms below the surface of the different sections, in the same year, we shall find, as a general rule, an increase of temperature in passing southward, as 81°, 83°, 82°, from the Sandy Hook to the Cape Henry section; in 1846, 75½°, 76°, 77½°, 79½°, from the Charleston section to Cape Canaveral. But in successive years we have for the highest temperature at twelve fathoms, on the Cape Henry section, higher than that of Hatteras; and the temperature in July, 1846, on the axis of the Gulf Stream, higher at Sandy Hook than in June, 1853, at Canaveral, by a degree and a half, and higher than Charleston by five and a half degrees. It is obvious that here an interesting field of inquiry opens, requiring careful research.

The summer was selected for commencing the researches in the Gulf Stream in part, and chiefly because of the greater facility afforded for observation by the comparatively smooth sea and moderate weather, but also because the changes at the surface of the water by heating would not tend to disturb the equilibrium.

An investigation of the effect of the seasons was postponed until the normal state of the stream was known. It must be, however, obvious that if we know the rate of the Gulf Stream current as it passes along in its course, diminishing its velocity, we can compute the interval of time which must elapse between the passage of water of a certain temperature at Cape Florida, and its arrival with a gradually diminishing temperature at other points in the course of the stream. In a general way, as far as I have yet carried this comparison, the observed facts answer to what might be expected. The reverse will apply to the cold current from the north.

The lateral overflow of the warm water of the Gulf Stream is seen on either of the diagrams representing the curves of temperature at the same depths as that for Charleston, diagram Gulf Stream, No. 2; the warm water thinning out as it flows rapidly on the in-shore side, more slowly seaward, except near the surface. This prevails in the case before us as low as the curve of 67° Fahrenheit. In this, of course, we must abstract the effect of the irregularities caused by the intrusion of the cold water from below. The recession of the warmest water from the shore, as we reach lower depths, is well shown in the same diagram.

The effect of the form of the bottom of the ocean on the distribution of temperatures, and its connection with the observed alternations of warm and cold water, is the most important and interesting result of this year's explorations. Whether the cause of this distribution is the same in the sections where soundings have not yet been obtained—and we shall generalize, inferring the form of the bottom there from the distribution of temperature—is a question of temporary importance; for we can explore those depths and determine with certainty what lies below the lowest we have yet reached.

The Charleston section, diagram Gulf Stream, No. 2, shows very well the general effect of elevations and depressions of the bottom—the elevations raising up the cold water of the bottom, the depressions allowing it to settle into them. The curve of 57° illustrates this perfectly, passing obliquely along the in-shore band towards the deepest water, rising again along the slope of the first elevation, and being thrust by it high up towards the surface, descending again into the depression to rise again above the second elevation, and so onward; the current following the reverse order of that just described. That there is not perfect conformity to this law, is merely to say that these observations are like all other physical results. The wonder is that they agree so well when the difficulties of making them are considered. Each observation in each position gives an independent result, and all these cannot reasonably be expected to concur, and yet must be used in representing the phenomena. Theoretical considerations would lead us to expect greater diversities than we actually find in the results, even were the observations absolutely perfect.

The crowding of the cold water towards the inner shore is well shown in the diagram under notice, and the overflow of the warm water. A curious explanation of the sudden change from cold to warm, in passing what in these sections would be the cold wall, is seen obscurely in this diagram, but perfectly on that for St. Simons, where the sudden falling away of the in-shore slope causes the cold water to rise beyond its position of equilibrium, and thus, after passing through the thin stratum of warm water near the surface, the thermometer indicates a sudden fall; a much lower temperature than is to be found a few miles outside or in-shore. This is merely an extension of the principle before referred to, of the effect of the steep slopes in forcing up the cold water of the northern stream.

In order to comply with the directions to represent the probable course of the Gulf Stream, I have studied the observations of former years in connection with those of the present, and have determined the approximate result shown on diagram Gulf Stream, No. 1, and on the Congress map. The axis of the Gulf Stream, or warmest line at the surface, is represented by the strongest line in the diagram. The lines corresponding to the highest temperatures of the different bands, or axes of the bands, into which the surface is divided, are drawn full, like those of the warmest band decreasing in strength from the main line. Those corresponding to the lowest temperatures of these bands, or to the axis of the intrusive cold water, as they may be considered between the warmest bands, are dotted—the strength of the dots varying as the lines recede from the main axis of the Gulf Stream. In the Congress map the bands will be shaded—the dark shades corresponding to higher temperatures. It scarcely need be remarked that the curves are not drawn precisely through the points obtained on the several sections, but in no case but one is the distance from any point as great as the probable error in the determination of the points themselves, as derived from the distance of the positions as under and from the calculation of the different results given upon the trial sections, which were gone over at different times by different observers, and upon the various lines denoting the temperatures at the same depths.

Are these bands invariable in number and position? If connected with the form of the bottom of the ocean, they must be so within moderate limits. But this has only been proved for the sections from Charleston southward. The comparison of the separate results on the trial sections enables us to determine this point numerically from the observations themselves; so also do the separate results as shown by the positions of the maxima and minima at different depths. The results thus deduced, as far as they have been tried, are the following: The axis of the Gulf Stream, marked A, on the Sandy Hook section, diagram Gulf Stream, No. 1, though it recedes from the coast, as a general rule, as the depth increases, is the best determined of all these lines. In cases of the curves of the highest and lowest temperatures in the band, marked B, C, D, and E, where they cross the Sandy Hook section, the order of the difference is the same as that of the distance between the positions, and the probable error considerably less than the average of the half-distance between the positions in the part of the ocean where the maximum or minimum is found. The actual changes of position, with varying circumstances, are probably of the same order. The cold wall minimum, which generally occurs in the same vertical lines from the surface downwards, is the next best determination to that of the axis of the stream. As these are most definitely marked, and were obtained from positions much nearer each other than the other lines, such a result was to be expected. The remark in regard to limit of uncertainty applies to the two cold streaks outside of the Gulf Stream, C and E, and to the warm one, D, between them.

The position of the next warm streak is quite uncertain, and it is not inserted on the chart, though its occurrence is well made out. In the sections where the soundings for temperature were carried close into the coast, the same regimen of the water is shown as outside, and one maximum inside of the cold wall is clearly indicated in all the sections but one. The minimum nearest the shore on the Sandy Hook section corresponds to the remarkable increase of slope in the ocean bed found in previous soundings, and represented in the sections from Sandy Hook on the off-shore chart of the Coast Survey, embracing the coast from Gay Head to Cape Henlopen.

The question as to whether the different points of high and low temperatures, as they succeed each other in the sections, should be joined to represent a continuous line, is a difficult one, especially if the form of the bottom be admitted as controlling the distribution of temperatures, as that form may vary so arbitrarily. There is hardly a doubt in regard to the continuity of the first cold line B; none as to that of the axis of the stream A; but near to this on the Charleston, St. Simons, and St. Augustine sections, follow a minimum and maximum entirely well defined on each section, and yet which is probably not connected with the next set of similar points observed on Canaveral to the south of them, and Cape Fear to the north. There is a similar set of points on the Cape Henry section. At present the probability of the case is as I have shown it on the diagram, and any doubt in regard to it must be cleared up by future observations directed to this point.

By our researches at present, the position of the axis of the stream is traced to 88° W., and that of the cold wall is carried with considerable degree of probability to 85° W.

The changes of position of the main and subsidiary streams in different years, with the seasons and with winds and other causes, remain yet to be made out. The observations already made show that these are considerable.

The general conformity of the sweep of the Gulf Stream hitherto admitted is now minutely traced, and shown to be more thorough even than was supposed, passing into the bight of the coast of Georgia, deflected by Hatteras, turning in towards the capes of the Chesapeake, and, sweeping eastward, deflected by the banks which lie off the coast of New England.

SECTION IV.—FROM CAPE HENRY TO CAPE FEAR, INCLUDING PART OF VIRGINIA AND NORTH CAROLINA. (SKETCH D.)

Three parties, each executing triangulation combined with topography, and one hydrographic party, have been employed in this section during the whole or a part of the past season. The secondary triangulation of Back bay, the extension of Currituck sound, has been continued northward to beyond the Virginia line; that of the Cape Fear river carried to a point above the separation of its northeast and northwest branches; and the tertiary triangulation of Core sound connected with that of previous years, going southward from Ocracoke inlet, and northward from Cape Lookout; and the reconnaissance for the extension of the triangulation west of Beaufort, over Bogue sound, made. In connection with these respective triangulations, the topography of the eastern shore of Back bay, as far north as the Virginia line; of Smith's island, at the entrance to Cape Fear river; and of the river shore from Smithville to the head of Eagles' island, above Wilmington, and that of the shores west of Cape Lookout, to connection with sheet of Beaufort harbor, has been executed. The hydrographic survey of the Upper Cape Fear river, interior to the work of last year, was completed from New inlet to the town of Wilmington, and up to Brunswick river. Astronomical observations were made at a station in Raleigh, the State capitol, which was occupied as an intermediate point in determining the difference of longitude between Charleston, South Carolina, and Seaton station, Washington.

The details of these operations will be found in the pages immediately following this.

The drawings of Hatteras and Ocracoke inlets, and of Hatteras and Frying Pan shoals, and of the preliminary chart of Cape Fear entrance, have been completed, and those of the Cape Fear and Albemarle sound have made good progress. The engraving of charts of Beaufort harbor, Frying Pan and Hatteras shoals, of Hatteras and Ocracoke inlets, and Core and Pamplico sounds, has been completed, and that of Cape Fear has been in progress. The drawings of Cape Fear entrance and New inlet were prepared, with other data, for the commission on the improvement of the entrance and river.

Secondary triangulation.—The secondary triangulation of Back bay, lying in North Carolina and Virginia, which had advanced as far as the line Jones' hill—Gray's Point, at the close of last season, was resumed by Assistant J. J. S. Hassler, in December last, and continued until the close of May. The survey has been extended this year northward to the line Wash Flats—Ragged island, beyond the Virginia line. (See Sketch D, No. 1.) This party was also engaged in the execution of topographical work, in connection with the triangulation, and used the schooner Vanderbilt for transportation and accommodation. The statistics of the triangulation are thus given: number of stations occupied, eight; number of stations determined, seventeen; number of angles measured, two hundred and ninety; number of observations made, seventeen hundred and forty. The instrument used was the six-inch theodolite, C. S. No. 52, (Brunner.)

The secondary triangulation of the Cape Fear river was carried during the past season from Smith's island, line Cape Fear—Bald Head light, (see Sketch D, No. 2,) over the entrance, to above Wilmington, and the separation of the river, at the head of Eagles' island, into the northeast and northwest branches. This work was done by Assistant C. P. Bolles, aided by Sub-Assistant J. W. Gregorie, in the schooner Meredith, and occupied between October 15 and May 1. In its execution thirty-six stations were occupied, forty-one objects observed upon by two thousand and fifty-three (2,053) repetitions, and one hundred and sixty-two angles measured. The area covered by the triangulation amounts to sixty square miles. The instrument used was the six-inch theodolite, C. S. No. 35, (Gambey.) This party also executed the topography of this vicinity, noticed in its proper place, and since its withdrawal from the field has completed the computations of the season's work.

The triangulation of Core sound was continued northward during the season over Ocracoke inlet, (see Sketch D, No. 1,) to connection with that coming southward. This was commenced by Sub-Assistant A. S. Wadsworth in March, but the weather being particularly unfavorable to triangulation at that time, he proceeded, according to instructions, to execute the topography west of Cape Lookout, which was finished on the 18th of May. The triangulation was resumed, and with favorable weather the occupation of the four stations necessary to make the connection was completed in a few days.

The triangulation has an extent of eleven and a half miles—comprises an area of twenty-two and a half square miles; four stations were occupied, twelve angles were measured, and seven hundred and forty-one observations made with a six-inch theodolite, C. S. No. 29, (Gambey.) Mr. Bagwell aided Mr. Wadsworth in the work, the party having the use of the schooner Bancroft. The party was discharged on the 2d of June, when Mr. Wadsworth proceeded to make a reconnaissance of Bogue sound, west of the triangulation of Beaufort harbor. Good points were selected for stations for next season's observations, and signals erected as far as Bogue inlet, a distance of twenty-five miles westward. Since the close of this work, on the 22d of June, Mr. Wadsworth finished the computations of his season's work, and has been engaged in the topography of York harbor, Maine.

Topography.—The party of Assistant J. J. S. Hassler, engaged in the secondary triangulation of Back bay, North Carolina, executed in connection with it the topography of its eastern shore as far north as the Virginia line. (See Sketch D, No. 1.) The western shore, and the whole of the topography of the bay lying in North Carolina, will be executed during the next season. The extent of shore-line thus surveyed is thirty-seven miles, and the area covered by the work, which is embraced in two sheets, is forty-three square miles. Since breaking up his party, Mr. Hassler has been engaged in completing the drawing upon these sheets, besides the reduction of work of triangulation.

The topography of Smith's island, and of the shores of the Cape Fear river, (see Sketches D Nos. 2 and 3,) from Smithville to above Eagles' island, was executed by the party of Assistant C. P. Bolles, aided by Sub-Assistant J. W. Gregorie, who together had made the triangulation of the river. The sheets finished comprise an extent of shore-line equal to sixty miles, and an area of thirty-three square miles, and occupied in its execution the time from October 15 to May 1. This sheet has since been inked and turned into the office.

Sub-Assistant Wadsworth commenced the topography of Cape Lookout on March 12, and working westward joined the topographical sheet of Beaufort harbor (see Sketch D, No. 1) on the 18th of May, comprising within the limits of the work one hundred and ten (110) miles of shore-line, and eighteen (18) square miles of area. Mr. Bagwell aided Mr. Wadsworth in this work. This sheet has been inked and handed in to the office.

Hydrography.—A resurvey of the Cape Fear bars, to ascertain the changes which had taken place since the survey of the previous year, was made soon after the date of his last report, by Lieut. Comg. J. N. Maffitt, U. S. Navy, assistant in the Coast Survey. After this the survey was extended up the river to the junction of the Brunswick river with the Cape Fear and the northwest branch to the bridge above Wilmington. This was completed in January, as will be seen by the following extract from the report of Lieut. Comg. Maffitt, which also notes the operations connected with it, and the statistics of its execution:

"A series of current observations has been made in connection with the soundings, which will enable me to project a complete current chart. Tidal observations were made at Smithville, Orton light, and at Wilmington. On the 14th, 15th, and 16th of January, continuous hourly observations were noted without interruption at Smithville, Orton light, Campbell Island light, Upper West Jettee, and at Point Peter, opposite Wilmington. The watches were compared *twice daily*, as the morning and evening steamers passed each station. For this facility, as well as continuous courtesy, the Coast Survey is indebted to Gen. McRea, the president of the Wilmington and Raleigh railroad.

"No. of miles of soundings run	670
No. of soundings	37,858
No. of angles observed	5,320
No. of specimens	49
No. of current observations	44."

In regard to the changes of the bar, which are very remarkable, Lieut. Comg. Maffitt remarks as follows:

"By the 8th of December I had accomplished the work, as well as boring for specimens at different positions on the main bar and at the mouth of New inlet. On the main bar I succeeded in obtaining specimens to the depth of thirteen feet, and to the depth of ten feet at New inlet. These specimens were immediately labelled and forwarded to the Coast Survey office at Washington. The resurvey of the Cape Fear bars exhibits very marked changes, which are characteristic of all sand-bars. I have observed, and had it also attested by the pilots, that a strong northeasterly wind has the effect of deteriorating New inlet bar in depth, and the main and western bars are thereby improved; *vice versa*, a continuance of southerly or easterly winds shoals the main or western bars, and improves the New inlet. The migratory character of the various shoals in the channel way over these bars, renders it expedient for strangers always to employ a pilot, as the chart sailing directions cannot, under these circumstances, be relied upon for any specific length of time. A comparison of the original chart with the resurvey will exhibit very clearly the character which I have given of the channels at the entrance of the Cape Fear river. A general diminution is also obvious in the short space of twelve months, which, when considered with the great changes as made manifest in other surveys, is a matter of serious consideration for those interested in the commercial prosperity of Wilmington."

On the completion of this work, on the 12th of February, the party proceeded under instructions to execute the hydrography of Georgetown harbor and Winyah bay, South Carolina, which is noticed under the head of Section V.

SECTION V.—FROM CAPE FEAR TO THE ST. MARY'S RIVER, INCLUDING THE COAST OF THE STATES OF SOUTH CAROLINA AND GEORGIA. (SKETCH E.)

The progress made in this section has been quite satisfactory. In the following pages are given notice of the reconnaissance by Major Prince between the Cape Fear, North Carolina, and the Santee, South Carolina; of the observations by Dr. B. A. Gould, jr., Prof. L. R. Gibbes, and Assistant L. F. Pourtales, for connecting Charleston, Raleigh, and Washington for difference of longitude, by telegraph; of the main and secondary triangulation between the Edisto base and Charleston, by

Assistant C. O. Boutelle; of the triangulation from the base on Savannah river to Tybee entrance, by Capt. E. O. C. Ord; of the triangulation of Winyah bay, Georgetown harbor, commenced by Lieut. Joseph S. Totten, and completed by Assistant C. O. Boutelle and Major Henry Prince; of the topography of the same locality, by Mr. S. A. Wainwright; of its hydrography, by Lieut. Comg. J. N. Maffitt; and of the further examination of Charleston bar, and continuance of the tidal observations in Charleston harbor, by the same officer. During the year, charts of Cape Roman shoals and North Edisto entrance and river, South Carolina, have been published, and those of Charleston harbor, Winyah bay and harbor, of Tybee entrance, and of Savannah river, have been in progress.

Reconnaissance.—The reconnaissance of Section IV, which had been extended in 1852 as far as Cape Fear, was resumed during the last season and carried southward into Section V, as far as the North Santee river. This was prosecuted by Brevet Major Henry Prince, U. S. Army, assistant in the Coast Survey, who had commenced it at the limits of Section III, at Cape Henry. The coast reconnoitred during the past season was divided into three sections—the first extending from the Cape Fear river to the North and South Carolina boundary line; the second from thence to the line separating the districts known as Upper and Lower All Saints; and the third from that boundary to the North Santee river. Along nearly the whole of the first section extends a sound separated from the ocean by a narrow strip of sand-hills. Into this sound are several inlets, of which the principal are Lockwood's Folly, Shallotte, Tubbs and Little river; these were found to have from six to nine feet in them, with practicable entrances and good anchorages. The rivers in the section are mostly mere serpentine creeks, winding through marshes and swamps thickly covered with growth of black gum, tupelo, ash, oak, and pine. The points for the main triangulation, to be found on the sand strip above referred to, will be connected with those in the interior by cutting; which, however, is of a much less expensive character than that already executed in other parts of this section.

The two other sections resemble each other very much in character, both differing from the first somewhat in the nature and number of the swamp lands; while the growth is thicker, the value of the timber is much less than in the first section.

The neck between the Waccamaw river and the ocean sound is estimated in some places at sixty feet in height; and Brown's hill, on Sandy island, between the Peedee and Waccamaw, and about six miles from the coast, is estimated by Major Prince at ninety feet in height.

A straight line of four and a half miles, which may be used for a base, was examined on the Black river road near Georgetown. No good map of this region has ever been made, and the results of Major Prince's reconnaissance will be presented on the progress sketch.

In his report Major Prince acknowledges his indebtedness for the kindness which he constantly received, and the facilities for making his examinations which were everywhere afforded him.

Major Prince recommends that a small triangulation be carried first along this part of the coast, by which the stations for the main work may be determined, and the lines be laid off with certainty and without loss of time or expenditure in running or opening experimental lines. This is, in general, the system which experience has shown to be the best on this part of the coast.

About the middle of April Major Prince was called to finish the triangulation of Georgetown harbor, which will be noticed in its proper place. This was finished on the 8th of June; after which he assisted in the extension of the reconnaissance for the primary triangulation in the State of Maine, which has been before noticed. (Section I.)

Astronomical observations.—It will be recollected that in the winter of 1850, the late Prof. S. C. Walker made a preliminary determination of the difference of longitude by telegraph between Seaton station, Washington, and Charleston, to give the astronomical position of a point in this section of the survey. As that city was also intended to be used in the connection of Washington and New Orleans, the operations were resumed during the past winter by Dr. B. A. Gould, jr., at Charleston, and by Assistant L. F. Pourtales at the Seaton station. Repeated attempts were made to exchange signals directly between the two stations during the months of December and January, and until the middle of February, the best period of the year, but it was found utterly impracticable, owing to the condition of the telegraph wires and posts. It was therefore found necessary to establish an intermediate station, which was located at Raleigh, North Carolina, on the ground attached to the State-house; privilege for the occupation of which was granted by the Hon. David S. Reid, governor of the State.

While the station was being erected here, Dr. Gould established a series of experiments for further investigation of the velocity of transmission of telegraphic signals. The line used for these experiments was composed of four wires between New York and Washington, and thence extended to Petersburg, Virginia. Dr. Wolcott Gibbs, of New York, volunteered to assist in the experiments at that place, and Prof. J. F. Frazer those in Philadelphia, which were made on the nights of the 18th and 22d of March. The results of these observations are now being reduced, and will be specially reported upon.

The station at Raleigh having been completed, on the 3d of April Dr. Gould commenced the adjustment of the instruments, and at the first opportunity thereafter the exchange of signals with Mr. Pourtales at Seaton station, and with Prof. Lewis R. Gibbes, who took charge at the Charleston end of the line. These observations were continued on every clear evening, when the business of the line permitted, until the 14th of May, when the required number were obtained. These consisted in the exchange of thirty-four transits of stars with Washington on four nights, and of fifty-nine with Charleston on the same number of nights. Transits of sixty-five circumpolar stars with reversal, and of one hundred and nineteen zenith and equatorial stars, were taken, and other observations made for determining instrumental corrections.

The instruments used were, at Charleston, the transit instrument, C. S. No. 8, Kessel's clock, and both Saxton's and Morse's registers; at Raleigh, the transit instrument, C. S. No. 3, and the zenith telescope, C. S. No. 1. This instrument was also used in observations for latitude of the station, which was determined by eighty observations upon fifteen pairs of stars. Careful reference of the station was then made to the State-house to give its latitude and longitude.

Personal equations in observing, between Dr. Gould and Mr. Pourtales, were determined at the Seaton station, and between Dr. Gould and Prof. Gibbes through a comparison made by Assistant C. O. Boutelle at Charleston with Prof. Gibbes, and with Dr. Gould at Cambridge.

During the occupation of the Charleston station, and previous to the establishment of the intermediate one at Raleigh, one hundred and one observations were made for time and instrumental adjustment.

Since the close of these operations, Dr. Gould has been engaged in the reduction and discussion of their results, in which he has been assisted by Mr. E. L. Lane, who also aided him in the campaign.

Dr. Gould has also since been engaged in a thorough examination and discussion of the results of the Coast Survey observations for the determination of personal equations.

The use of the lines employed in the above work was granted gratuitously by the respective presidents, Elam Alexander and William M. Swain, Esqs., to whom our best thanks are hereby returned for their liberality.

Dr. Gould also acknowledges the efficient aid rendered by the various operators in the Charleston, Raleigh, Columbia, and Petersburg telegraph offices.

Primary triangulation, and secondary connected with it.—Assistant C. O. Boutelle resumed his work of the two last seasons in the extension of the primary triangulation between Edisto and Charleston on the 20th of last December, aided by Sub-Assistant B. Huger, jr. The first work was the tracing and opening of the line Elliott's cut—Charleston light, (see Sketch E, No. 1,) which was completed by the 8th of January. The signal at the station at Elliott's cut having been prostrated by a severe storm of the autumn of 1852, Mr. Boutelle next visited that point to restore it, which was done in a substantial manner, and with considerable improvement in the mode of erecting the signal. This accomplished, the party moved to Mathews' station, and commenced the observations there on the 28th of March, completing them on the 11th of April. Much cutting was required in further opening the line Mathews'—New cut, which had been commenced in 1852. The party then moved to East base, to occupy that point and obtain additional observations to the number it had been practicable to take in its previous occupation. The satisfactory number was had, and the station finally completed on the 3d of May. While finishing the primary work of the season, and opening the line Elliott's cut—New cut, Mr. Boutelle was called to execute the secondary triangulation of Georgetown harbor, the necessity for, and results of which are given under another head. In the occupation of the two primary stations, Mathews and East base, forty-two (42) angles were measured by two thousand one hundred and thirty-six (2,136) observations upon twenty-nine (29) objects.

The instruments used by Mr. Boutelle were a ten-inch theodolite, C. S. No. 43, (Gambey,) and an eight-inch, (Gambey,) C. S. No. 24. Mr. Boutelle repeats his acknowledgments to the proprietors of the lands over which his work extends, for offering him every facility of working in the opening of lines, &c., in furnishing means of transportation from point to point, and in many other ways repeatedly extending to him their kindness and hospitality.

As heretofore, the secondary work has been advanced in connection with the primary, and was resumed at the limits of last year, and carried along the Stono river and over James' island towards the secondary triangulation of the Wadmelaw as far as the line Prentice—Wilkes. (See Sketch E, No. 1.) It was very much desired to bring these triangulations to a connection at Church flats during the past season, but any further time devoted to them would have interfered with the primary work which had been laid out. The same instruments were used in this as in the foregoing work—the ten-inch theodolite, C. S. No. 43, (Gambey,) and a six-inch, C. S. No. 24. Eleven stations were occupied, and eighty-one angles measured upon eighty-seven objects by five hundred and thirty-five observations.

The triangulation of Winyah bay and Georgetown harbor (see Sketch E, No. 1) had been commenced by Lieut. J. S. Totten, and prosecuted with zeal until the entire prostration of his health compelled him to abandon it, which he did, yet reluctantly, about the first of May. It was very desirable to complete this work, and before the sickly season, and it was therefore necessary to call upon Mr. Boutelle and Major Prince to push it to completion. It was first proposed to divide the operations, assigning to the latter officer the triangulation of the upper part of the bay, and to Mr. Boutelle the lower part to the entrance; but upon consultation between those officers, they determined to work together, taking up the upper part of the bay first, pushing it on more rapidly because in conjunction, and thus get into the healthy neighborhood of the sea before the sickly season. This was done, and the triangulation completed to the entrance on the 7th of June. The base line selected by Lieut. Totten in the lower part of the bay was adopted and measured, and upon it the triangulation extended on the scheme proposed by that lamented officer, who had commenced the work. Sub-Assistant Huger, and Mr. C. B. Baker, aided in this work. The statistics show that nineteen stations were occupied, and two hundred and ninety-eight angles measured upon two hundred and forty objects by two thousand six hundred and ninety-six observations.

Since the close of the work in this section, Mr. Boutelle has, with the assistance of Messrs. Huger and Baker, brought up the computation required by it, and, in connection with Major Prince, has extended the reconnaissance for the primary triangulation in Section I nearly to the boundary.

The secondary triangulation of Georgetown entrance and Winyah bay (see Sketch E, No. 1) was commenced about the first of last January, by Lieut. Joseph S. Totten, U. S. Army, assistant in the Coast Survey, aided by Mr. C. B. Baker. Some delay was experienced in procuring a vessel for the party, but they finally succeeded in getting the schooner Ozella, of Baltimore. The reconnaissance for the triangulation was immediately commenced, points selected, and signals erected. The site for a base line was chosen, and Lieut. Totten about to commence its measurement and the observations, when, about the middle of April, his health, which had been very delicate during the whole season, had so materially failed, that at the earnest solicitation of his friends he reported his inability to continue it, and from that time became dangerously ill. His condition seemed to justify the hope that he might yet be able to reach his home while living. This hope was vain—he died on the passage to Baltimore on the 14th of May. A meeting of his fellow-officers of the Survey was held in Washington to pay a tribute of respect to his memory, the proceedings of which are given in Appendix No. 44.

Mr. Boutelle and Major Prince took charge of the party and completed the work which has been noticed above.

The triangulation of the Savannah river, which was left last year at the line Proctor—Fort Jackson, was resumed in March last by Capt. E. O. C. Ord, U. S. Army, assistant in the Coast Survey, and carried from the base on Union Causeway as far as the line Magnetic Point—Mungen. (See Sketch E, No. 4.) The work was continued until the 11th of June, when the advance of the season rendered it impracticable to prosecute it further. The area covered by this triangulation amounted to thirty square miles; eleven hundred and seventy-six (1,176) observations of secondary horizontal angles were measured, and fifty-six (56) tertiary. The instrument used in these observations was an eight-inch theodolite, C. S. No. 36, (Gambey.)

Upon the close of his field-work in this section, Capt. Ord returned to the office, and there finished the computations required of his season's observations, and turned them into the office previous to his departure for the Western coast to take charge of the triangulation of the Santa Barbara islands.

Topography.—To complete the survey of Georgetown harbor during the season, a topographical party was detailed to follow immediately the triangulation as it advanced, and from these points to furnish at once shore-line for the hydrography. The survey was commenced on the 1st of April and continued until the 22d, when the party broke up, having finished the required shore-line, amounting to sixty-four and a half miles, extending on both sides of the harbor from the city to the entrance of Winyah bay. This was executed by Sub-Assistant S. A. Wainwright, who obtained the means of transportation from the tender Bouncer, of the hydrographic party, through the kindness of Lieut. Comg. Maffitt, to whom the vessel belongs. Mr. Wainwright since his return to the office has been engaged in inking the sheets of this work, and in preparing for work during the coming season.

Hydrography.—The hydrographic survey of Georgetown entrance and Winyah bay, South Carolina, (see Sketch E, No. 1,) in connection with the other operations in that section, noticed above, was made by the party of Lieut. Comg. Maffitt, U. S. Navy, assistant in the Coast Survey. This was commenced on the 14th of February, and completed on the 6th of May, when the Crawford, the vessel used by the party, was despatched in the Gulf Stream explorations, which had been previously noticed. I quote extracts from the report of Lieut. Comg. Maffitt upon the execution of the Georgetown work, giving statistics, &c.

"On the 12th of February I sailed for Georgetown, South Carolina, and arrived on the 14th. As soon as the signals could be erected, the survey of the bar and Winyah bay was commenced and vigorously prosecuted to its completion on the 6th of May. The bar of Georgetown, like the southern bars in general, is subject to constant changes; the absence of previous reliable surveys prevents a comparison by which the changing character of the bar can be judged. Two new channel-ways have recently come into use, both of which will be fully delineated by the Coast Survey; and, with the assistance of buoys and landmarks, can no doubt be navigated with greater facility than the old channel. The evidence of all the pilots goes to prove that 'Mother Norton' shoal is rapidly increasing in a southeasterly direction, which naturally presses the last quarter of the ebb-tide more to the eastward, with the tendency, it is presumed, to improve the northeast or new channel. I am informed by the residents on North island that Lighthouse Point is rapidly wearing away. The pilots also assert that the flat about the northwest buoy is shoaling; and, also, that the Great dry breaker has increased vastly in area for the last ten years. Positive evidence of this, as well as of the change in the main channel, is clearly demonstrated by my finding and determining the site of the two old range-beacons which twenty years ago marked out the channel. That range now strikes across the middle of the Great dry breaker, where the level of the sand at low tide is, at present, twenty inches above the surface of the water. The increase of the Great dry breaker has forced the main channel to the westward, to the destruction of an inner channel, called the Goose Neck channel. At the steamboat wharf on South island I established a permanent tide-gauge, and also one of the same character at Georgetown. The observations were made by reliable and careful men, day and night, and the watches regulated by a meridian mark. An iron gauge was driven into the water at the lower end of the bar, but the general roughness of the sea prevented the nice comparison I had anticipated. Great attention was given to this gauge. A full system of current observations was carried out in the bay and at important points on the bar.

"Number of miles of soundings run - - - - - -	598
"Number of angles observed - - - - - - -	9,850
"Number of specimens - - - - - - -	90
"Number of soundings - - - - - - -	68,520
"Number of current observations - - - - - -	16."

The office-work of this party has advanced well in plotting and reducing the sheets of this and the previous section.

SECTIONS VI AND VII.—FROM THE ST. MARY'S RIVER TO ST. JOSEPH'S BAY, COAST OF FLORIDA, AND INCLUDING THE FLORIDA REEF AND KEYS, AND FROM ST. JOSEPH'S BAY TO MOBILE POINT. (SKETCHES F AND G.)

The work in Section VI has made satisfactory progress during the past year, and as much has been done in Section VII as our means permitted, there being no particular appropriation for it. Unless the work is systematically commenced in this section, and prosecuted on a similar scale to that of other parts of the coast, it will be found beginning when the others are completed. I have represented this for some years, and have taken advantage of the possible diminution of expenditure in other parts of the coast to introduce an estimate for this section, without swelling the total amount of the Coast Survey appropriation. When these means are received, the work in Section VII will be pressed forward. The importance of a complete survey of St. Andrew's bay has been especially pressed upon me, but the means at my disposal permitted only the completion of the survey of the entrances to Apalachicola, and some general and special reconnaissance, which will be stated in detail in its place.

The triangulation of the Florida reef and keys has been extended from above Point Elizabeth to Point Charles; the topography from Soldier key to Old Rhodes key; and a minute topographical survey and marking of the keys east of Key West has been commenced. The hydrography of the reef has advanced to near Turtle reef; and soundings for temperature of the Gulf Stream have been made. In occupying a position off Cape Canaveral, a temperature as low as 38° Fahrenheit was found at the depth of one thousand and fifty fathoms; showing that the cold water from the north underlies the warm water even in this latitude of $28\frac{1}{2}$°.

Lieut. Comg. Craven, in making the sections of the Gulf Stream across the axis of the stream from Cape Canaveral, (June 9,) after leaving soundings on the shore and crossing a very deep interval, where no bottom was had at one thousand and fifty fathoms, found bottom on the eastern side at four hundred and sixty fathoms, and struck the bank or ridge thus discovered in the sections made across the stream from Saint Augustine, Ossabaw entrance, and Charleston. The Gulf Stream explorations have been more particularly noticed in connection with each other in another part of this report; and a more full account is given of the discovery just mentioned in that connection, and in the Appendix No. 17.

A complete survey was made of the entrance to the St. John's river, to furnish data for judging of the practicability of improving the bar; and the operations are stated, under their several heads, in the part of the report on this section which gives the details.

Of Section VI, a preliminary chart of St. John's river entrance and Fort George inlet, and sketch of the western coast of Florida, have been published within the year, and additions made to chart of Key West, scale $\frac{1}{100,000}$; a chart of Key West, scale $\frac{1}{50,000}$, and of Florida keys and reef, No. 1, have been in progress. Of Section VII, sketches of Channel No. 4, Cedar keys and St. Mark's harbors; of east and west entrances to St. George's sound; and of the reconnaissance of St. Joseph's and St. Andrew's bays, have been issued within the year; others resulting from the past season's work in the section have been in progress.

I have continued the investigations of the tidal phenomena at Key West, with some interesting results. The discussion, as far as it has gone, will be found in Appendix No. 27, in a paper read before the American Association for the Advancement of Science, at their meeting in Cleveland. The tides are intermediate in their type, between those of the Atlantic and the Gulf of Mexico. While they ebb and flow twice in the twenty-four hours, like the Atlantic tides, the difference in height of the two consecutive high or low waters is very considerable, amounting at a mean to nearly half a foot in a tide of one foot five inches, and reaching nearly ten inches when at the greatest. The method of wave interference, which I applied to the tides at Cat island and Fort Morgan, has also been used in this, and compared with the ordinary modes of reduction of which these tides admit. The difference in height of two consecutive high tides exceeds, at a mean, that of two low tides, in the proportion of four to three nearly, or the diurnal inequality in the height of low water is but three-fourths that of high water at this place. The diurnal inequality in the interval is not large.

The mean interval between the time of the moon's transit over the meridian of Key West, and the time of high water, (the corrected establishment,) is nine hours and twenty-two minutes; the greatest interval exceeds this, and the least falls short of it, by thirty-four minutes. Theory shows that these tides correspond to the transit next but one before the time of high water, but practically this is not a matter of importance.

I have been able to trace from these observations the two tides of long period pointed out by Mr. Airy as resulting from theory, the one having half a lunar month for its period—the other, half a solar year. This result is clear, although in part masked by the effect of the wind, the regularity of which, in this region of the trade winds, is striking.

Reconnaissance.—The reconnaissance in Section VII has been extended by Assistant F. H. Gerdes by a general examination of St. Andrew's sound and of the adjacent coast, including St. Joseph's bay, of which the sketch is incorporated in that of the Section, Sketch G, No. 1, and by a special reconnaissance of St. George's sound, in reference to the selection of points of triangulation, from South Cape to Cape St. Blas.

Triangulation.—A preliminary survey of the entrances into St. George's sound, (main or west and middle entrances,) Florida, has been executed by Assistant F. H. Gerdes. (See Sketch G, No. 2.) In this work two astronomical stations were occupied, and observations made upon seventeen sets of stars, with a transit instrument for time, and upon six pairs of stars with a zenith telescope for latitude; magnetic and azimuth observations were also made. In the triangulation, two preliminary base lines were measured and twelve stations occupied. About twelve miles of shore-line were surveyed with a plane-table, and general soundings made of the bars, entrances, and outer harbor. The depth of water on the main or western bar was found to be thirteen and a half feet, and on the eastern fifteen.

Mr. Gerdes has furnished the following maps and sketches, resulting from his season's work in Section VII:

Map of the main or west entrance of St. George's sound.

Map of the middle entrance of St. George's sound.

Map of the special reconnaissance of St. George's sound from South Cape to Cape St. Blas.

Sketch of reconnaissance of St. Andrew's and of the coast including St. Joseph's bay.

The statistics of his work are given in the following table:

	Observations with zenith telescope.	For time with transit instrument.	For azimuth.	Magnetic variation.
St. George's island	6 pairs of stars	12 stars	Every 5 m. for 2 h.	1 pointing.
Dog island	3 ditto	6 ditto		1 ditto.

Mr. Gerdes was assisted during the season by Mr. J. G. Oltmans, and used as means of transportation and accommodation the schooner Gerdes.

The topographical operations of this party are referred to under their proper head.

The triangulation of the reef and keys has been continued southward and westward along Key Largo, during the past season, by the party of Lieut. James Totten, U. S. Army, assistant in the Coast Survey. The work was commenced at station El Camino, above Point Elizabeth, on the 18th of December, and was carried as far as Point Charles, (see Sketch F, No. 1,) within Rodriguez key, before the 28th of April, when the party was transferred to the vicinity of Key West to furnish points to the eastward for the topographical party of Sub-Assistant R. M. Bache, engaged in surveying and marking the keys for the General Land Office.

Lieut. Totten was assisted during the season by Mr. C. T. Jardella, and employed the schooner Petrel.

He gives the statistics of his season's work as follows:

	No. of stations occupied.	No. of sets of observations.	No of single observations.	Area covered by triangulation, square miles.	Length in metres of longest side of triangle.	Length in metres of shortest side of triangle.
Vicinity of Key Largo	19	1,146	6,965	110.94	13987.4	642.5
Vicinity of Key West	14	586	3,531	108.97	19525.9	1284.4
Total	33	1,732	10,496	219.91		

The instruments used were the ten-inch theodolite, C. S. No. 27, (Pistor & Martens,) and six-inch (Gambey) C. S. No. 55.

Lieut. Totten, in reporting his work to the eastward of Key West, makes some interesting remarks upon the climate, quality of soil, and general character, which are appended to this report. (See Appendix No. 18.)

The triangulation of the entrance to St. John's river, of Fort George inlet, and of the island between, was made in the early part of the season, by Sub-Assistant G. A. Fairfield. A base line, of one thousand and eight metres in length, was measured upon a sand-spit of Fort George island, from which the triangulation was carried, embracing the entrance to the river, and including the first bend above Mayport mills; thence across to the Fort George inlet and to its entrance. (See Sketch F, No. 2.) The work was done between the latter part of January and first part of March, and included the occupation of eleven stations, and the measurement of one hundred and five angles upon eighteen objects, by eight hundred and sixty observations. The instrument used was an eight-inch theodolite U. S. C. S., No. 36, (Gambey.)

The observations were computed as the work advanced, and the results furnished to the topographical and hydrographic parties, who immediately followed in execution of their portion of the survey.

Hourly observations of tides were made day and night, at both entrances, to ascertain the differences in the times of high and low water, and in the progress of the tide in the two. The gauges were placed in positions as nearly similar as could be, and the observations were made with great care.

Topography.—The topography executed by Assistant Gerdes, in Section VII, during the past season, has been of the main or west entrance into St. George's, including the town of Apalachicola, and of the middle entrance into St. George's sound, including Dog island. The amount of shore-line on the former sheet is equal to fifteen miles, and on the latter, to nine. These sheets have been inked by Mr. Gerdes and handed into the office since his return from the southern sections, and before taking up the topography of the Hudson river, upon which he was engaged during the summer. Mr. Gerdes remarks upon the importance of the harbor of Apalachicola, in his report, as follows: "The harbor of Apalachicola, to which both the entrances surveyed lead, is most important, and only second to Mobile, on the Gulf. There were twelve ships anchored at the East Pass, and six near the town, although the business season is nearly over.

"The town exports 150,000 bales of cotton; the commerce is therefore considerable; and as both inlets have been very little known, and erroneously located, their survey seems to attract great attention and to give satisfaction here."

The topography of the Florida keys has been continued during the past season by two parties. That of Sub-Assistant I. H. Adams commenced at Soldier key, the first south of Cape Florida, and completed two sheets, embracing that key, Ragged key, Sands' key, Elliott's key, Old Rhodes key, Cæsar's creek, and ten small keys inside the creek. (See Sketch F, No. 1.) The party took the field about the end of November, and continued until April 15, when the appropriation originally assigned to it was nearly exhausted. The extent of shore-line surveyed amounts to seventy-three and one-fourth miles, and the area covered by the work to ninety square miles.

Mr. Adams describes these keys as follows:

"*Soldier key.*—This island, which is five and a half miles below the light-house at Cape Florida, is very small, being only two hundred metres, (218.7 yards,) and about one hundred in breadth, and is formed of coral rock, with a thick growth of mangrove around the edge, the inside being partly cleared. The next group of keys south is called 'The Ragged Keys.' They are five in number, and from four hundred to five hundred metres in length. The outer edge is partly of coral and partly of mangrove, growing out of deep mud.

"*Sands' key* is next below, and is about one and a half miles long. For one mile from the northern end it is three hundred metres in width, and widens at its lower extremity to three-fourths of a mile. The outside is generally of coral rock, with small intervals of mangrove, extending thickly to the water's edge. In all these patches of mangrove the mud is very deep and sticky, which makes it difficult to get near the shore. The greater portion of the inner shore of this key is of a very deep soft mud, although in a few places the coral extends for short distances. The southern shore of this key makes one side of Sands' cut, which is not more than fifty metres in width. It is important as a guide to vessels coming into this harbor from outside the reef.

"*Elliott's key* (next below) is nearly seven miles in length, and varies from one-fourth to one-half of a mile in width. The outer shore is of coral rock, with mangrove and sea grape. This beach is quite good for several miles, and there is not much mud of any great depth. The inner shore was much more difficult to trace accurately from the small number of triangulation points, and from the greater amount of mud, which I found increased as we proceeded south. The creek below Elliott's key (Cæsar's creek) is six hundred metres at the entrance in width. There is a fine harbor on the outside for vessels drawing from six to eight feet, and it is considered the best on this part of the coast. On the inside there are ten keys opposite the opening of the creek, varying from four hundred to five hundred metres in length. Several of them are three or four hundred metres in breadth. To these keys I was obliged to give names to distinguish them from those below.

"*Adams' key* is the most northerly, partly covered with mangrove, north side of coral rock.

"*Meigs' key*, small and covered with mangrove.

"*Reid's key*, small and covered with mangrove.

"*Rubicon keys*, surrounded by very deep mud.

"*Porgee key*, very dense growth of mangrove.

"*Totten's key*, very dense growth of mangrove, and very deep mud all round.

"The next key (south) is Old Rhodes key. It extends two and a half miles below Cæsar's creek, and is from one-half to three-fourths of a mile in width, and covered with thick mangrove growth. Inside of this key is a lagoon, three-fourths of a mile wide, and about two miles in length. It is filled with a quantity of very small keys rising from deep mud. There are twenty of these keys. Totten's key, which is on the western side of the lagoon, is one and a half mile in length, and three-fourths of a mile in width. For some distance from the shore it is almost impossible to get a boat through the mud."

There being no vessel belonging to the survey available for this party, Mr. Adams chartered the schooner Colonel De Russy to furnish the necessary transportation.

Mr. C. M. Bache assisted Mr. Adams during the season in this work. Since leaving the field, Mr. Adams has been engaged in inking his sheets and bringing up his work of the winter.

The surveying and marking of the keys for the General Land Office was commenced as early as the means could be obtained, in April, by Sub-Assistant R. M. Bache. The work was begun at Boca Chica and the adjacent keys lying to the east of Key West, (see Sketch F, No. 3,) embracing on the sheet an extent of shore-line of forty-five miles, and an area of nine square miles.

With reference to the island, Mr. Bache thus speaks:

"Only a small portion of the island of Boca Chica appears to be fit for cultivation; but the survey has shown that there are only two inconsiderable outlets to a very large lagoon in the island, and, consequently, that it can be readily converted into a very valuable salt pond. There is another lagoon on the island of about the third of the size of the one just mentioned, and with the same facilities for converting it into a salt pond."

During the early part of the winter, the plane-table party of Sub-Assistant R. M. Bache was employed in the execution of the topography of the shores of the entrances of the St. Johns and Fort George inlet and the vicinity, within the limits of the triangulation. (See Sketch F, No. 2.) The amount of shore-line surveyed was forty-six miles, and the area covered by the work was about thirteen square miles.

The party had the use of the Coast Survey schooner Hassler, for purposes of transportation.

A complete map of the survey of these entrances and immediate vicinity, together with the information respecting the tides, has been furnished to Lieut. H. G. Wright, U. S. Corps of Engineers, who had been intrusted by the War Department with the duty of devising a plan for the improvement of the entrance into St. John's river, under the act of Congress of August 30, 1852, making appropriations for river and harbor improvements.

Hydrography.—To make complete the survey of the entrance to the St. John's river and Fort George inlet, Florida, the hydrographic party under Lieut. Comg. T. A. M. Craven, U. S. Navy, assistant in the Coast Survey, immediately followed the other parties, and executed the hydrography of the vicinity. (See Sketch F, No. 2.) The vessel employed was the steamer Corwin. The statistics of the work, which occupied from the first of March to the middle of April, are thus given:

Number of angles measured - - - - - -	616
Number of soundings made - - - - - -	9,271
Miles of soundings run - - - - - -	188
Area sounded out, in square miles - - - - - -	17

Observations of tides were made at two stations, and of currents at nine.

Upon the completion of this survey, the party of Lieut. Comg. Craven proceeded to the continuation of the hydrography along the general reef. The sheet of this year's work joins that of last year at Triumph reef, (see Sketch F, No. 1,) and extends southward to near Turtle reef. It includes the soundings off Elliott's key, Old Rhodes and Arseniker keys, Long reef, Ajax reef, and Pacific reef. This work was done during the month of May and part of June, and covered an area sounded out, of one hundred and thirteen and a half (113½) square miles; seven hundred and fourteen (714) miles of soundings were run; forty-three thousand five hundred and four (43,504) casts of the lead taken; and one thousand eight hundred and eight (1,808) angles measured.

Light-house examinations, &c.—A special examination of the Coast Survey signals along the Florida reef, of their site, and the practicability and cost of making them permanent for the use of navigators, as provided for in the act of Congress of August, 1852, was made by Lieut. Totten, and his report thereon was communicated to the department under date of November 3, and is given in Appendix No. 52.

SECTION VIII.—FROM MOBILE POINT TO VERMILION BAY, INCLUDING THE COAST OF ALABAMA, MISSISSIPPI, AND PART OF LOUISIANA. (SKETCH H.)

An extended reconnaissance has been made in this section, combining the operations necessary to furnish preliminary charts, with those for the progress of the work itself. Special reconnaissances of some of the more important bays west of the Mississippi have also been made, and preliminary charts and sketches founded on these and the work previously mentioned accompany this report. The uncertain character of the information in regard to this part of the coast, and its increasing commerce, rendered such determinations desirable, and next in order of importance to the regular operations intended to connect Mobile and New Orleans. These have steadily advanced: the secondary triangulation from Lake Borgne westward, and the plane-table survey following it closely. The signals for completing the connection with New Orleans are erected, and their occupation will complete this division of the work, until it may be expedient to pass further up Pontchartrain. It seems now probable that the main triangulation can be carried more readily from the head of Lake Borgne to the coast, at the mouth of the Mississippi or its vicinity, than round by the Chandeleur islands. The hurricane of August, 1852, was reported to have made changes in parts of the coast of which the hydrography had just been executed, and of which charts had been prepared for publication. This proves, however, to be the case to but a limited extent, as will be seen from the detailed account of the progress of this section. Nassau roads and Horn Island Pass showed no considerable changes. The examination of Ship shoals, Louisiana, off Isle Dernière, has been one of the most useful results of this season's work, and has been thoroughly executed by a land survey, with astronomical determinations, which will form a part of the general survey of the coast, and by minute hydrography. This will provide the information necessary to enable the Light-house Board to determine the important question, submitted by law to them, in regard to the best mode of warning navigators of their approach to these dangerous shoals in the track of commerce between New Orleans and the ports of Texas, and to which public attention has been of late years especially drawn by the loss upon them of the steamer Galveston. The hydrography of Mississippi sound has been carried westward, and the entrance of Pascagoula river closely surveyed in reference to the question of the location of a light-house there. Five sketches and preliminary charts of localities in this section, besides the general sketch of the coast, will accompany the report of this year.

The tidal observations referred to in my report of 1851, as forming part of the series for the Gulf of Mexico, have been executed. There are, now, results of hourly observations for a year of the tides at Fort Morgan and Cat island, and for four and two months respectively at the mouth of the Mississippi and Isle Dernière. It is almost unnecessary to say that the tides of the last-named stations belong to the single-day class; and that when their relation to those of the more elaborate series east and west of them is established, data will be furnished for computation without the necessity for multiplying the observations at the stations themselves. The results have been worked up in the office, as far as practicable, as the observations were reported.

The second edition of chart of Horn Island Pass; preliminary sketch of Mobile bay, small scale, and of Ship shoal, Louisiana; Grand Pass; Barataria bay; entrance to Timballier bay; and diagrams of tides at Cat island, have been published during the year; and charts of Mobile bay, Nos. 1 and 2; Mississippi sound, Nos. 1 and 2; and sketches of Nassau roads, Chandeleur islands, have been in progress.

Reconnaissance.—The general reconnaissance of the coast of this section, of the bays, sounds, lakes, adjacent islands, &c., for the purpose of determining the scheme of triangulation, was resumed during the past season, by Assistant F. H. Gerdes, and extended westward from the Delta of the Mississippi to Point au Fer, at the entrance to Atchafalaya bay, including the bays of Barataria, Camisade, Lafourche, Vermilion, Bonne Terre, and Caillou. (See Sketch H, No. 1.)

With this reconnaissance were connected determinations for latitude and azimuth, and of longitude by chronometers, to furnish a preliminary sketch of this important part of the coast, which is imperfectly laid down in existing charts. Observations for magnetic variation were also made in the same connection.

Special reconnaissances, including a preliminary triangulation and topographical survey, and the essential soundings, were made of the entrances to Barataria and Timballier bays, (see Sketches H Nos. 4 and 5;) the reports in relation to which, containing many valuable details, are given in the Appendix, Nos. 19 and 20. On each of these sheets one point has been occupied as an astronomical station.

It was originally determined to turn the main triangulation of the coast of Louisiana southward between the Chandeleur islands and the main; but subsequent examination having led to the opinion that it could more advantageously be carried across the main from the head of Lake Borgne to the Delta of the Mississippi, Mr. Gerdes was instructed to make a more minute examination, and to report the plan of triangulation resulting from it. This has in part been executed during the present season.

A survey of Isle Dernière was made for light-house purposes, including the measurement of a short base triangulation, the determinations of latitude and azimuth, the difference of longitude by chronometers, and the topography of the island and its vicinity. The points thus established and the shore-line were furnished at once to Lieut. Comg. Sands, for the execution of the hydrography.

Mr. Gerdes has furnished, as resulting from the work of the season in this section—

1. A preliminary sketch of the coast from the Delta of the Mississippi westward to Point au Fer, with reconnaissance of the principal bays. (See Sketch H, No. 1.)
2. A preliminary chart of the entrance into Barataria bay. (Sketch H, No. 4.)
3. A preliminary sketch of the entrance into Grand Pass, Timballier bay. (Sketch H, No. 5.)
4. A topographical survey of Isle Dernière and its environs, for the chart of Ship shoals, Louisiana. (Sketch H, No. 6.)
5. A sketch of the reconnaissance between Lake Borgne and the mouths of the Mississippi, for the extension of the primary triangulation of the section.

Mr. Gerdes gives the results of his work in these general and special reconnaissances, as in the following table of statistics:

	Observations with zenith telescope.	For time.	For azimuth.	Magnetic variation.	Shore-line.
		With transit instrument.			
Barataria bay, (Fort Livingston.)	5 pair of stars.	12 stars.	2 pointings.	Every 5 m. for 2 h.	12 miles.
Isle Dernière.........	21 pair of stars.	62 stars.	6 pointings.	Every 10 m. for 4 h.	33¼ miles.
		With sextant.			
Timballier bay.........	....	12 stars.	....	....	5 miles.

Secondary triangulation.—The progress of this part of the work, notwithstanding the exertions of Assistant S. A. Gilbert, who has had charge of it for the past four years, has, from the difficult character of the country through which it passes, and the obstacles to ready vision from point to point, been comparatively slow. The diagram (Sketch H, No. 1) shows its progress along the shores of Lake Borgne and over the extremity of that lake, and the scheme for its extension to New Orleans, and over Lake Pontchartrain (see Sketch H, No. 1) to near Madisonville. All the signals for this extension have been erected, with the exception of one in the centre of the lake, which it has been found desirable and practicable to construct, and for which Mr. Gilbert has devised a very ingenious plan. The opening of the lines necessary to connect the city of New Orleans with the triangulation, was a tedious part of the season's work.

By an accident occurring in the opening of one of the lines of the triangulation in the early part of the season, Mr. Gilbert was disabled for more than a month and a half, thus throwing his work into a less favorable part of the year.

Mr. Gilbert reports great difficulty in the preservation of the station points on the south and east shores of Lake Borgne, as many of them necessarily placed near the water are liable to its encroachments. Proctor's Point, on Lake Borgne, has been washed away to the extent of fifty or sixty feet in two years. He has taken pains to secure the points as far as practicable.

The party has had the use of the schooner G. M. Bache for transportation during the season.

The area covered by this triangulation amounts to one hundred and eighty-nine (189) square miles; the number of stations occupied fifteen, (15) and the number of angles measured at them, forty-seven, (47.) The instrument used in these observations was a ten-inch Gambey theodolite, (U. S. C. S., No. 23.) The reconnaissance covers an area of three hundred and ninety-six (396) square miles.

Mr. Gilbert, upon closing his work in this section, and finishing the computations required, has been employed in the execution of plane-table work in Section I.

Topography.—Assistant Wm. E. Greenwell, who has executed the topography in this section from its commencement, in 1847, resumed that portion of the work in November last, and continued until May, commencing at Isle au Pied, and extending along the southern shore of Mississippi sound and Lake Borgne nearly to the western limit of the lake. (See Sketch H, No. 1.) Two sheets were completed, comprising an area of ninety-eight (98) square miles, and an extent of shore-line of four hundred and twenty-five (425) miles. Re-surveys were also made of part of Ship and Dauphine islands, to ascertain the changes produced by the hurricane of August 23, 1852.

Mr. Greenwell was assisted in this work by Mr. William M. Johnson, and used the schooner Phœnix as means of transportation and accommodation of the party.

In his report upon the character of the topography of this region, Mr. Greenwell speaks of the great changes in the position of the shore-line, thus:

"From the experience of the past year, I find that the lake shores of this region, and so likewise the sound shore running from Isle au Pied to Malheureur Point, are fast being cut away, and at the rate of seventy-five to one hundred feet per annum.

"What is worthy of remark also is, that whilst these inland shores, subject to the fierce northers of the winter, are being washed away, the eastern shores of this marshy region, though washed by the heavy waves of the Gulf, are gradually encroaching upon the sea in nearly the same ratio.

"This last may be attributed mainly to the under-tow, which is constantly throwing up sand-banks and reefs outside, which serve to check the force of the waves, and behind which deposites are being made by the eddy at each succeeding gale, until this gradually rises above the surface and becomes linked with the main shore itself. This mass of sand, shells, &c., is so firmly cemented, as it were, with the marsh mud, as to resist without wash the heavy swell from the Gulf."

Mr. Greenwell repeats his remarks upon the great resources of this country in the article of lumber, and the facilities and inducements for an active and profitable trade in it, which were quoted in my report of last year. He notices the very considerable improvement of the country, and the increase of villages and towns along the coast from Mobile bay westward, and speaks of the recognised value of the information obtained from the Coast Survey results in this section as guides in projecting and maturing these improvements.

In the course of the season Mr. Greenwell made an examination of Dauphine island, for the purpose of ascertaining what changes had been produced there by the great storm of August, 1852; and also to examine the condition of the termini of the base line measured upon this island, and for the additional security of which, steps had been taken by him in the course of the previous year. The facts which he presented are such as to require a re-examination of the site of the western terminus, which will be made by Mr. Gerdes, who assisted in the measurement of the base. There is at present an opening into Mississippi sound through the island, but not deep enough to be of value to navigation, and one which it is supposed will close again. The west end of the island is still increasing in extent.

About two miles of the east spit of Petit Bois island has been cut away, opening a new channel, through which from twelve to eighteen feet of water can be carried into the Gulf. This channel will prove one of great importance to the vessels plying between New Orleans and Mobile, as they can, through it, go from the smooth water of Mississippi sound into Mobile bay with only ten miles of outside sailing.

Hydrography.—The hydrographic operations in this section have been conducted by Lieut. Comg. B. F. Sands, U. S. Navy, assistant in the Coast survey, in the Coast Survey steamer Walker. Considerable attention having been attracted to Ship shoal, Louisiana, (see Sketch H, No. 6,) lying in the track of vessels bound from the northern shores of the Gulf and New Orleans to the Texan ports, and upon which the steamer Galveston was lost, and a special appropriation having been made for a survey in connection with the determination of the site of a light-house, Lieut. Comg. Sands was instructed to make a thorough and complete survey of the shoal and adjacent waters as the first work of the season. From his report on the subject, I quote as follows:

"The position of Ship shoal in the track of vessels plying between Texas and New Orleans, makes it a very dangerous one. It shoals suddenly to five feet on the inshore or northern side; the three-fathom curve extending east and west eighteen miles, with a mean breadth of three miles; the northern edge being nine miles from the nearest land, Racoon Point, Dernière island.

"The approach on the northwest and north side is dangerous, and vessels plying between it and the shore should be careful with their lead-line, and go no nearer than four fathoms, from which depth the water shoals rapidly to nine and five feet. There is a channel of five and six fathoms along the northern edge of the shoal, which would serve as a guide for vessels beating along the shore, taking care to tack on their southern course before shoaling from four fathoms. The southern and eastern approach is very gradual from three fathoms."

A special report, by Lieut. Comg. Sands, on this locality, with reference to the site and necessity of a light-house, will be found in Appendix No. 54.

An examination of the entrance to Horn Island Pass, to ascertain whether any changes had been made there by the hurricane of August, 1852, next received attention. After a thorough resurvey of the locality, Lieut. Comg. Sands "found that some of the shoal lumps had been knocked away, taking from the approach some of its dangers, rendering its channel easier of access, but not otherwise changing its depth or rendering it necessary to alter the sailing directions." The square beacon had been washed away, but he erected in its place a large tripod with a barrel on the pole.

Nassau roads, at the north end of the Chandeleur islands, was next examined to ascertain what effect the same storm had produced upon the passage there, and whether any changes had taken place since the survey of May, 1852. No material change was found to have occurred in the hydrography of the roads since that time. The light-house had been destroyed by the sea from the northward undermining its base; and there is some slight change of the topography of the point. As the dwelling of the keeper is still standing, it may be used instead of the light-house in the sailing directions, as it was adjoining the tower.

The issue of the charts of Nassau Roads and Horn Island Pass, which had been suspended in consequence of the doubt in regard to changes, will now be made at once.

It had been reported that a channel had broken through Ship island; but upon examination it was found that if such had been the case it had filled up again, not being enough water for a whale-boat to pass through at high water, spring tide.

Upon the completion of the above examinations, Lieut. Comg. Sands resumed the general hydrography of the section in Mississippi sound from the western limit of the work of last year, the meridian of Round island, and extended it to a line between Bellefontaine and a mile west of the western point of Horn island, (see Sketch H, No. 1,) including a survey of the mouths of the Pascagoula river, for the purposes of the Light-house Board. It was intended that outside work should have been done, but the boisterous character of the weather and other circumstances prevented the execution of this part of my instructions.

After the completion of the work in Mississippi sound, Lieut. Comg. Sands, on his way from Section VIII, made an examination of the small passage between Pelican and Dauphine islands, which was, a few years since, used by the steamboats plying between Mobile and New Orleans, and which had been reported as closing. The information derived is as follows:

"Considerable change had been made by the gale of August, 1852; altering the shore-line, and *shoaling* the pass instead of *deepening* it, as was reported. A narrow passage of three feet was cut through the middle of the narrow spit of sand running towards Dauphine island, and the northern point was cut off and joined to Dauphine island, making a point where the shore-line was before nearly straight, jutting out towards Pelican island, leaving but six feet in the channel; and steamboats were using the old channel between Great and Little Pelican instead."

The statistics of the work of the party for the season are given in the following table:

	Area.	Miles of soundings.	Number of casts of lead.	Sets of angles.
Ship shoal	200	923	35,275	1,122
Mississippi sound	65	247	17,053	533
Horn island	15	113	6,706	249
Nassau roads	16	147	10,045	315
	296	1,430	69,079	2,219

Surveys of sites for Light-houses, &c.—Examinations and surveys of Ship shoal and Racoon Point with reference to the location of a light-house, and at the entrance of the East Pascagoula river, were made by the same party, special reports of which will be found in Appendix Nos. 54 and 53. The hydrography of Ship shoal was based on the map of Assistant F. H. Gerdes, a full report of whose work on Isle Dernière and the vicinity is given in the Appendix No. 21.

Tides.—The observations of the tides of the Gulf of Mexico, which had been prosecuted in the preceding section in the earlier part of the season, were continued westward into this section, where two stations have been occupied. Observations were made hourly, day and night, by Mr. Gustavus Würdeman, at the Southwest Pass into Mississippi river, for four lunations, and at Racoon Point, near Ship shoal, Louisiana, for two lunations. The results show the usual care which has characterized Mr. Würdeman's observations.

SECTION IX.—FROM VERMILION BAY TO THE BOUNDARY, INCLUDING PART OF THE COAST OF LOUISIANA, AND THE COAST OF TEXAS. (SKETCH I.)

The organization of parties in this section has been as in the previous year, except that an astronomical party has taken the place of a topographical party, and two additional tidal observers have been employed. Determinations of latitude, azimuth, and of the magnetic elements, have been made at two stations. The secondary triangulation has advanced over a part of Matagorda bay. The topography has been carried from the Brazos to Cany creek, at the head of the same bay. The hydrography of Galveston bay has been continued; that of San Luis Pass and bay, and of the Rio Grande entrance, has been completed. Examinations for the sites of light-houses have been made at Aransas pass, and at the entrance of the Sabine river. Three tidal stations have been occupied.

The details of these operations are given under the several heads just referred to.

A chart of Galveston entrance, and of San Luis Pass, a preliminary chart, on a small scale, of Galveston bay, and sketches of Aransas Pass, from a re-survey, and Sabine Pass, have been published during the year.

Astronomical and magnetic observations.—The eastern terminus of the base line measured in this section, on Galveston island, in 1850, and Jupiter triangulation station, near Quintana, mouth of the Brazos, (Sketch I, No. 1,) were occupied during the past season for observations of latitude and azimuth, in connection with which, moon culminations and magnetic declination, dip, and intensity, were also observed at each station. Assistant G. W. Dean had charge of the party, and made the observations, in which he was aided by Sub-Assistant B. F. West. The observations for latitude were commenced at station East Base on February 19, and continued until the 22d of March, when those for azimuth were commenced. Although the elongation mark was erected on a hill rising a few feet above the general level of the prairie, and only about one mile and a quarter from the station, yet, on account of the very great movement of the atmosphere, much difficulty was experienced in observing upon it. The azimuth of this mark was connected with the triangulation of the section, and all the other observations necessary were completed by the 30th of March, and the party was transferred to Jupiter station—a primary point in the triangulation in the vicinity of the town of Quintana. The preparations for the occupation of this station were finished on the 20th of April, when the observations for latitude and time were commenced. On the 4th of May those for azimuth were commenced, and with favorable weather were finished on the 16th of that month. The elongation mark was at a distance of about three-fourths of a mile from the station, and approximately in line with Velasco primary point. Two severe gales occurred during the season, one on the 14th of April and the other on the 2d of May, which somewhat retarded the work, and caused some slight damage to the camp equipage; but in both instances, in consequence of the precaution taken by Mr. Dean, no injury at all was sustained by the instruments. These gales were very severe, and their effects were felt heavily by the shipping along the whole coast.

The work executed by the party is thus given by Mr. Dean:

"At station East Base, Galveston island. For latitude, 150 observations upon 57 stars with zenith telescope, C. S. No. 5, (Würdeman.) The stars were arranged in 33 sets, 22 of which were from the Greenwich and 11 from the B. A. catalogue.

"The 22 sets from the Greenwich Twelve Year catalogue gave, from the preliminary computations, for the latitude of the instrument - - 29° 12′ 53″.05 ± 0″.11

"The 11 sets from the B. A. catalogue gave - - - - - 29° 12′ 53″.82 ± 0″.20

"Combining these results by giving weights inversely as the square of errors:

"Latitude of zenith telescope - - - - - - - - - - - - - -	29° 12′ 53″.24
"Reduction to geodetic station - - - - - - - - - - - -	0″.51
"Latitude of station - - - - - - - - - - - - - - - - - -	29° 12′ 52″.73

"The probable error of a single observation was 0″.35.

"The value of the micrometer of the zenith telescope was determined by one hundred and ninety-six (196) observations upon Polaris at western elongation. For local time, eighty (80) observations were made upon sixteen (16) stars selected from the Nautical Almanac and Greenwich catalogue, paired as high and low. The instrument used was a forty-eight-inch transit, C. S. No. 4, (Troughton & Simms.)

"On account of unfavorable weather, only three moon culminations were observed.

"For azimuth, one hundred and seventy-nine (179) observations were made upon Polaris at eastern and western elongations and lower culmination; also upon Lambda Ursæ Minoris at lowest culmination, with one hundred and eighty-four (184) observations upon the elongation mark. For the connection of the mark with the triangulation, one hundred and four (104) observations were made. The instrument used was the twenty-four-inch theodolite, C. S. No. 2, (Troughton & Simms.)

"For magnetic declination, one hundred and twenty-five (125) observations were made, upon six different days, from which the variation was determined to be 8° 52′.4 E., and the diurnal movement of the magnet 8′.5.

"For horizontal intensity, two sets of vibrations and deflections were observed with magnet C. 32, and two with magnet S. δ, upon two different days. For moment of inertia, two sets with each magnet were observed upon the same day. The values of magnet scales were determined with declinometer D, by Jones.

"For magnetic dip, three sets of observations were made on three different days, the instrument used being the dip circle C. S. No. 4, (Barrow & Co.)

"The mean dip obtained from the results of these observations is 57° 40′.4.

"For total magnetic intensity, two sets of observations were made on two different days with Lloyd needles.

"At Jupiter station, near Quintana, the following observations were made: For latitude, one hundred and forty-nine (149) observations upon sixty-five (65) stars, arranged into thirty-seven (37) sets, and selected from the Greenwich Twelve Year and B. A. catalogues.

"The fifteen sets from Greenwich catalogue gave, from the preliminary calculations, for the latitude of the instrument - - - - - - - 28° 54′ 49″.60 ± 0″.10
and twenty-two sets from B. A. catalogue gave - - - - 28° 54′ 49″.64 ± 0″.23

"Combining these results, giving weights inversely as the squares of the errors:

"Latitude of instrument	28° 54′ 49″.61
"Reduction to geodetic station	0″.87
"Latitude of station	28° 54′ 48″.74

"The probable error of a single observation was 0″.26.

"For time, seventy-seven (77) observations were made upon fifteen Nautical Almanac stars, paired as high and low stars.

"For azimuth, one hundred and nine (109) observations were made upon Polaris at lower culmination, and one hundred and twenty-six (126) observations upon the elongation mark, in five positions of the instrument.

"For magnetic declination one hundred and thirty-five (135) observations were made on six different days, from which the variation was determined to be 8° 55′.4 E., and the diurnal movement 8′.8.

"For horizontal intensity two sets of vibrations and deflections were observed, with magnet C. 32, and two with magnet S. δ, upon two different days. For moment of inertia, two sets with each magnet were observed upon the same day.

"For magnetic dip four sets were observed, which gave the following mean result: 57° 11′ 7″; besides one in various azimuths to test the axes of the needles.

"Two sets were observed for intensity with the Lloyd needles on two different days.

"The instruments used at this last station were the same that were employed at station East Base.

"A meteorological register was kept at both stations, in which two hundred and three (203) observations of the barometer and wet and dry bulb thermometers were recorded."

Operations were closed at this station on the 17th of May, when the party returned from the field. The instruments being properly disposed of, Messrs. Dean and West were engaged in the computation of their season's work until the end of July, when Mr. Dean was called to my party, in Section I, to assist in the observations in the primary triangulation, in which duty he has been since engaged.

Mr. West, who had been upon detached duty to Mt. Washington, after the attachment of Mr. Dean to my party, returned to Portland suffering from disease, which finally assumed a typhoid form, and terminated his life on the 25th of August, just as he had reached twenty-one years of age. He was an efficient and promising young officer, and was much esteemed and beloved by his associates and those with whom he was thrown in the performance of his duty. The loss which the Coast Survey and his friends have sustained in his untimely death, is expressed in the resolutions adopted by them, and given in Appendix No. 45.

Primary and secondary triangulation.—These branches of the work have been under the charge of Assistant James S. Williams, aided by Sub-Assistant S. C. McCorkle, and during part of the season by Mr. G. W. Parrish. The reconnaissance of last year for the triangulation over Matagorda bay, which had extended just beyond the eastern end of the bay, was resumed on the 14th of December, and carried westward to the Colorado river. (See Sketch I, No. 1.) Mr. Williams, in his report, says the "Bay of Matagorda is admirably suited for triangulation; its width is convenient; there is no timber near it, except on the Colorado; and the depth of water within one hundred yards of the shore, (usually two and a half to three feet,) admits the economy and convenience of using vessels." He further says: "From the mouth of Cany creek southwestward, a sandy strip, not anywhere more than a mile wide, extends for sixty miles to Pass Cavallo; this separates the Bay of Matagorda from the Gulf of Mexico. The average width of the bay, for ten miles from its head, is not more than two miles; then it suddenly opens to a width of about four miles; and this continues very uniformly to this place, (Matagorda.) The northern shore of the eastern part of the bay is marshy, and extends back in a prairie far enough, as I judge, to include the interior points of the primary triangulation, giving sides of twelve to fifteen miles.

"Fortunately, there is a piece of dry prairie accessible from the bay, which gives a good position for a secondary point to be connected with 'Kenner,' the westernmost point of my last year's reconnaissance."

The reconnaissance was closed on the 15th of February, when the party was divided—Mr. Williams to occupy the points of the primary triangulation, and Mr. McCorkle those of the secondary. In the occupation of station West Base, Mr. Williams met with very unfavorable weather; and on the 2d of May a violent hurricane suddenly came up, which prostrated the camp and the observing scaffold, and so injured the instrument—the fourteen-inch theodolite, C. S. No. 53, (Brunner)—that the further continuation of the primary work was rendered impracticable, and Mr. Williams commenced the plane-table work which had been assigned him for a later part of the season.

The secondary work was carried from the line Rhodes—Cany, westward, to Bath—Live Oak. (See Sketch I, No. 1.) This was continued until June 8, in which time eight stations were occupied, and thirty-nine (39) angles measured, by one thousand and four (1,004) observations. The instrument used was the six-inch theodolite, C. S. No. 56, (Gambey.)

The following statistics are given by Mr. Williams in his report:

Number of stations occupied, nine; angles measured, forty-two, (42;) observations made, one thousand five hundred and nine, (1,509;) area of triangulation, one hundred and thirty-three and three-tenths (133.3) square miles.

Since the return of the parties from the field, Mr. Williams and Mr. McCorkle have made the computations of the season's work.

Topography.—The storm of May 2d, before referred to, having deprived Assistant Williams of the means of extending his triangulation, he removed to Velasco and took up the plane-table work west of the Brazos, continuing it to Cany creek, (see Sketch I, No. 1,) near the head of Matagorda bay, which was reached on the 8th of June. The sheet embraces an extent of shore-line of forty-six (46) miles, and covers an area of twenty (20) square miles. Mr. Williams, since his return from the field, has inked this sheet and turned it into the office.

Hydrography.—Lieut. Comg. Craven, who had charge of the hydrography in this section in 1852, having been transferred to Section VI, Lieut. Comg. H. S. Stellwagen, detailed as chief of a hydrographic party, was assigned to its continuance in the Coast Survey schooners Morris and Belle. The work remained under his charge until the close of May, when he was called north for the survey of the Nantucket shoals; leaving the party under command of the senior officer, Lieut. John Wilkinson, U. S. Navy, assistant.

The first work of the season was in San Luis Pass and bay, which was executed by the party in the schooner Morris. In regard to the bar at this place, Lieut. Comg. Stellwagen remarks:

"This bar is a pretty good one; the water nearly the same depth as Galveston; the course straight in, and but a little distance to run. The anchorage inside is limited in extent, but has accommodated considerable shipping; and when the canal connecting Oyster bay with the Brazos river is completed, it will probably be the export harbor for a large and productive region of country, as the bar at the mouth of the Brazos in a great measure obstructs the outlet in that direction."

While the Morris was at work in San Luis bay, the Belle was engaged in Galveston bay, completing the hydrography there.

An examination and survey were made at the mouth of the Sabine river, and a re-examination made of Aransas Pass, with a view to the location at each place of a light-house. These are referred to under their appropriate heads. Upon the completion of these surveys, the schooner Belle was laid up at Galveston, and the party in her transferred to the Morris, for the purpose of bringing the whole force to the completion of the hydrography of the entrance to the Rio Grande river. The survey was made in connection with the operations of the boundary commission, and in pursuance of arrangements made under the sanction of the commissioner by Major W. H. Emory, astronomer and surveyor of the commission, intended to avoid the necessity for a double survey of this locality. The failure to receive my first instructions, the injury sustained by the schooner Morris in the hurricane of May 2, while at Galveston, and other circumstances, threw this work into a late period of the year, and made its execution particularly difficult. It is, therefore, due to Lieut. John Wilkinson, to whose energy and perseverance the success of the undertaking is due, that I should express the high sense which I entertain of his efforts, and the ability which insured his success.

The operations were closed on the 20th of August, and it being desirable to avoid a long sea voyage in the then condition of the Morris, she was taken to Pensacola for repairs. My instructions, directing the vessel to be taken to Key West, had not been received. Finding that an epidemic prevailed at Pensacola, Lieut. Wilkinson transferred part of the officers and the crew of the Morris to a brig ready to sail for New York, and detached the other officers from the vessel, which was laid up under the charge of ship-keepers. Assistant Surgeon Bryan, who remained at the naval hospital at Pensacola, died of the prevailing fever. This highly esteemed and accomplished medical officer had for several years been attached to the Coast Survey, and his loss is most deeply lamented.

The injuries to the Morris in the hurricane at Galveston, measurably interfered with the progress of the season's work, especially that designed to have been executed on the outside.

The amount of work executed is, however, satisfactory, as is shown by the annexed table of statistics giving the results:

	Miles of soundings.	Number of soundings.	Number of angles.	Area sounded out.
Galveston bay	400¾	19,180	750	80
San Luis	213¾	14,758	884	7¼
Aransas Pass	7¾	320	17	1
Sabine	18¾	852	41	1¼
Rio Grande	100	5,085	376	8¾
Total	741	40,195	2,068	98¼

Surveys for sites of light-houses, &c.—In accordance with the instructions of the department, a re-examination was made of Aransas Pass, to determine the expediency of placing there a light-house or a light-boat. The result of the examination shows that while the depth of water on the bar has remained very nearly the same, the channel has changed its position nearly the whole breadth of the pass since 1851, when the first survey was made by Lieut. Comg. Craven. (See Sketch I, No. 5.)

These changes are so frequent and great, that it seems very evident that a fixed structure cannot be erected to answer the purpose of guiding vessels over the bar, and that a light-boat is necessary for that purpose. My report on the subject, transmitting that of Lieut. Comg. Stellwagen, who made the examination, will be found in Appendix No. 56.

The survey and selection of a site at the entrance to the Sabine river for a first-class light-house, appropriated for in the act of Congress of March 3, and referred by the department to this office, was made by Lieut. J. Wilkinson. A site was selected well calculated to answer the general and local purposes for which the light-house is intended, and its position was indicated upon a sketch transmitted to the department in my report of July 12, also given in Appendix No. 55, (see Sketch I, No. 2,) with the report of Lieut. Wilkinson, and a letter from Lieut. Montgomery Hunt, light-house inspector of the district.

Tides.—The irregularity of the tides at Galveston required that the observations should be continued there to obtain the necessary information in regard to the rise and fall, and to trace the progress of the tide-wave in the Gulf. It was also deemd necessary to compare these results with determinations at the immediate entrance of the bay, at Bolivar Point, and a self-registering tide-gauge was established there for the purpose. The reductions are made in the office as the results come in, and the records of the two gauges compared. Considerable progress has been made by Mr. Heaton, of the tidal party, in the computations of the observations at Galveston.

A tidal station has been established at the mouth of the Rio Grande, in connection with the survey of that entrance, and for continuing the series on the Gulf of Mexico.

The observations have been made by Mr. G. Würdeman, of the Coast Survey, who has observed the tides at several stations in the Gulf, and takes great interest in the progress of solution of this important problem of the Gulf tides. The promptness and fidelity with which he has devoted himself to these observations insures their accuracy and reliability, and has entitled him to repeated acknowledgments. Other points in this section are embraced in the series he occupied as tidal stations to ascertain the phenomena of the tides in the Gulf.

SECTIONS X AND XI.—COAST OF CALIFORNIA, AND OF OREGON AND WASHINGTON TERRITORIES.

Prior to the date of my last report, the surveying parties on the Western coast had furnished a preliminary reconnaissance, with sailing directions and other hydrographic notes, from San Francisco to the northern boundary; a more minute general reconnaissance, with astronomical determinations of important points, sailing directions, and other information, from San Francisco to the southern boundary; the astronomical determinations of the positions of twenty-five harbors, capes, and headlands; preliminary surveys of fifteen harbors and anchorages; topographical surveys of eight capes or points for the selection of sites for light-houses, and for purposes of defence, in some cases with the hydrography in connection. The maps, charts, and sketches founded on these, which have been engraved and published, have been twenty-seven in number. A list which shows the particulars of this progress is given in Appendix No. 8.

The operations of the past year have been directed especially to the completion of the more minute hydrographic reconnaissance with astronomical determinations of the principal points from San Francisco to the northern boundary; to the resurvey of Humboldt and Columbia river entrances, and to the survey of Umquah, and several minor ports and anchorages; to a commencement of the survey of the Santa Barbara islands, and their connection with the coast; to the continuation of the survey of San Francisco harbor, in connection with the systematic work on the coast, extending it north and south from that point; to additional astronomical determinations, and to further examinations and surveys for sites of light-houses. The details of these and other results obtained by the parties will be given under the head of the several operations.

A systematic series of tidal observations has been commenced, intended to develop the phenomena of the tides along our entire Western coast, stations for prolonged series of observations being selected at the most suitable points, as far as the unsettled character of parts of the country will permit, and to be connected by observations at intermediate stations of a more temporary kind.

The present organization on the Western coast includes two triangulation parties; an astronomical party, with instruments for triangulation and for magnetic observations, and an assistant for topographical work; two topographical parties—one under the general direction of the chief of the main triangulation party; a hydrographic party, with a steamer and sailing-vessel, usually at work on different parts of the coast; and a party for tidal observations.

The results are worked up as fast as sent to the office, and the notices and charts rapidly published. The details for the past year will be found in the subsequent pages.

Charts and sketches of the reconnaissance from San Francisco to San Diego, San Francisco city, Santa Barbara, Points Conception and Caxo, Catalina harbor, Cape Mendocino, reconnaissance from Gray's harbor to Admiralty inlet, Straits of Fuca, Cape Flattery, and Nee-ah harbor, Shoal Water bay, and False Dungeness harbor, and Cortez bank, have been completed within the year, and either published or are ready for publication. Charts of San Diego bay, San Francisco bay and harbor, and Columbia river, and sketches of Umquah river and Ewing harbor, have been in progress.

Astronomical observations and triangulation.—From October until March last, Assistant George Davidson, aided by Sub-Assistant John Rockwell, was engaged in observing moon culminations for longitude near San Francisco. During this time he also determined the latitude of Point Reyes, (Punta de los Reyes,) Sir Francis Drake's bay, by the zenith telescope, and the approximate difference of longitude from San Francisco by chronometer. The lamented decease of Sub-Assistant Ruth also threw upon Mr. Davidson the triangulation for connecting the Santa Barbara islands with the main. A reconnaissance was made in the autumn of last year, and this spring a base of about six and three-tenths miles in length was carefully measured with rods, near San Pedro, and the triangulation was commenced. (See Sketch J, No. 1.) Observations for azimuth were made, and the former astronomical station of Mr. Davidson was connected with the work. Mr. Davidson turned over this work to Captain E. O. C. Ord, U. S. Army, and proceeded with the hydrographic party of Lieut. Comg. Alden to the coast of Oregon, determining approximately astronomical positions, and making sketches of the coast. The latitude and longitude of Bodega bay, Haven's anchorage, Mendocino City, Shelter cove, Humboldt bay, Trinidad bay, Port St. George, Port Orford, and Umquah river entrance, were thus determined. Mr. Davidson also made the triangulation in connection with the hydrography of Mendocino City harbor, Shelter cove, Point St. George, and the entrance of the Umquah, and assisted in determining Cape Blanco reef.

At the last dates from him, August 17, he was with the party of Lieut. Comg. Alden, in execution of instructions for the completion of the survey of the Columbia river, and of part of the coast of Washington Territory.

Triangulation.—After completing the special triangulations of San Francisco and the adjacent bays, Assistant R. D. Cutts commenced the general triangulation of the coast, including the primary and secondary series, and with tertiary points for the plane-table parties which follow him. The site of a base about six and a third miles in length was selected at Pulgas ranch, and the base measured carefully with wooden rods compared with a standard bar. Every precaution was taken to render this a reliable measurement, and a report with very full details has been received. Messrs. Rockwell and Custer assisted Mr. Cutts in this work, and the latter made a profile of the base. The triangulation is connected with the base by a well-shaped quadrilateral, both diagonals of which are determined. The progress of the triangulation to September 30 is shown in Sketch J, No. 6.

During the last winter permission was given to Mr. Cutts to return to the Atlantic States, and while at the office he rendered valuable service in regard to the work of publication in progress, and gave minute information in regard to the coast, and the wants of commerce and navigation there. He returned to Section X early in May last.

The temporary employment of Mr. Davidson, in the connection of the Santa Barbara islands with the main, has been stated. Captain E. O. C. Ord, detailed to replace him, left New York on the 20th of July, and on the 26th of September had commenced the work at the point at which it was left by Mr. Davidson.

Topography.—The topographical party of Assistant A. M. Harrison, in October, November, and December last, executed the plane-table sheets marked Nos. X and XI, on Sketch J, No. 6, from Point Lobos, San Francisco entrance, to Point San Pedro, and No. VII, Contra Costa, near Angel island, San Francisco bay, and sent them to the office. They next commenced the survey of Santa Catalina island, and made some progress in it, then removed to the coast near San Pedro, and commenced the survey for light-house purposes, required by the hydrographic party. Mr. Harrison expected to continue his work along the coast to Point Año Nuevo. In July last he was joined by Sub-Assistant W. M. Johnson, who, after acquiring the special knowledge of the country which is necessary, will take charge of the party, relieving Mr. Harrison, who was one of the early volunteers for the Western coast, and has faithfully discharged the duties required of him there.

The topography of the coast north of San Francisco was carried from Bonita Point to within three miles of Duxbury reef, (sheet No. 9, Sketch J, No. 6,) by Sub-Assistant Augustus F. Rodgers, and sent to the office on the 15th of April last. During the time of working on this sheet, efficient aid was rendered to the hydrographic party engaged in outside work, by the erection of signals for their use. Having advanced beyond the range of the triangulation, Mr. Rodgers executed, as a basis for his work, the auxiliary triangulation to Duxbury reef, shown on the sketch, occupying five tertiary stations. Returning in May to San Francisco bay, sheet No. 4 (Sketch J, No. 6) was taken up, completed, and transmitted to the office by the middle of September. During this time also a special survey, in detail, was made for the site of a light-house at Point Bonita, and communicated. Up to September 30, the date of Mr. Rodgers' general report, he had been occupied in revising the shore-line of the map of the city of San Francisco, and in reconnaissance for the main triangulation, under the direction of Assistant R. D. Cutts.

Under the direction of Assistant George Davidson, Mr. James S. Lawson has executed the topography of Point Reyes, Sir Francis Drake's bay, and the profile of the San Pedro base, besides other work in connexion with the hydrographic reconnaissance, and as assistant in Mr. Davidson's party in the operations already referred to.

Hydrography.—After returning from Oregon last winter, Lieut. Comg. Alden, U. S. Navy, assistant in the Coast Survey, in the steamer Active, commenced the survey of San Francisco bay and entrance, which was prosecuted as the weather permitted until June, when the party proceeded on the hydrographic reconnaissance northward, revising the survey of Humboldt harbor, and making new surveys of Crescent City harbor, under Point St. George, the reefs off Point St. George and Cape Blanco, Port Orford, Ewing harbor, the entrance and six miles up the river Umquah. The remarks of Lieut. Comg. Alden on this reconnaissance are as follows: "We found, much to my surprise, good anchorages every night except the one before we got in here, (Columbia river.) At every stopping-place the observatory was put up and sights obtained. A survey of the anchorage at Mendocino City, which is some seventy miles to the southward of that cape, and of a snug cove forty miles further on, was made. Humboldt bar has been examined; the bay at Crescent City, under Point St. George, surveyed; the hydrography of Point Orford, or Ewing harbor, done; and a survey made of the entrance of the Umquah, including six miles of the river. We found a good wide passage through the reef off Rogue's river, and examined those through the reefs off Point St. George and Cape Blanco; they are all entirely safe and perfectly practicable.

"For steamers bound north, particularly in the summer time, when it is necessary to keep close to the land for shelter from the wind, which blows almost a gale down the coast, such 'cut-offs' will prove invaluable. We have brought a line of soundings up the coast, getting casts at intervals of every two miles, and seldom at a greater distance than one mile from the shore, often within a quarter of a mile, and frequently within two or three hundred metres of the rocks. So you will perceive that our opportunities for giving the coast a thorough examination have been complete. We were delayed in Humboldt seventeen days—two weeks by fogs—before we could get any sights at all, and then three days on account of the roughness of the bar, the sea breaking the whole time entirely across. We found the bar pretty nearly as it was when we surveyed it two years ago; but I am satisfied, from all the information I could get, that it has undergone very important changes in the mean time.

"The entrance to this river, (Columbia,) the South channel—or rather what they call the Point of Sands, or North Spit—has crept down a little towards the beach; but the change is not half so great as I had been led to imagine from the reports of pilots and others. When we came in, or rather when we made the breakers, the fog was very thick. It soon, however, lifted a little, so that one of our marks could be discerned through the mist, and giving the north breaker, or Point of Sands, a wide berth, we crossed the bar in a *quarter less five fathoms*, more water than I have ever known there before; the tide, too, had been flowing only about one hour. There is a new channel opened into the old North channel, through the middle sands, about half way, which the pilots use now to bring vessels in, drawing twelve or thirteen feet of water; the wind being more favorable in that quarter at this season of the year, it is found very convenient."

* * * * * * *

"The entrance to the Umquah is narrower than that of Humboldt, and there is less than two and a half fathoms of water on the bar. We went in and came out without difficulty, but drawing only eight feet of water."

At the close of the working season last year, charts were sent to the office of Columbia river entrance, reconnaissance of the coast from Port Townsend to Columbia river, Nee-ah harbor, False Dungeness or Port Angelo, and Shoalwater bay, which were at once put into the hands of the engraver. These, with the reconnaissance above mentioned, in two sheets, accompany the present report.

In June last, the schooner Ewing, Lieut. Comg. T. H. Stevens, U. S. Navy, attached to this party, was sent to examine the Cortez bank, reported as south of San Nicolas and San Clemente islands, and determined the position and extent of the bank, finding ten fathoms of water on it. The report on this examination, which was immediately published, is in the Appendix No. 24, with a sketch accompanying it marked J, No. 3.

A very exact series of tidal observations were made by Lieut. Comg. Alden at Rincon Point, in January and February of this year, and communicated. The results of my discussion of them are given in Appendix No. 28, and were published in a form suited to practical use by navigators, in a hydrographic notice, also appended to this report, Appendix No. 29.

During the course of the year Lieut. Comg. Alden rendered various acts of service, which were suitably acknowledged. The survey of the city shore-line of San Francisco was communicated to the authorities of the city, and to the agent of the Pacific Mail Steamship Company. The Farallones were visited, at the request of the collector of the port, to prevent the interference of certain parties there with the contractor for erecting the light-house in the landing of the materials intended for that structure. The place where the wreck of the steamer "S. S. Lewis" occurred was visited, and a part of the passengers brought thence to San Francisco. An attempt was made to render assistance to the clipper "Carrier Pigeon," wrecked near Point Ano Nuevo. The assistance rendered by Acting Lieut. R. M. Cuyler to the passengers of the steamer "Tennessee," wrecked near San Francisco entrance, is acknowledged by Lieut. Comg. Alden, in a report which is appended to this (Appendix No. 42.)

The schooner Ewing has been engaged in furnishing transportation to the parties surveying the Santa Barbara islands, and in the hydrography of that vicinity, and in executing someadditional work required at San Diego.

Tides.—Three tidal stations have been established by Lieut. W. P. Trowbridge, Corps of Engineers, assistant—one at San Diego, one at San Francisco, and one at

Columbia river. These are furnished with self-registering gauges, and are intended as points of comparison for the intermediate temporary stations. In connection with this work, Lieut. Trowbridge will also make the magnetic observations required at the different localities.

Light-houses.—A minute survey of Point Bonita, for the site of a seacoast light, was made by Sub-Assistant Augustus F. Rodgers, under the direction of Assistant R. D. Cutts. The report of these officers, with the accompanying sketch, were forwarded to the Light-house Board, and are appended to this report. (Appendix No. 57.)

Lieut. T. H. Stevens, in the schooner Ewing, was engaged, when advice was last received from him, in the examination of the coast near San Pedro for selecting the best site for a light-house there.

OFFICE WORK.

In the introduction to my report, I stated the change in the assistant in charge, which occurred in March last, by the appointment of Brevet Major I. I. Stevens as governor of the Territory of Washington, and the detail of Captain H. W. Benham, of the Corps of Engineers, to fill his place; and while paying a well-deserved tribute to the distinguished services of Major Stevens, expressed my confidence in the zeal and abilities of his successor. Captain Benham has been industriously occupied in mastering the details of the office and of the survey generally, and in repairing the losses sustained by the resignation of experienced employés, who left the office to join Governor Stevens' exploration of the northern route to the Pacific. The drawing and engraving divisions of the office suffered especially in this way; and it has required great effort to keep up their usual efficiency, and, while pressing forward the work on the more elaborate charts, to furnish the very numerous sketches, charts, and maps of preliminary surveys required for the immediate publication of current work. It has, however, been effected at but a small sacrifice of the progress of the more finished maps. The compilation of the map ordered by Congress, showing in colors the progress of the survey, has added to the difficulties just referred to; no additional appropriation having been made for its execution.

With the office estimates for each year is presented to the Superintendent a programme for the work of the fiscal year, intended to provide for the execution of the work required by the results of the field parties for that year, and of such back work as remains from previous years. A list of the probable results from the field and hydrographic work is furnished, as the basis of this, from the instructions of the Superintendent. During the progress of the year, the monthly reports show the advance made in this work, and the expenditures for it. At the close of the year, a comparison of the work projected, and of that executed, is reported; and with the new set of estimates, a programme for the next year. Thus a systematic execution of the details, and due responsibility for every portion of them, is insured.

The divisions of the office, as naturally arranged from the character of the operations, are: 1. The computing division; 2. The drawing; 3. The engraving; 4. The electrotyping; 5. The printing; 6. The publishing, distributing, and sale; 7. The instrument making and carpentry; 8. The archives, library, and clerical force. Under these heads will be given general remarks on each division, chiefly from the report of the assistant in charge of the office, with a statement, in general terms, of the character and kind of work executed by each one in their several divisions. A detailed statement of the results produced, showing the share of each one in the labor, as extracted from the reports of the chiefs of the several divisions of the office, is given in the Appendix No. 25, in the same order in which the divisions are here named.

"In the *computing division*—as I have found it, the best organized portion of the office proper—I am much gratified to say, that every call from parties in the field, as well as from persons not connected with the survey, has been promptly responded to, to the best of the means available. In addition to this, I have the pleasure of stating that the whole of the field-work of last year and of the present, (1853,) as far as received, has been computed, and the revisions made as far as the receipt of the computations of the observers would permit.

"I would state that my own observations led me to unite in the belief of the chief, Assistant Julius E. Hilgard, that 'the industry, zeal, and fidelity of all the gentlemen engaged in the computing department, is deserving of great commendation;' as also to refer to his remark in relation to the extension, care, and improvement in the system of recording the results, made 'chiefly by Mr. Schott,' acting in charge of the computers for the greater portion of the time since I entered the office, to whose anxious, faithful industry I have great pleasure in testifying, as well as in acknowledging the kindly aid and valuable assistance of Mr. Hilgard himself, the regular chief of this division, during the intervals of his field service that he has held the direct charge in the office."

The general distribution of the duties of this division among its members has been as follows: The computations of latitude and azimuth were made by *Mr. E. Nulty;* their revision, and the reduction of transit observations, were made by *Mr. Main.* The work of triangulation was computed by *Mr. Werner*, and revised by *Mr. Rumpf*, who also had in charge the registers of geographical positions. *Mr. J. E. Nulty* and *Mr. Wiessner* were engaged in different classes of work, as demanded by its occurrence. The clerical work was performed by *Mr. Hoover*, who also made miscellaneous computations.

Mr. Schott, when not in charge of the computing division, or engaged on special duty, made computations of astronomical work, and discussions of results generally.

A detailed list of the computations made is contained in Appendix No. 25, marked A.

"In the *drawing division*, the most important, perhaps, of all the others in the office, I have, as previously alluded to, had to regret the want of draughtsmen of the higher class, which in a much greater number, either by regular employment or by contract work, have heretofore been available for the necessities of the office for the preparation of the more finished charts. In addition to this, until quite recently, there has been the still more important deficiency of a proper chief to this division. The former acting head having left in May, for two or three months a temporary charge of the division was of necessity intrusted to persons who were inexperienced in the duties; and, though under the general direction of my assistant, Captain Foster, his time was so occupied with other duties in addition to this, that the division did not show the progress so much to be desired in every case in the office. I am, however, much gratified to state, that this change having been accepted by Captain Gibson about three months ago, there has been since that time a steady improvement and a rapid progress in this division. The different branches of the work were at once taken hold of by Captain Gibson most effectively, and particularly the projects for the different charts, and for the sketches for the annual report, so indispensable for the early diffusion of the knowledge of the useful results of the survey. Of these a large number have been prepared—all indeed, I think, that could be desired or expected; while for the more important maps, preparations are being made for getting in hand, either by contract or otherwise, all those for which we have the available material now in the office."

The duties have been divided as follows: Assistants *W. M. C. Fairfax*, and *M. J. McClery*, and *Mr. Joseph Welch* executing the reductions of topography of the finest class, and in miscellaneous examinations and verifications; *Mr. J. J. Ricketts* and *Mr. J. P. R. Mechlin* executing the first class reductions of hydrography; *Mr. C. Mahon*, *Mr. J. Lambert*, and *Mr. A. Boschke*, not now connected with the office, in reductions of topography and hydrography of a finer class; and *Messrs. E. Hergesheimer*, *A. Balbach*, *E. Freyholdt*, *L. D. Williams*, *J. R. Key*, *W. P. Schulz*, and *B. Hooe, jr.*, in miscellaneous reductions, drawings, and tracings. *Mr. W. B. McMurtrie*, draughtsman of the hydrographic party of Lieut. Comg. Alden on the Pacific coast, *Mr. J. C. Tennent*, and *Mr. Thomas Adams*, have been temporarily engaged at different times in this division; the former of these gentlemen has returned to the Western coast, and the latter is no longer connected with the office.

In the Appendix No. 25 will be found a statement by Captain Gibson of the maps and charts completed, near completion, and in progress, also the details of the distribution of duties among the members of the division by list B, Appendix No. 25.

"In the *engraving division* the work has progressed steadily, and generally with much faithfulness on the part of the persons employed; and though, from the illness and subsequent loss of the services of one of the principal engravers in the office, the illness of others on contract work, and the loss of the efficient head of this division, and, perhaps, from the unusual issue of last year, we shall not be able to report for this the completion of the usual number of large and finished harbor plates; yet I expect to have prepared for this report an amount of new sketch-plates, as I learn, unprecedented as to the number and the extent of recent results of the survey which they will furnish to the country. Many of the finer maps are, besides, so far advanced, that the number to be completed and published during the ensuing year will make up, with this year, at least the full average desired or expected.

"In this division, during the past month, Lieut. Hunt, of the engineers, has been assigned to the charge for as much of the time as he could spare from his other special duties. Previously the division was under the charge of Mr. J. C. Tennent, from the month of April."

The finest engraving on the large maps and harbor charts has been executed by *Messrs. Siebert*, *Rollé*, *Dankworth*, *John Knight*, *McCoy*, and *Smith*, the three first principally executing topography, *Mr. McCoy* the views, and *Messrs. Knight* and *Smith* the lettering; *Messrs. H. M. Knight*, *Woodward*, *Young*, *Throop*, and apprentice *Evens*, executing work on harbor charts, and in sanding; apprentices *Oehlschlager*, *Pettit*, and *J. J. Knight*, have been engaged in practice, and in work on the sketches to accompany the annual report.

The engraving executed by each one of this division is shown in list C of Appendix No. 25.

The apprentice system has not worked well during the past year; but Captain Benham has introduced modifications in the details which it is hoped may encourage its continuance as mutually advantageous to the office and to the apprentices themselves.

The reports given in Appendix No. 25, marked C, Nos. 1, 2, 3, and 4, show the plates *finished* during the year, and now *in progress*, and *all the plates which have been engraved* in the Coast Survey office, or that are now in progress of engraving.

"The *electrotyping*, under the skilful superintendence of *Mr. Mathiot*, has continued to meet the necessities of the other branches of the office, and it is hoped that by a judicious forethought, and the successful experience obtained in joining portions of engraved plates, for electrotyping additions, the re-engraving of any considerable portion of work once correctly executed, may in all cases be dispensed with hereafter.

"During the past year, forty-seven electrotype plates have been made; twenty-three of which were 'altos' or moulds, and the remaining twenty-four bassos, ready for the printer's use. Five plates have been altered and enlarged by combining with them sixteen pieces by the electrotype process, thus expediting, in a most important degree, the printing of the maps from these plates; while the great expense of the re-engraving of large portions of them has been avoided. In addition to this, about sixty blank plates are reported as having been prepared by the electrotype process for the engraving division.

"The other labors of this branch comprise the electro-gilding of nineteen deep-sea thermometers, and parts of some of the other scientific instruments used on the survey, together with the making and graduating of several metre scales."

The labors of Mr. Mathiot, and of his assistant, Mr. Cronin, are shown in the statement marked D, Appendix No. 25.

Mr. Mathiot also rendered acceptable service in arranging the articles sent to the exhibition of the industry of all nations at New York, among which were some admirable specimens of his own skill.

Through the attention of Lieut. Washington A. Bartlett, U. S. Navy, special agent for the Treasury Department, in Paris, for procuring the lens lights for the Western coast, I was placed in communication on the subject of the electrotype process with the Director of the Dépôt de la Guerre of France. An officer of the dépôt had been sent to England to inquire into the electrotype processes in use there, especially with those used for copying engraved plates for maps, first introduced by the officers of the Ordnance Survey. It was a gratifying result of this communication, that the Director, (Colonel Blondel,) in acknowledging the memoir sent to him from the Coast Survey office, observed: "The perusal of the memoir has convinced me at once of the superiority of the electrotype methods which are used in the United States. The reproduction in less than three days of a plate of large size, is an improvement of the highest importance." This letter was accompanied by an interesting account of the organization of the Dépôt de la Guerre, for which the thanks of the Coast Survey are due to Colonel Blondel.

"In the *printing office*, still under the experienced charge of *Mr. O'Brien*, an ample supply of the maps, charts, sketches, proofs, &c., has been constantly in readiness for all the calls from the agents, for sale, for the purposes of distribution to libraries, institutions, and to individuals, and for office purposes, amounting to more than twenty-four thousand sheets in all; in addition to which there have been stretched and prepared for the draughtsmen of the office, and for the topographical parties, nearly five hundred sheets of antiquarian paper, and about sixty original topographical and hydrographic sheets of drawing-paper have been backed with cloth. In this branch of the office, it early occurred to me that much might be saved in convenience and expense, with quite an increase of usefulness, by having portions of all the charts printed upon a strong thin paper. The facility of mailing or otherwise transporting them is so much greater, and particularly for the Western coast of the United States, while the cost of the sheets being generally only about one-fourth of those on thick paper, seem to render such a course very advisable, as a most important advanced step towards distributing the charts of the Coast Survey in the most convenient manner, and at the least possible expense. I have, therefore, directed that, for the present at least, one-half of all impressions of charts of the Western coast shall be taken on such thin paper, and that about one-fourth of all the other maps should be so printed. Such maps will be much more useful where they are preferred, as they will often be, and a great gain will result, as mentioned, in the lesser outlay for the material.

"I would also state that repeated efforts have been made within the last few months to accomplish your wishes for the obtaining, if possible, of some suitable strong 'cloth paper,' or cloth-backed paper, ready manufactured to our use, for the purposes of our draughtsmen; and even, as it has been hoped might be possible, for the uses of the topographical parties and the printing office also. This, though unsuccessful as yet, will not be lost sight of in the future. The number of sheets printed by Mr. O'Brien and his assistant, Mr. Rutherdale, are given in the Appendix No. 25, marked E.

"The *map room*, since January last, has been under the charge of *Mr. King*, whose care and faithfulness in that duty has given me much satisfaction. There have been furnished from this depository during the year, as shown by the annexed list, (Appendix No. 25, marked F) for sale to the agents in the different cities, nearly four thousand four hundred of our best charts. There have been gratuitously distributed, under the act of Congress, to literary and other institutions, and to individuals throughout our own and other countries, more than seven thousand two hundred copies, making, with nearly eight hundred required in the office, more than twelve thousand four hundred copies in all.

"Mr. King has also been charged with the direct preparation for distribution of the Annual Report of the Coast Survey; of these, besides many copies of former years, there have been gratuitously forwarded from the office, of the report and sketch-maps for 1851, the last yet received from the binder, between three thousand and four thousand copies. The list F, Appendix No. 25, shows that about two thousand of these have been sent already to individuals in the different States; about four hundred to five hundred to literary and other institutions in our own country; nearly five hundred to the officers of the army and navy, and Navy Department for its libraries at navy yards and vessels; nearly three hundred to the public press; and about one hundred and thirty have been forwarded to European countries through the Smithsonian Institution and otherwise; while, through the kindness of the Hon. W. L. Marcy, the Secretary of State, arrangements have been made for forwarding several hundred copies more, through our Legation at London, to commercial and scientific institutions and individuals in England, and to similar institutions and individuals of the Continental nations, through their ministers resident in Great Britain.

"The remaining copies of the report in the office are held for distribution in Texas, California, and Oregon, from whence the preparatory circulars of inquiry, &c., have not yet been returned, and for the occasional incidental calls and future uses of the office.

"There have also been distributed from this branch of the office about eight hundred copies from different circulars, communicating useful information to the navigation and commerce of the country; besides nearly two thousand five hundred other printed notes to individuals and to institutions in reference to the annual reports, deemed necessary to secure them from being duplicated or lost.

"In the *instrument shop* much labor upon the many different kinds of instruments in use on the survey has been performed during the past year, under the skilful and faithful direction of *Mr. Vierbuchen*, with the general superintendence of Mr. Saxton. Some seventy of the most important instruments have received repairs, including in the number fifteen theodolites, twenty-six sextants, seven telescopes, five deep-sea thermometers, two self-registering tide-gauges, seventeen metre-chains, besides a large number of others necessary for the work.

"In addition to this, many valuable instruments have been completed entirely in the shop, such as eight self-registering tide-gauges, eight deep-sea thermometers, two plane-tables, five telescopes, three protractors, with many others, such as scales, metre-rods, a range instrument, and tools of various kinds. I cannot but consider this shop a most valuable, if not indispensable, addition to the survey, from the excellence of the work there performed, the immediate execution of it when necessary, and the undoubted reduction of the expense over the cost of the same work in private establishments.

"In the *carpentry shop*, where two to three persons have been constantly employed under the direction of, and including, Mr. Wood, a large amount of necessary labor has been performed in the preparing of the wood-work portion of the more valuable instruments, as stands for the theodolites, plane-tables, &c.; the making of the accurately-fitting cases for the finer and more delicate articles; the boxing of plates, maps, books, &c.; with considerable work upon the furniture, drawing fixtures, record cases of the office and library, not to dwell upon the large amount of repairing required upon the dilapidated buildings of the main office.

"The charge of the *clerical force* of the office has been with *Mr. Boggs* for the last six months, who has likewise attended to the accounts of disbursements, and generally very satisfactorily. The knowledge of the routine of the office possessed by *Mr. Whyte*, with his faithful services, have been of much value; and *Sergeant Uhrlandt*, of the engineer detachment, has also acted for a large portion of his time as one of my clerks, in which duty he has proved very useful and reliable, as he also has in the general charge of the messengers and buildings, order and other books, with which he has been intrusted. In addition to the gentlemen above named, *Mr. P. C. F. West* and *Mr. J. L. Elliott* have been engaged in the clerical duty of the office.

"The *archives* and *library* have continued during the past year under the charge of *Mr. Snow*, to whose faithfulness and systematic arrangement their availability for ready reference, and the uses of the survey, are principally due.

"In the archives the tidal records have been rebound, and all original survey maps have been secured in suitable separate cases, distinctly marked for reference.

"In the library, now consisting of above two thousand two hundred volumes, are found most of the books needed for the uses of the survey, and to these additions are constantly made of the best works as they are published from time to time; over five hundred having been purchased during the last two years, while quite a number have been received by donation from individuals and from scientific institutions; and I have the pleasure of stating that the system of foreign exchange, mentioned by Mr. Snow, I have taken measures to carry out, as I trust, to a very considerable extent, and from which I would anticipate most favorable results."

Captain Benham acknowledges the special assistance derived from the general disbursing agent of the survey, *Samuel Hein, Esq.;* from the assistant in the Weights and Measures office, *Joseph Saxton, Esq.;* and from the following named officers in the Coast Survey office: *Captain A. A. Gibson*, U. S. Army; *Lieut. E. B. Hunt*, of U. S. Corps of Engineers; *Brevet Captain J. G. Foster*, of the same corps; and *Assistant L. F. Pourtales*, in charge of the tidal party. He speaks also with commendation of the services of the clerks in his immediate office, and of the faithfulness of the messengers and watchmen.

The important services of Captain Benham, in relation to the surveys of Minot's Ledge and the Sow and Pigs reef for the erection of light-houses, have been mentioned elsewhere; as also those of Captain A. A. Gibson, in taking views for charts of harbors in Section I.

In his annual report, Captain Benham calls attention to the necessity for the franking privilege by the superintendent and assistant in charge, and gives facts in relation to the matter of the strongest kind. This is probably the only bureau connected with the Treasury Department which has not the privilege, and the labor of franking which thus comes upon the chief clerk of the Treasury Department is very onerous. Captain Benham thus remarks: "In the six months from the first of July, since which time I have directed the strictest accountability, and an accurate record of the franks used, they amount to upwards of twenty thousand; of which about eight thousand were required for the distribution of the report of 1851."

I proceed next to notice certain computations and other work not included under the divisions of the office, but executed under my general superintendence.

The valuable aid of Prof. Peirce has been secured in the improvement of the computations of longitudes from observed moon culminations. It is well known that the comparisons of observed results with the lunar ephemeris furnish only determinations of the rudest kind; that the method of comparing observations is unsatisfactory, from the numerous results lost in practice for the want of corresponding ones; and, what is worse, from the nature of the computations. Prof. Peirce determined for each lunation of the year, by the method of least squares, corrections having the form indicated by examination of many years of observation, which, when applied to the longitude of the ephemeris, would cause them to differ less from the observed longitudes than the results of observation would differ among themselves. The least number for the error of observation of a lunar transit was obtained from an elaborate discussion of the observations at Greenwich, Cambridge, Edinburgh, and Washington. The application of this method to the observations of one year has proved very successful, and the further discussion is in steady progress. The interesting report of Prof. Peirce, stating his methods more in detail, is given in Appendix No. 31.

Prof. W. C. Bond has observed, by the "American method," during the past year, for the Coast Survey, fifty-five moon culminations, and has communicated observations chiefly for comparison with corresponding ones on the Western coast. The interesting remarks on the spring governor by Prof. Bond, with the details in relation to the performance of two of these instruments, are given in the Appendix No. 32.

George P. Bond, Esq., of Cambridge, has directed, during the past year, the computations of the observations for difference of longitude by chronometer between Cambridge and Liverpool, which had been made under the immediate supervision of Wm. Cranch Bond, Esq., director of the observatory at Cambridge, with the co-operation of Director Hartnup, of the Liverpool observatory. Mr. George P. Bond presented an elaborate plan of reduction of these results, and has caused its execution to be steadily carried forward, so that I expect to receive, early in the next year, the results of the valuable labors, in a complete form. A report of the progress already made in these computations is appended, No. 34.

Prof. A. G. Pendleton, U. S. Navy, assistant, has continued the computations of longitudes, taking up chiefly those of the Western coast, Point Concepcion, and Nee-ah bay, and of Charleston, S. C.

The tidal party under the direction of Mr. W. W. Gordon, and, since his resignation, under that of Assistant L. F. Pourtales, has been diligently engaged in re-computing the older tidal observations, and bringing them into form, and in reducing the new ones as they come in. This party is under my immediate supervision for the observations and computations. Sub-Assistant George A. Fairfield is attached to it, in charge of tide-gauges, a duty in which he is assisted from time to time by Mr. Henry Mitchell. This branch of the work has been referred to under the head of the several geographical sections. The office-work of the party is fully reported in Appendix No. 25. The comparisons of the work of former years, and of theory with observation, and the special discussions, have been made by Messrs. Pourtales, Mitchell, and Heaton; and the measurements from the self-registering gauges, the reduction of the work as it comes into the office, by Messrs. Hawley, Nes, Taylor, and Montgomery. Lieut. A. W. Evans, U. S. Army, assistant, has also been temporarily attached to this party, and its numbers and the persons employed have varied much within the year, as occasion required, or the junior members of the survey were disposable for the duty.

Lieut. E. B. Hunt, of the Corps of Engineers, assistant, besides his duties in the office, has rendered valuable service in superintending the transfer and printing of the plates of the Coast Survey report of 1852, for the Senate. In the progress of this work, the art of lithographic transfer, in all its details, has become familiar to him, and his remarks upon the processes, placed in the Appendix No. 36, will be read with interest and with profit. When in New York, Lieut. Hunt superintended the placing of the Coast Survey and Weights and Measures articles in the exhibition of the industry of all nations.

The much lamented decease of Prof. S. C. Walker left Assistant L. F. Pourtales in charge of the special computations of longitude, and of certain telegraph operations, in which he had been engaged. Mr. Pourtales has retained the charge of the Seaton station also, and of the telegraph computations referred to, while directing the labors of the tidal party.

During part of the year, Prof. E. Yulee, and during the remainder, Mr. C. M. Yulee, under his supervision, has been engaged in computations of moon culminations at Washington. The whole series of five years' observations will, it is expected, be computed in a few months.

The disbursements of the Coast Survey have been made with their accustomed regularity by Samuel Hein, Esq., general disbursing agent. All the estimates and the accounts of the parties pass through his hands, and after administrative examination by the Superintendent, are transmitted for audit to the First Auditor, who, after examination, passes them to the First Comptroller. Besides these important duties, Mr. Hein has discharged others, in the care of the property of the survey, and the repairs of the vessels used by the parties.

The usefulness of P. B. Hooe, Esq., as clerk to the Superintendent, deserves my warm acknowledgments.

Respectfully submitted, by

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE,
Secretary of the Treasury.

APPENDIX.

APPENDIX No. 1.

Distribution of the parties of the Coast Survey upon the coast of the United States during the surveying season, 1852–'53.

No. of section of survey.	Limits included in the several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
I	Passamaquoddy bay to Point Judith, including the coast of Maine, New Hampshire, Massachusetts, and Rhode Island.	1	Primary triangulation, and astronomical & magnetic observations.	A. D. Bache, superintendent; J. E. Hilgard, assistant; G. W. Dean, assistant.	Sebattis, Maine; geodetic, astronomical, and magnetic observations; J. E. Hilgard, assistant. (See also Section III, and office.) Blue Mountain, Maine; geodetic observations; George W. Dean, assistant. (See also Section IX.)
		2	Reconnaissance ...	C. O. Boutelle, assistant; Brevet Major Henry Prince, U. S. Army, assistant.	Extension of reconnaissance to line Moose ā bec, Range Mountain, Maine, near boundary. (Part of season. See also Section V.)
		3	Secondary triangulation and measurement of heights.	Captain T. J. Cram, U. S. Topographical Engineers, assistant.	Measurement of heights; coast of New Hampshire and Maine.
		4	Secondary triangulation.	C. O. Boutelle, assistant; B. Huger, jr., sub-assistant.	Casco bay, continued. (Part of season. See also Section V.)
		5	Topography.......	A. W. Longfellow, assistant; A. S. Wadsworth, sub-assistant.	York harbor, Maine; Portland harbor and approaches. (See also Section IV.)
		6	Topography.......	Henry L. Whiting, assistant.	Coast of Massachusetts from Ipswich towards Newburyport; part of Cuttyhunk for site of light-house; vicinity of Gay Head, Martha's Vineyard, Massachusetts. (See also Section III.)
		7	Topography.......	S. A. Gilbert, assistant...	Plymouth harbor and approaches; Monomoy Point, Massachusetts, and vicinity. (See also Section VIII.)
		8	Hydrography	Lieutenant Commanding H. S. Stellwagen, U. S. Navy, assistant.	Shoals east and south of Nantucket completed; south side of Martha's Vineyard, from No Man's Land to Muskeget channel; Gloucester harbor, Massachusetts; minute survey of Minot's Ledge for Light-house Board. Location of surf-boats. (See also Section IX.)

APPENDIX No. 1—Continued.

No. of section of survey.	Limits included in the several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
I	Passamaquoddy bay to Point Judith—Continued.	9	Hydrography	Lieutenant Commanding Maxwell Woodhull, U. S. Navy, assistant.	Shoals north of Nantucket; Portland harbor, Maine; Plymouth harbor, Massachusetts; minute survey of Sow and Pigs reef, off Cuttyhunk, Massachusetts, for location of light-house. Location of surf-boats. (See also Section II.)
		10	Tidal observations.	G. A. Fairfield, sub-assistant.	Placing tide-gauges at Siasconsett, Great Point, Hyannis, &c. General charge of tide-gauges at Portland, Portsmouth, Boston, &c. (See also Section VI, and office.)
		11	Views	Captain A. A. Gibson, U. S. Army, assistant.	Entrances to Salem, Newburyport, and Portsmouth, N. H., harbors. (See also office.)
		12	Inspection	Captain H. W. Benham, corps of engineers, assistant.	Examinations of vicinity of Minot's Ledge, and of Sow and Pigs reef, off Cuttyhunk, Massachusetts, for light-house sites.
II	Point Judith to Cape Henlopen, including the coast of Connecticut, New York, New Jersey, Penn., and Del.	1	Triangulation	Edmund Blunt, assistant; Lt. D. T. Van Buren, U. S. Army, assistant; Lt. A. H. Seward, U. S. Army, assistant.	Hudson river continued from line Bear Mount, Dickerson. (Part of season. See also Section III.)
		2	Topography	F. H. Gerdes, assistant; G. G. Oltmans, aid.	Resurvey of shore-line of Sandy Hook for changes. Hudson river from New York city northward. (See also Section VIII.)
		3	Hydrography	Lieut. Commanding Maxwell Woodhull, U. S. Navy, assistant.	Resurvey of Romer shoals, Swash channel, and vicinity, New York harbor, for site of beacon. Resurvey of Jersey flats. (See also Section I.)
		4	Hydrography	Lieut. Com'g R. Wainwright, U. S. Navy, assistant.	Hudson river from junction of Captain Gedney's work. (See also Section III.)
		5	Tidal observations.	....	Tidal observations at Governor's Island continued. (Self-registering gauge.)
III	Cape Henlopen to Cape Henry, including the coast of Delaware, Maryland, and Virginia.	1	Astronomical observations.	L. F. Pourtales, assistant.	Observations for telegraphic difference of longitude, Washington and Charleston, Washington and Raleigh. Moon culminations observed at Seaton Station. (See also Sections IV and V, and tidal party, office.)
		2	Azimuth and magnetic observations.	J. E. Hilgard, assistant; S. Harris, aid.	Observations of azimuth and magnetic elements at Station Davis, Eastern Shore of Maryland. (See also Section I.)
		3	Primary and secondary triangulation.	Edmund Blunt, assistant; Lieut. A. H. Seward, U. S. Army, assistant.	Completion of triangulation of Chesapeake bay to the Capes. (See also Section II)
		4	Secondary triangulation.	John Farley, assistant; J. E. Hilgard, assistant.	Measurements of verification of triangulation of outer coast between Cape Henlopen and Cape Henry. (Part of season. See also Section I, and office.)
		5	Secondary and tertiary triangulation.	John Farley, assistant; J. R. Offley, sub-assistant.	James river, Virginia, from Richmond to Harrison's bar continued. (Part of season.)

APPENDIX No. 1—Continued.

No. of section of survey.	Limits included in the several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
III	Cape Henlopen to Cape Henry—Continued.	6	Secondary and tertiary triangulation.	Lieutenant Wm. P. Trowbridge, Corps of Engineers, assistant.	James river, from Richmond to Warwick bar. (Part of season. See also Sections X and XI.)
		7	Secondary and tertiary triangulation.	Captain W. R. Palmer, U. S. Top. Engineers, assistant; Lt. D. T. Van Buren, U. S. Army, assistant.	Rappahannock river, Virginia, from Fredericksburg to Port Royal, nearly: reconnaissance to mouth of river. (See also Section II.)
		8	Topography	H. L. Whiting, assistant..	Verification work on Patapsco river, Md., continued. (See also Section I.)
		9	Topography.......	Geo. D. Wise, assistant; E. F. Mason, aid.	Outer shore of peninsula of Eastern Shore of Maryland and Virginia, continued.
		10	Topography.......	John Seib, sub-assistant..	Shore-line of James river, Virginia, from Warwick bar to Harrison's bar. Continuation of topography of Chesapeake from Back river to Newport News Point, and shores of Hampton Roads.
		11	Topography.......	S. A. Wainwright, sub-assistant.	Shore-line of James river, Virginia, from Richmond to Warwick bar. (See also Section V.)
		12	Hydrography	Lieut. Commanding J. J. Almy, U. S. Navy, assistant.	Outer coast of Maryland and Virginia completed to Cape Charles; of entrance to Chesapeake, including both capes, nearly completed, and of the bay near the entrance, continued.
		13	Hydrography	Lt. Comg. R. Wainwright, U. S. Navy, assistant.	James river, Virginia, from Richmond to Harrison's bar, completed; Rappahannock river, near Fredericksburg, commenced: tidal stations in James river. (See also Section II.)
		14	Tidal observations.	....	Tidal observations at Old Point Comfort, Va., continued; tides of verification at Annapolis, Md., and Petersburg, Va.
IV	Cape Henry to Cape Fear, coast of Virginia and North Carolina.	1	Astronomical observations.	Dr. B. A. Gould, jr......	Difference of longitude of Raleigh, N. C., and Washington; for longitude determinations between Washington and New Orleans; latitude observations. (See also Section V.)
		2	Secondary triangulation and topography.	J. J. S. Hassler, assistant.	Continuation of Currituck sound; Back bay north of the Virginia and North Carolina line.
		3	Secondary triangulation and topography.	C. P. Bolles, assistant; J. W. Gregorie, sub-assistant.	Cape Fear river, from near New Inlet to head of Eagles island, above Wilmington.
		4	Tertiary triangulation and topography.	A. S. Wadsworth, sub-assistant; Geo. H. Bagwell, aid.	Core Bank and sound, N. C., to former survey of Beaufort harbor, N. C.; reconnaissance south of Beaufort. (See also Section I.)
		5	Hydrography	Lt. Comg. J. N. Maffitt, U. S. Navy, assistant.	Cape Fear entrance and river, to head of Eagles island, above Wilmington, completed; tidal observations Cape Fear river and Smithville, N. C. (See also Section V.)
		6	Inspection of parties.	A. D. Bache, superintendent.	Cape Fear river, and at Raleigh, N. C.

APPENDIX No. 1—Continued.

No. of section of survey.	Limits included in the several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
IV & V	Gulf Stream......	......	Hydrography....	Lt. Comg. J. N. Maffitt, U. S. Navy, assistant; acting master J. P. Jones, U. S. Navy.	Exploration of Gulf Stream on sections across it from Cape Hatteras, Cape Fear, and Charleston harbor entrance. (See also Sections IV and V.)
V	Cape Fear to St. Mary's river, including the coast of South Carolina and Georgia.	1	Reconnaissance...	Bvt. Maj. Henry Prince, U. S. Army, assistant.	From the Cape Fear river, N. C., to the Santee river, S. C.; triangulation of Winyah bay and Georgetown harbor. (See also Section I.)
		2	Primary and secondary triangulation.	C. O. Boutelle, assistant; B. Huger, jr., sub-assistant.	Opening of lines and occupation of primary stations, New Cut, Matthews & Elliott's Cut, between Edisto base and Charleston; secondary triangulation of Stono river over James' island; triangulation of Winyah bay and Georgetown harbor, S. C., from the extrance to Georgetown. (See also Section I.)
		3	Astronomical observations.	Dr. B. A. Gould, jr.; Professor Lewis R. Gibbes.	Telegraphic difference of longitude of Charleston and Raleigh, for connexion with Washington and New Orleans. (See also Section IV.)
		4	Secondary triangulation.	Capt. E. O. C. Ord, U. S. Army, assistant; R. J. Breckenridge, aid.	From the base on Union Causeway to near Tybee entrance. (See also Section X.)
		5	Secondary triangulation.	Lt. Jos. S. Totten, U.S.A., asst.; C. B. Baker, aid.	Entrance and harbor of Georgetown, S. C., commenced.
		6	Topography......	S. A. Wainwright, sub-assistant.	Shore line of Winyah bay and Georgetown harbor. (See also Section III.)
		7	Hydrography.....	Lieut. Com'g J. N. Maffitt, U. S. Navy, assistant.	Additional examination of Charleston bar. Hydrography of Winyah bay and its approaches, and of Georgetown harbor. Tidal stations there, and at Charleston. (See also Section IV, and Sections IV and V, Gulf Stream.)
		8	Inspection of parties.	A. D. Bache, superintendent.	Near Charleston and at Georgetown harbor, S. C.; on Savannah river, Ga. General examination for commencement of triangulation between the Savannah and the St. Mary's.
V & VI	Gulf Stream......	......	Hydrography.....	Lieut. Com'g T. A. M. Craven, U. S. Navy, assistant.	Exploration of Gulf Stream in sections across from Charleston, S. C., and near Savannah entrance, Ga., St. Augustine and Cape Canaveral, Fla. (See also Section VI.)
VI	From St. Mary's river to St. Joseph's bay, coast of Florida.	1	Secondary triangulation.	Lieut. Jas. Totten, U. S. Army, assistant; C. T. Jardella, aid.	From Point Elizabeth, near Carysfort reef, to near Key Tavernier; also from Key West eastward, for marking the keys. Report on signals for reef, for Light-house Board.
		2	Secondary triangulation.	George A. Fairfield, sub-assistant.	Entrance of St. John's river, Fla., and Fort George inlet. (See also Section I, and office.)
		3	Topography......	J. Hull Adams, sub-assistant; C. M. Bache, aid.	Florida keys continued from Cæsar's creek, Soldier Key to Old Rhodes Key.

APPENDIX No. 1—Continued.

No. of section of survey.	Limits included in the several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
VI	From St. Mary's river to St. Joseph's bay—Continued.	4	Topography.......	R. M. Bache, sub-assistant.	Shore-line and togography of entrance to St. John's river, and Fort George inlet, Fla.; of Boca Chica, and marking for Land Office. (Part of season.)
		5	Hydrography......	Lieut. Com'g T. A. M. Craven, U. S. Navy, assistant.	Entrance to St. John's river, and Fort George inlet, Fla.; of Florida reef from Triumph reef to Turtle reef. (See also Sections V and VI, Gulf Stream.)
		6	Inspection of parties.	A. D. Bache, superintendent.	Inspection of progress of parties on St. John's river, and general examination of coast to St. Mary's.
VII	From St. Joseph's bay to Mobile bay, including part of the coast of Florida and Alabama.	1	Reconnaissance....	F. H. Gerdes, assistant; G. G. Oltmans, aid.	Special reconnaissance with astronomical positions; eastern and western entrances to St. George's sound, harbor of Apalachicola. General reconnaissance of St. Andrew's and St. Joseph's bays and of the coast westward.
		2	Tidal observations.	G. Würdeman......	Pensacola, Florida.
VIII	From Mobile bay to Vermilion bay, including the coast of Alabama, Mississippi, and part of Louisiana.	1	Reconnaissance....	F. H. Gerdes, assistant; G. G. Oltmans, aid.	General reconnaissance from Lake Borgne to Delta of Mississippi, and of the coast west of the Mississippi to Atchafalaya bay. Special reconnaissanee with astronomical positions of Barataria and Timballier bays, La.
		2	Triangulation and topography.	F. H. Gerdes, assistant; G. G. Oltmans, aid.	Measurement of preliminary base, triangulation and topography of Isle Dernière and vicinity of Ship shoal, La. (See also Section VII.)
		3	Secondary triangulation.	S. A. Gilbert, assistant.	West of Lake Borgne to New Orleans, and up Lake Pontchartrain to near Madisonville, signals erected. (See also Section I.)
		4	Topography.......	W. E. Greenwell, assistant; Wm. M. Johnson, sub-assistant.	Shores of Lake Borgne, La. Examination of Dauphine island. (See also Section X.)
		5	Hydrography	Lieutenant Commanding B. F. Sands, U. S. Navy, assistant.	Ship shoal, La.; Horn Island Pass; entrances to Pascagoula river; continuation of hydrography of Mississippi sound westward; examination of Naso roads, of Ship island, of passage between Dauphine and Little Pelican islands.
		6	Tidal observations..	G. Würdeman	Hourly observations of tides at Southwest Pass of the Mississippi river, and at Ship shoal, La.
IX	Vermilion bay to the boundary-part of Louisiana & Texas.	1	Reconnaissance ...	Jas. S. Williams, assistant	Extension of triangulation over Matagorda bay.
		2	Astronomical and magnetic observations.	George W. Dean, assistant; B. F. West, sub-assistant.	East base, near Galveston, and Jupiter station, near Velasco. (See also Section I.)
		3	Primary and secondary triangulation, and topography.	James S. Williams, assistant; S. C. McCorkle, sub-assistant; Geo. W. Parrish, aid.	Triangulation westward towards Matagorda bay, and over its eastern arm; topography of the Brazos river and of the Gulf shores to Cany creek.

APPENDIX No. 1—Continued.

No. of section of survey.	Limits included in the several sections.	No. of parties in section.	Operations.	Persons conducting the operations.	Localities of the several operations.
IX	Vermilion bay to the boundary-part of Louisiana and Texas—Continued.	4	Hydrography	Lieutenant Commanding H. S. Stellwagen, U. S. Navy, assistant.	Hydrography of San Luis Pass and bay, and of Galveston upper bay; examination for light-house at Aransas Pass. (Part of season. See also Section I.)
		4	Hydrography	Lieutenant John Wilkinson, U. S. Navy, assistant.	Hydrography of approaches, entrance, and part of Rio Grande; examination of entrance of Sabine river for site of light-house.
		5	Tidal observations..	G. Würdeman	Hourly tidal observations at the mouth of the Rio Grande, and at Matagorda entrance.
			Tidal observations..	F. Muhr	Hourly tidal observations at Galveston.
X & XI	Western coast of the United States — California, Oregon, and Washington.	1	Primary and secondary triangulation.	R. D. Cutts, assistant; John Rockwell, sub-assistant.	Measurement of preliminary base, and commencement of main triangulation of coast near San Francisco bay.
		2	Geographical determinations.	George Davidson, assistant; James S. Lawson, aid.	Latitude and longitude of Point Reyes, Bodega bay, Haven's anchorage, Mendocino city, Shelter cove, Humboldt, Trinidad bay, Point St. George; Port Orford, mouth of Umquah; astronomical observations at San Francisco.
		3	Secondary triangulation.	Geo Davidson, assistant; James S. Lawson, aid.	Measurement of preliminary base, and commencement of triangulation near San Pedro, for connexion of Santa Barbara islands, (part of season.) Triangulation of Humboldt harbor; near Mendocino city, of mouth of Umquah; near Crescent city, under Point St. George.
		4	Secondary triangulation.	Captain E. O. C. Ord, U. S. Army, assistant.	Continuation of triangulation just named. (See also Section V.)
		5	Topography.......	R. D. Cutts, assistant; A. F. Rodgers, sub-assistant.	Shores of San Francisco bay and northward; of Point Bonita for site of light-house.
		6	Topography.......	A. M. Harrison, sub-assistant; Wm. M. Johnson, sub-assistant.	Shores of part of San Francisco bay & of Contra Costa; of coast in vicinity of San Pedro and towards Pt. Año Nuevo; of Santa Barbara islands commenced. (See also Section VIII.)
		7	Topography.......	James S. Lawson	Point Reyes; of Humboldt harbor; of mouth of Umquah, Crescent city; Mendocino city.
		8	Hydrography	Lieut. Commanding Jas. Alden, U. S. Navy, assistant.	Revised reconnaissance from San Francisco bay to Columbia river entrance; resurvey of Humboldt entrance; examination of Mendocino city, Trinidad bay; Crescent city, under Point St. George; mouth of Umquah; resurvey of Columbia river entrance.
			Hydrography	Lieut. Thos. H. Stevens, U. S. Navy, assistant.	Examination of bank near San Clemente island. Hydrography of Santa Barbara islands commenced.
		9	Tidal observations.	Lieut. W. P. Trowbridge, U. S. Engineers, assistant.	Establishment of tidal stations at San Diego, Monterey, San Francisco, Columbia river, &c.

APPENDIX No. 2.

List of army officers on Coast Survey duty March 1, 1853.

Name.	Rank.	Date of attachment.
Thomas J. Cram	Captain topographical engineers	December 7, 1846
Henry Prince	Captain and brevet major 4th infantry	December 10, 1850
Edward O. C. Ord	Captain 3d artillery	December 30, 1852
Isaac I. Stevens	First lieutenant and brevet major engineers	September 14, 1849
William R Palmer	First lieutenant topographical engineers	March 2, 1852
Augustus A. Gibson	First lieutenant 2d artillery	January 17, 1851
James Totten	do do	December 10, 1850
Edward B. Hunt	Second lieutenant engineers	May 5, 1851
John G. Foster	Second lieutenant and brevet captain engineers	March 20, 1852
Joseph S. Totten	First lieutenant 2d artillery	December 2, 1852
Daniel T. Van Buren	do do	December 2, 1852
Augustus H. Seward	Second lieutenant 5th infantry	December 8, 1851
William P. Trowbridge	Second lieutenant engineers	April 18, 1851
Andrew W. Evans	Brevet second lieutenant 7th infantry	November 10, 1852

APPENDIX No. 2 *bis*.

List of army officers on Coast Survey duty September 1, 1853.

Name.	Rank.	Date of attachment.
Thomas J. Cram	Captain topographical engineers	December 7, 1846
Henry Prince	Captain and brevet major 4th infantry	December 10, 1850
Henry W. Benham	Captain engineers	April 1, 1853
Edward O. C. Ord	Captain 3d artillery	December 30, 1852
William R. Palmer	Captain topographical engineers	March 2, 1852
Augustus A. Gibson	Captain 2d artillery	January 17, 1851
James Totten	First lieutenant 2d artillery	December 10, 1850
Edward B. Hunt	Second lieutenant engineers	May 5, 1851
John G. Foster	Second lieutenant and brevet captain engineers	March 20, 1852
Daniel T. Van Buren	First lieutenant 2d artillery	December 2, 1852
Augustus H. Seward	Second lieutenant 5th infantry	December 8, 1851
William P. Trowbridge	Second lieutenant engineers	April 18, 1851
Andrew W. Evans	Brevet second lieutenant 7th infantry	November 10, 1852

APPENDIX No. 3.

List of navy officers on Coast Survey duty March 1, 1853.

Vessel.	Locality of service.	Name.	Rank.	Date of attachment.
Schooner John Y. Mason.	Section III	R. Wainwright	Lieutenant commanding	January 31, 1848
		S. D. Trenchard	Lieutenant	March 1, 1853
		Edward Brinley, jr	Acting master	March 8, 1852
		John B. Stewart	Passed midshipman	November 15, 1852
Schooners Crawford and Bouncer.	Section IV	J. N. Maffitt	Lieutenant commanding	May 9, 1843
		A. C. Rhind	Acting master	June 20, 1845
		J. P. Jones	do	June 28, 1852
		J. C. P. De Krafft	Passed midshipman	December 22, 1852
		J. D. Langhorne	do do	May 20, 1850
		J. R. Hamilton	do do	August 31, 1852
Steamer Corwin and tender Angle.	Section VI	T. A. M. Craven	Lieutenant commanding	November 27, 1850
		B. N. Westcott	Lieutenant	April 3, 1852
		J. S. Dungan	Assistant surgeon	May 12, 1852
		John C. Febiger	Master	December 3, 1851
		Julian Myers	Acting master	November 11, 1849
		Thomas C. Eaton	Passed midshipman	July 23, 1852

APPENDIX No. 3—Continued.

Vessel.	Locality of service.	Name.	Rank.	Date of attachment.
Steamer Walker	Section VIII	B. F. Sands	Lieutenant commanding	May 14, 1850
		W. S. Bishop	Passed assistant surgeon	May 1, 1851
		J. B. McCauley	Acting master	October 16, 1850
		J. M. Bradford	Passed midshipman	November 17, 1852
		S. S. Bassett	....do......do	March 17, 1849
		R. C. Duvall	....do......do	November 17, 1852
Schooners Morris and Belle.	Section IX	H. S. Stellwagen	Lieutenant commanding	October 22, 1852
		John Wilkinson	Lieutenant	November 12, 1852
		M. P. Jones	Acting master, (Morris)	August 17, 1850
		L. H. Lyne	....do....do...(Belle)	Sept. 26, 1850
		Hunter Davidson	Passed midshipman	January 17, 1852
		George S. King	....do......do	November 12, 1852
Steamer Active and schooner Ewing.	Sections X and XI.	James Alden	Lieutenant commanding	May 18, 1849
		Thomas H. Stevens	Lieutenant	February 21, 1851
		J. C. Wait	....do	May 6, 1852
		J. S. Kennard	....do	May 6, 1852
		R. M. Cuyler	Acting lieutenant	May 6, 1852
		James Suddards	Assistant surgeon	April 3, 1852
	Office	John J. Almy	Lieutenant commanding	March 12, 1852
	Office	M. C. Perry, jr	Lieutenant	January 15, 1853
	Office	R. L. Law	Passed midshipman	May 1, 1851
	Office	Maxwell Woodhull	Lieutenant commanding	March 30, 1848
	Office	John Rutledge	Lieutenant	May 3, 1852
	Office	A. W. Habersham	Passed midshipman	December 4, 1852
	Office	A. N. Smith	Master	August 4, 1852
	Office	A. G. Pendleton	Professor of mathematics	May 8, 1848
	Office	George W. Doty	Lieutenant	May 1, 1851
	Office	T. B. Huger	....do	May 14, 1852

APPENDIX No. 3 *bis*.

List of navy officers on Coast Survey duty September 1, 1853.

Vessel.	Locality of service.	Name.	Rank.	Date of attachment.
Schooners Madison & Gallatin.	Section I	Maxwell Woodhull	Lieutenant commanding	May 30, 1848
		John Rutledge	Lieutenant	May 3, 1852
		John Rudenstein	Passed assistant surgeon	June 27, 1853
		Samuel R. Franklin	Acting master	April 2, 1853
		Joseph B. Smith	....do......do	August 4, 1852
		John D. Langhorne	Passed midshipman	May 20, 1850
		Hunter Davidson	....do......do	January 17, 1852
		S. L. Breese	....do......do	August 18, 1853
Steamers Bibb and Corwin.	Section I	H. S. Stellwagen	Lieutenant commanding	October 22, 1852
		T. B. Huger	Lieutenant	May 14, 1852
		Madison Rush	....do	April 5, 1853
		Foxhall A. Parker	....do	March 31, 1853
		A. N. Smith	....do	August 4, 1852
		Jacob S. Dungan	Assistant surgeon	May 12, 1852
		W. E. Wysham	....do......do	July 23, 1853
		Charles W. Aby	Acting master	May 19, 1853
		Edward C. Stout	....do......do	June 1, 1853
		Edward Renshaw	Passed midshipman	June 3, 1853
		S. S. Bassett	....do......do	March 17, 1849
		W. K. Mayo	....do......do	July 9, 1853
		C. E. Thorburn	....do......do	July 20, 1853
Schooner John Y. Mason.	Section II	Richard Wainwright	Lieutenant commanding	January 31, 1848
		S. D. Trenchard	Lieutenant	March 1, 1853
		John B. Stewart	Acting master	November 15, 1852
		Gustavus Harrison	Passed midshipman	July 29, 1853
Steamer Hetzel and schooner Graham.	Section III	John J. Almy	Lieutenant commanding	March 12, 1851
		M. C. Perry, jr	Lieutenant	January 15, 1853
		Van R. Morgan	do	May 20, 1853

APPENDIX No. 3 *bis*—Continued.

Vessel.	Locality of service.	Name.	Rank.	Date of attachment.
Steamer Hetzel and schooner Graham.	Section III	D. B. Phillips	Passed assistant surgeon	April 9, 1853
		W. W. Low	Acting master, (Graham)	April 8, 1853
		R. L. Law	....do....do...(Hetzel)	May 1, 1851
		John T. Walker	Passed midshipman	April 7, 1853
		W. R. Mercer	....do......do	...do..........do.
		Dawson Phenix	....do......do	...do..........do.
Schooners Crawford and Bouncer.	Section IV	John N. Maffitt	Lieutenant commanding	May 9, 1843
		A. C. Rhind	Master	June 20, 1845
		J. P. Jones	Acting master	June 28, 1852
		W. D. Whiting	Passed midshipman	July 30, 1853
		J. C. P. DeKrafft	....do......do	December 22, 1852
		J. R. Hamilton	....do......do	August 31, 1852
Schooners Morris and Belle.	Section IX	John Wilkinson	Lieutenant	November 12, 1852
		D. L. Bryan	Passed assistant surgeon	December 11, 1852
		M. P. Jones	Acting master	August 17, 1852
		L. H. Lyne	....do......do	Sept'ber 26, 1852
		George S. King	Passed midshipman	November 12, 1852
Steamer Active and schooner Ewing.	Sections X and XI.	James Alden	Lieutenant commanding	May 18, 1849
		Thomas H. Stevens	Lieutenant	February 21, 1851
		J. C. Wait	....do	May 6, 1852
		J. S. Kennard	....do	..do..........do.
		R. M. Cuyler	Acting lieutenant	June 20, 1845
		James Suddards	Assistant surgeon	April 3, 1852
		Alex. M. De Bree	Acting master	April 2, 1853
	Office	B. F. Sands	Lieutenant commanding	May 14, 1850
	Office	J. B. McCauley	Passed midshipman	October 16, 1850
	Office	R. C. Duvall	....do......do	November 17, 1852
	Office	T. A. M. Craven	Lieutenant commanding	November 27, 1850
	Office	B. N. Westcott	Lieutenant	April 3, 1852
	Office	J. C. Febiger	....do	December 3, 1851
	Office	Julian Myers	Passed midshipman	November 11, 1849
	Office	Thomas C. Eaton	....do......do	July 23, 1852
	Office	A. G. Pendleton	Professor of mathematics	May 8, 1848

APPENDIX No. 4.

List of assistant engineers United States Navy on Coast Survey duty March 1, 1853.

Vessel.	Name.	Rank.	Date of attachment.
Steamer Corwin	F. C. Dade	Second assistant engineer	May 14, 1852
	Hiram Haines	Third assistant engineer	...do........do.
	J. C. Hull	.....do.......do	...do........do.
Steamer Walker	A. C. Stimers	Second assistant engineer	November 18, 1852
	W. H. Nones	.....do.......do	August 3, 1852
	C. Lindsley	Third assistant engineer	November 18, 1852
	George E. Shock	.....do.......do	...do........do.
Steamer Active	N. C. Davis	First assistant engineer	February 22, 1853
	E. A. Whipple	.....do.......do	April 10, 1852
	W. A. R. Latimer	Second assistant engineer	...do........do.
	H. C. Jewell	Third assistant engineer	June 17, 1852
Steamer Hetzel	James M. Adams	Second assistant engineer	June 7, 1850

APPENDIX No. 4 *bis*.

List of assistant engineers United States Navy on Coast Survey duty September 1, 1853.

Vessel.	Name.	Rank.	Date of attachment.
Steamer Corwin	F. C. Dade	First assistant engineer	May 14, 1852
	S. H. Houston	Second assistant engineer	May 11, 1853
	J. C. Hull	Third assistant engineer	May 14, 1852
Steamer Bibb	E. S. De Luce	First assistant engineer	June 4, 1853
	A. Broadnix	Second assistant engineer	...do ...... do.
	H. S. Barker	Third assistant engineer	June 7, 1853
Steamer Hetzel	E. W. Manning	......do......do	May 27, 1853
Steamer Active	N. C. Davis	First assistant engineer	February 22, 1853
	E. A. Whipple	......do......do	April 10, 1852
	H. C. Jewell	Third assistant engineer	June 17, 1852
Steamer Walker	W. H. Nones	Second assistant engineer	November 18, 1852
Steamer Legaré	C. W. Geddes	First assistant engineer	May 19, 1853
Waiting orders	G. E. Shock	Third assistant engineer	November 18, 1852

APPENDIX No. 5.

List of Coast Survey maps, sketches, and preliminary charts, engraved and engraving.

1. LIST OF MAPS ENGRAVED.

No. 1.	Richmond island	$\frac{1}{20000}$
2.	Wellfleet harbor	$\frac{1}{50000}$
3.	Nantucket harbor	$\frac{1}{20000}$
4.	Hyannis harbor	$\frac{1}{30000}$
5.	Harbor of Edgartown	$\frac{1}{20000}$
6.	Harbor of Holmes' Hole and Tarpaulin cove	$\frac{1}{20000}$
7.	Harbor of New Bedford	$\frac{1}{40000}$
8.	General chart of the coast from Gay Head to Cape Henlopen	$\frac{1}{400000}$
9.	Fisher's Island sound	$\frac{1}{40000}$
10.	Harbor of New London	$\frac{1}{20000}$
11.	Mouth of Connecticut river	$\frac{1}{20000}$
12.	Harbor of New Haven, (new edition, 1852)	$\frac{1}{30000}$
13.	Harbors of Black Rock and Bridgport	$\frac{1}{20000}$
14.	Harbors of Sheffield and Cawkin's islands	$\frac{1}{20000}$
15.	Huntington bay	$\frac{1}{30000}$
16	Harbor of Oyster or Syosset bay	$\frac{1}{30000}$
17.	Harbors of Captain's islands, east and west	$\frac{1}{20000}$
18.	Hart and City island and Sachem's Head harbor	$\frac{1}{20000}$, $\frac{1}{10000}$
19.	Hell Gate	$\frac{1}{5000}$
20.	New York bay and harbor and the environs—sheet No. 1	$\frac{1}{30000}$
21.	Do......do......do......do....2	$\frac{1}{30000}$
22.	Do......do......do......do....3	$\frac{1}{30000}$
22.	Do......do......do......do....4	$\frac{1}{30000}$
23.	Do......do......do......do....5	$\frac{1}{30000}$
25.	Do......do......do......do....6	$\frac{1}{30000}$
26.	Do......do......do	$\frac{1}{80000}$
27.	Western part of south coast of Long Island	$\frac{1}{80000}$
28.	Little Egg Harbor	$\frac{1}{30000}$
29.	Delaware bay and river—sheet No. 1	$\frac{1}{80000}$
30.	Do......do......do....2	$\frac{1}{80000}$
31.	Do......do......do....3	$\frac{1}{80000}$
32.	Seacoast of Delaware, Maryland, and part of Virginia	$\frac{1}{200000}$
33.	Harbor of Annapolis and Severn river	$\frac{1}{60000}$
34.	Mouth of Chester river	$\frac{1}{40000}$
35.	Pasquotank river	$\frac{1}{60000}$
36.	Mobile bay entrance	$\frac{1}{40000}$
37.	Cat and Ship Islands harbors	$\frac{1}{40000}$
38.	Galveston bay entrance	$\frac{1}{40000}$

2. LIST OF SKETCHES AND PRELIMINARY CHARTS ENGRAVED.

No. 1.	Current chart, Boston harbor	$\frac{1}{100000}$
2.	Minot's Ledge	$\frac{1}{10000}$
	Davis' South shoal—sixth edition	$\frac{1}{200000}$

No. 4.	Sow and Pigs reef	$\frac{1}{240}$, $\frac{1}{200000}$
5.	Buttermilk channel	$\frac{1}{5000}$
6.	Beacon ranges, New York harbor	$\frac{1}{40000}$
7.	Romer and Flynn shoals	$\frac{1}{40000}$
8.	Changes in Sandy Hook	$\frac{1}{10000}$, $\frac{1}{40000}$
9.	Chincoteague inlet	$\frac{1}{40000}$
10.	Seacoast of part of Virginia	$\frac{1}{200000}$
11.	Metomkin and Wachapreague inlets and Hog Island harbor	$\frac{1}{40000}$
12.	Entrance of Chesapeake bay	$\frac{1}{100000}$
13.	Cape Charles and vicinity	$\frac{1}{80000}$
14.	Cherrystone inlet	$\frac{1}{40000}$
15.	Pungoteague creek	$\frac{1}{40000}$
16.	Fishing or Donoho's Battery	$\frac{1}{100000}$
17.	Hatteras shoals	$\frac{1}{20000}$
18.	Cape Hatteras	$\frac{1}{20000}$
19.	Hatteras inlet—fourth edition	$\frac{1}{20000}$
20.	Ocracoke inlet	$\frac{1}{40000}$
21.	Beaufort harbor	$\frac{1}{20000}$
22.	New river and bar	$\frac{1}{15000}$
23.	Frying Pan shoals	$\frac{1}{120000}$
24.	Entrance to Cape Fear river and New inlet	$\frac{1}{40000}$
25.	Cape Roman shoals	$\frac{1}{100000}$
26.	Bull's bay	$\frac{1}{40000}$
27.	North Edisto river—second edition	$\frac{1}{50000}$
28.	Entrance to Savannah river	$\frac{1}{30000}$
29.	Savannah city, Front and Back rivers	$\frac{1}{20000}$
30.	St. Andrew's shoals	$\frac{1}{60000}$
31.	St. John's river entrance	$\frac{1}{25000}$
32.	Mosquito inlet	$\frac{1}{40000}$
33.	Cape Cañaveral	$\frac{1}{60000}$
34.	Key West—second edition	$\frac{1}{100000}$
35.	Rebecca shoals	$\frac{1}{600000}$
36.	Western coast of Florida	$\frac{1}{1200000}$
37.	Reconnaissance, vicinity of Cedar Keys	$\frac{1}{300000}$
38.	Channel No. 4, Cedar Keys	$\frac{1}{30000}$
39.	St. Mark's bar and channel	$\frac{1}{40000}$
40.	Eastern and Western entrances St. George's sound	$\frac{1}{80000}$
41.	Entrance to Mobile bay	$\frac{1}{10000}$
42.	Mobile bay—second edition	$\frac{1}{200000}$
43.	Horn Island Pass and Grand bay	$\frac{1}{300000}$
44.	Horn Island Pass	$\frac{1}{40000}$
45.	Pascagoula river	$\frac{1}{20000}$
46–55.	Cat Island tidal diagrams	
56.	Pass Christian	$\frac{1}{40000}$
57.	Delta of the Mississippi	$\frac{1}{60000}$
58.	Barataria bay entrance	$\frac{1}{30000}$
59.	Timballier bay entrance	$\frac{1}{20000}$
60.	Isle Dernière	$\frac{1}{80000}$
61.	Entrance to Sabine river	$\frac{1}{30000}$
62.	Entrance to Galveston bay	$\frac{1}{40000}$
63.	Galveston bay—second edition	$\frac{1}{200000}$
64.	San Luis Pass	$\frac{1}{20000}$
65.	Aransas Pass	$\frac{1}{30000}$
66.	Alden's reconnaissance of western coast from San Francisco to San Diego	$\frac{1}{1200000}$
67.	Cortez Bank	$\frac{1}{10000}$, $\frac{1}{1200000}$
68.	San Diego entrance—second edition	$\frac{1}{150000}$, $\frac{1}{25000}$
69.	Catalina harbor	$\frac{1}{15000}$
70.	Prisoner's harbor, Cuyler's harbor, and northwest anchorage San Clemente island	$\frac{1}{20000}$
71.	Santa Barbara	$\frac{1}{20000}$
72.	San Simeon, Santa Cruz, San Luis Obispo, and Coxo	$\frac{1}{20000}$, $\frac{1}{40000}$
73.	Point Concepcion	$\frac{1}{40000}$
74.	Point Pinos	$\frac{1}{20000}$
75.	Monterey harbor	$\frac{1}{40000}$
76.	San Pedro	$\frac{1}{20000}$
77.	San Francisco bay entrance	$\frac{1}{400000}$
78.	San Francisco city—third edition	$\frac{1}{10000}$
79.	Mare Island straits	$\frac{1}{30000}$
80.	McArthur's reconnaissance of western coast from Monterey to mouth of Columbia river—sheet No. 1, third edition.	
81.	McArthur's reconnaissance of western coast from Monterey to mouth of Columbia river—sheet No. 2, third edition.	
82.	McArthur's reconnaissance of western coast from Monterey to mouth of Columbia river—sheet No. 3, third edition.	
83.	Humboldt bay	$\frac{1}{30000}$
84.	Trinidad bay	$\frac{1}{20000}$
85.	Mouth of Columbia river—second edition	$\frac{1}{40000}$

No. 86.	Mouth of Columbia river	$\frac{1}{200000}$
87.	Cape Hancock, or Disappointment	$\frac{1}{20000}$
88.	Shoalwater bay	$\frac{1}{80000}$
89.	Alden's reconnaissance of western coast from Gray's harbor to Admiralty inlet	$\frac{1}{600000}$
90.	Cape Flattery and Nee-ah harbor	$\frac{1}{40000}$
91.	Harbor of False Dungeness	$\frac{1}{30000}$

3. LIST OF MAPS ENGRAVING.

No. 1	Portsmouth harbor	$\frac{1}{20000}$
2.	Newburyport harbor	$\frac{1}{20000}$
3.	Salem harbor	$\frac{1}{25000}$
4.	Boston harbor	$\frac{1}{40000}$
5.	Eastern series (from Block island eastward)	$\frac{1}{80000}$
6.	Long Island sound—sheet No. 1	$\frac{1}{80000}$
7.	Do . . . do . . No. 2	$\frac{1}{80000}$
8.	Do . . . do . . No. 3	$\frac{1}{80000}$
9.	South side Long Island—sheet No. 2	$\frac{1}{80000}$
10.	Do . . . do . . No. 3	$\frac{1}{80000}$
11.	Chesapeake bay . . . do . . No. 1	$\frac{1}{80000}$
12.	Patapsco river	$\frac{1}{60000}$
13.	Albemarle sound	$\frac{1}{200000}$
14.	Do . . . sheet No. 1	$\frac{1}{80000}$
15.	Do . . . do . . No. 2	$\frac{1}{80000}$
16.	Charleston harbor	$\frac{1}{30000}$
17.	Key West	$\frac{1}{50000}$
18.	Mobile bay—sheet No. 1	$\frac{1}{80000}$
19.	Do . . . do . . No. 2	$\frac{1}{80000}$

APPENDIX No. 6.

List of information furnished by Coast Survey under authority of Treasury Department.

Date.		To whom communicated.	Information communicated.
1852.			
November	3	Engineer bureau	Tracing of Brewster island.
	6	Captain Geo. Dutton, corps of engineers	Tracing of Bridgeport harbor.
	18	Wm. M. Eddy, surveyor general, California	Tracing San Francisco bay.
		Do . . . do . . . do	Tracing entrance to San Francisco bay.
		Do . . . do . . . do	Tracing Contra Costa.
		Do . . . do . . . do	Tracing from Point Lobos, southward.
		Do . . . do . . . do	Tracing Santa Barbara.
		Do . . . do . . . do	Tracing San Diego bay.
		Do . . . do . . . do	Tracing San Francisco city.
		Do . . . do . . . do	Tracing Alden's reconnaissance western coast.
		Do . . . do . . . do	Tracing Yerba Buena island, San Francisco bay.
		Do . . . do . . . do	Tracing Angel island and Racoon straits, San Francisco bay.
December	2	General Jos. G. Totten, Chief Engineer	Tracing Milneberg harbor, Louisiana.
	6	Major Z. B. Tower, corps of engineers	Tracing Marblehead harbor, Massachusetts.
	11	Captain G. B. McClellan, corps of engineers	Tracing Matagorda bay, Texas.
		Board of Commission	Tracing Harrison's bar, James river, Va.
		Do	James river, from Warwick to Richmond.
		Commission for the improvement of Savannah river.	Savannah river, Georgia—current chart.
	10	H. F. Walling, esq , civil engineer, Millville, Mass.	Tracing of Salem and Beverly harbors, from Salem city to Manchester village.
	10	Professor Jos. Henry, Smithsonian Institute	Tracing of Kent island, Chesapeake bay.
	21	Captain H. Brewerton, corps of engineers	Tracing of Susquehanna river to Port Deposit, Md.
	29	Do . . . do	Tracing of Chesapeake bay, from Havre de Grace to Patapsco river, Md.
	29	Commission on Improvements	Cape Fear river, N. C.
1853.			
January	3	Seth H. Ingalls, esq	Tracing of Minot's Ledge and vicinity, Massachusetts.
	4	Lieut. J. F. Gilmer, corps of engineers	Tracing of shore-line of Savannah river, Georgia.
	5	Lieut. J. D. Kurtz, corps of engineers	Tracing of Mississippi sound, Pascagoula bay, Miss.

APPENDIX No. 6—Continued.

Date.		To whom communicated.	Information communicated.
1853.			
January	5	Captain T. J. Lee, topographical engineers	Tracing of Minot's Ledge, Massachusetts.
	10	Dr. B. A. Gould, jr., editor of Astronomical Journal.	Latitude of Key West, Cedar Keys, and St. Marks, Florida, with the chronometric determinations of longitude of same places.
	13	G. W. Blunt, esq., New York	Copy of reduction of sheet of Albermale sound, N. C.
	15	Dr. Thos. H. Buckler, Baltimore, Md	Tracings of Patuxent river, Magothy river, and Middle and Back rivers, Chesapeake bay.
	15	Duff Green, esq., Washington, D. C.	A tracing of the interior of a part of Long Island.
		Lieut. W. H. C. Whiting, corps of engineers	A tracing of Galveston bay, Texas.
	26	Capt. H. Brewerton, corps of engineers	Tracing entrance to Patapsco river, Chesapeake bay, Maryland
	26	Lieut. J. F. Gilmer, corps of engineers	Map of Savannah river, Georgia.
February	12	Capt. H. Brewerton, corps of engineers	A tracing of the re-survey of the Patapsco river, Chesapeake bay.
	21	Duff Green, esq., Washington, D. C	A tracing of the topography of the interior of Long Island.
March	2	Hon. R. K. Call, Ex-governor of Florida	Copy of report of Assistant F. H. Gerdes, on the reconnaissance of the bar, river, and habor of St. Marks, Florida.
	7	Authorities of San Francisco, California	A tracing of a portion of the hydrographic survey of the harbor of San Francisco.
	7	Lieut. W. H. C. Whiting, corps of engineers	Tracing of Trinity river, Texas.
	7	G. W. Blunt, esq., New York	Tracing of Chesapeake bay, $\frac{1}{80000}$.
	7	Duff Green, esq., Washington, D. C.	Tracing interior of Long island—additional topography.
	7	Light-house Board	Tracing Gerdes' reconnaissance of Barrataria bay.
	7	Gov. I. I. Stevens, Washington Territory	Map of Washington Territory, compiled from best authorities.
April	1	Captain Shortland, Royal Navy	Difference of longitude between Cambridge, Mass., and Halifax, N. S.
	12	Captain T. J. Lee, topographical engineers	Tracing of Cape Canaveral shoals, Florida.
	19	H. F. Walling, esq., Millville, Mass.	The relative longitudes of City Hall, New York, State House, Boston, and Greenwich, and a proof of Narragansett bay.
	20	Tipton Walker, esq., Galveston, Texas	Tracing Galveston city, harbor, bay, and gulf coast.
	20	Lieut. D. N. Couch, U. S. Army	Tracing of Matagorda bay, Texas.
	20	Hon. Jos. S. Cottman, Maryland	Tracing of Wicomico, Annemessic, Pocomoke, and Manokin rivers, Chesapeake bay.
	20	Capt. H. Brewerton, corps of engineers	Tracing of Patapsco river, Chesapeake bay.
	20	J. G. Floyd, esq	Tracing of Forge river and Moriche's bay, Long Island, New York.
	20	G. W. Blunt, esq., New York	Tracing of Albemarle sound and portion of Chesapeake bay.
	20	Board of Improvements	Tracing of Beaufort harbor, North Carolina.
	20	Lieutenant M. Harrison, corps of engineers	Tracing of Shrewsbury river, New Jersey.
	20	Topographical bureau	Tracing of Cape Canaveral, Florida.
	20	Alexander Hamilton, jr., esq., New York	Tracing Riker's island, Long Island sound.
	20	J. Egerton, esq., New Orleans, Louisiana	Tracing North coast, Gulf of Mexico.
	20	Dr. Jesse J. Simpkins, Eastville, Northampton county, Virginia.	Tracing of Cape Charles and vicinity.
	22	Captain H. W. Bayfield, Royal Navy	Telegraphic difference of longitude between Cambridge, Massachusetts; Bangor, Maine; and Halifax, Nova Scotia.
May	17	Pacific Mail Steamship Company	Portions of the sheet of sounding of San Francisco bay and harbor.
	18	Hon. R. S. Floyd	Soundings of East Pass of Apalachicola.
	24	Smithsonian Institute	Meteorological observations in course of work.
August	1	Lieut. G. G. Meade, U. S. topographical engineers.	Reconnaissance of Cedar Keys.
		Do.............do.............do	Elevations and plans of beacons.
	1	Lieut. H. G. Wright, corps of engineers	Entrance to St. John's river and Fort George inlet, Florida.
	1	J. J. Shipman, esq., Farmingdale, Long Island, N. Y.	Huntington and Oyster bay, Long Island sound.
	1	G. R. Cinnamond, esq., Baltimore, Maryland	Curtis creek, Patapsco river, Maryland.
	1	W. B. Thompson, esq., Newbern, North Carolina.	Tracing portion of Beaufort harbor, North Carolina.
	1	J. R. Trimble, esq., Baltimore, Maryland	Tracing of Susquehanna river, Maryland.
	1	H. F. Walling, esq., Millville, Massachusetts	Tracing of Narragansett bay, Rhode Island.
		Do..........do...........do	Tracing Rhode Island from Point Judith to Beavertail light.

APPENDIX No. 6—Continued.

Date.		To whom communicated.	Information communicated.
1853.			
August	1	H. F. Walling, esq., Millville, Massachusetts......	Tracing Beaver-tail light to Saughkonnet Point.
		Do...........do...........do...........	Tracing Saughkonnet river.
	1	F. W. Risque, esq., Washington, D. C	Tracing Point Look-out, Chesapeake bay.
	1	W. C. King, esq., Beaufort, North Carolina......	Tracing of Beaufort harbor, N. C., and vicinity.
	8	A. Welch, esq., Lambertville, New Jersey........	Tracing of vicinity of Back creek, Elk river.
September	15	Lieut. M. Harrison, corps of engineers...........	Tracing of Barnegat bay, coast of New Jersey.
	17	Light-house Board	Tracing Point Bonita, San Francisco bay.
	21	Chamber of Commerce, New York city...........	Comparative map of Sandy Hook.
October	4	Hon. R. J. Walker, Washington, D. C...........	Tracing West bay of Galveston island and Chocolate bay.
	4	Do............do..........................	Tracing from San Luis to Jupiter island west of Brazos river.
	5	A. Randall, esq., San Francisco, California.......	Tracing of Point Reyes, California.

APPENDIX No. 7.

List of geographical positions determined by the United States Coast Survey since July, 1850.

The present list is a continuation of that published in the annual report for 1851, and contains the geographical positions of points determined astronomically and trigonometrically since the date of the former, with the repetition of some points previously published for convenience of reference. The following explanations will give all the information requisite for the use of the tables.

For the purposes of the survey, the coast is divided into eleven sections, in all of which the work is carried on simultaneously. The survey being in different stages of progress in the several sections, and new results being added from year to year to those here given, the same divisions have been adopted in this publication.

The several sections are defined as follows:

Section I. From Passamaquoddy bay to Point Judith.
Section II. From Point Judith to Cape Henlopen.
Section III. From Cape Henlopen to Cape Henry.
Section IV. From Cape Henry to Cape Fear.
Section V. From Cape Fear to St. Mary's river.
Section VI. From St. Mary's river to St. Joseph's bay.
Section VII. From St. Joseph's bay to Mobile bay.
Section VIII. From Mobile bay to Vermilion bay.
Section IX. From Vermilion bay to the Rio Grande.
Section X. Coast of California, San Diego bay, to 42d parallel.
Section XI. Coast of Oregon, 42d to 49th parallel.

The tables give the latitudes and longitudes of the trigonometrical points in each section, and their relative azimuths, or bearings and distances.

The manner in which these data have been obtained may be briefly explained here.

In each section a base line of from five to ten miles is measured with all possible accuracy. A series of triangles, deriving the length of their sides from this base, is then established along the coast by the measurement of the angles between the intervisible stations. In this primary series the triangles are made as large as the nature of the country will permit, because the liability to error increases with the number of triangles.

On the bases furnished by the sides of the primary triangles a secondary triangulation is next established, extending along the coast, and over the smaller bays and sounds, and determining a large number of points at distances a few miles apart.

The distances between the points thus determined, as given in the tables, are liable to an average error of about one foot in six miles, until a final adjustment between the base lines shall have been made.

In some parts of the survey the base lines for the primary triangulation have not yet been measured, or the connexion between the secondary and primary triangulation has not yet been made, in which cases the distances depend on preliminary base lines, measured with great care, and they are liable to an average error of one foot in three miles. This applies to the positions on Savannah river in Section V, and to those in Sections VI, IX, X, and XI.

As, on the completion of the primary triangulation in each section, the several series form one connected chain, the different bases afford verification of each other, and of the triangulation connecting them. The first three sections are thus connected.

Observations for latitude and azimuth are made at a number of stations of the primary triangulation in each section. The differences of latitude, longitude, and azimuth between these and other stations are then computed, under the supposition that the earth is a spheroid of revolution of the following dimensions, which are those determined by Bessel from all the measurements made to the present time, viz:

Equatorial radius = 6377397. 16 metres.
Polar radius = 6356078. 96 metres.
Eccentricity = 0. 08169683

It has been found that the differences of latitude and longitude, as computed in this manner from the distance and azimuth between two stations, and which are called geodetic, differ from those obtained by astronomical observations at the several stations, by quantities which are greater than the errors of the observations. Such disagreements are due to local irregularities in the figure and density of the earth; and the error resulting from them in the determinations of latitude and of the meridian plane is designated as station error. It amounts, according to the results obtained at present, to between one and two seconds of arc in the eastern section of the survey, and to about half a second in the sections south of the Delaware.

In order to eliminate the influence of station errors on the general results, observations are made at a number of stations, the results are referred to a central station by means of the geodetic differences, and the mean of all is used for the computation of the positions given in the tables. The geographical positions must therefore be considered as liable to future changes, from the accumulation of new observations, and the final discussion of all the results obtained.

The *differences of longitude* are obtained, as has been stated, by computation from the distances, latitudes, and azimuths of the triangulation. In adding up these differences from station to station, an accumulation of the unavoidable errors is probable. They are checked, however, by differences of longitude, determined by means of the electro-magnet telegraph, in every section where the introduction of the latter makes it practicable.

SEATON STATION, in Washington city, has been selected as the centre for the telegraphic differences of longitude. The sections at present connected by telegraph are Sections I, II, III, and V. The first three being also connected by triangulation, the check on the geodetic differences of longitude is here obtained, and the agreement is very close.

The longitudes from Greenwich in these sections depend upon that of Cambridge Observartory, as determined by chronometric differences between Liverpool and Cambridge, and by occultations, eclipses, and moon culminations, observed at various observatories in the United States, and referred to Cambridge by means of telegraphic differences.

The following statement shows the result up to the present time:

Longitude of Cambridge from Greenwich.

	h. m. s.
By moon culminations observed at Cambridge, Hudson, Ohio, Wilkes' Observatory, and National Observatory.	4 44 28.4
By eclipses and occultations at Cambridge, Brooklyn, Philadelphia, and Wilkes' Observatory	4 44 29.6
By chronometric differences	4 44 30.1

The longitude adopted for the present is 4h. 44m. 29.5s., or 71° 07′ 22.50″.

In Sections IV, VI, VIII, and IX, the longitudes are counted from some central station in each, for which we have at present the following data, subject to future corrections:

	° ′ ″
Sec. IV. Stevenson's Point, west of Greenwich	76 10 43.5
Sec. VI. Cape Florida, west of Greenwich	80 09 24
Do....Sand key, west of Greenwich	81 52 43
Sec's. VIII and IX. Fort Morgan, Mobile Point, west of Greenwich	88 00 25

The longitudes in Sections X and XI are reckoned from Greenwich. They depend on moon culminations observed at Point Conception, San Diego, Point Pinos, Port Orford, Cape Disappointment, and Cape Flattery, compared with corresponding observations at Greenwich and American observatories, and on chronometric differences between the same and other stations.

Explanation of the tables.

The first column on the left contains the name of the several stations or triangulation points. Their general locality is intimated by the heading at the top of the page, by means of which they will be readily found on the sketches accompanying the tables. Sub-headings in the first column indicate the locality more minutely where it is practicable.

The stations are generally either prominent objects of permanence, such as spires, light-houses, beacons, &c., or they are points on prominent hills, capes, or points of land, where signals have been erected for the purpose of the survey, and which are marked on the ground. In a small number of cases in the first three sections, but much more frequently in the southern sections, where settlements on the coast are sparse, and few permanent objects are to be found, the stations have no other distinguishing mark than the signal erected on the spot; and after its decay, the mark left on the ground to designate the station point. The latter generally consists of posts or stones set around the point, while the centre of the station is designated by an earthen cone or glass bottle buried under the surface of the ground, and marked on top by a stone or post. Where the station is on a rock, a copper bolt, or a hole filled with lead or sulphur, will be found to designate the exact spot.

The sketches showing the configuration of the land as well as the relative positions of the stations, no great difficulty will be experienced in finding the latter when desired for local surveys or reference. In any case where minute descriptions of particular points are required, they can be had by application addressed to the Coast Survey Office.

The second and third columns contain the latitudes and longitudes of the stations named.

The fourth column contains the azimuth of the line joining the station named in the first column to that named in the fifth—that is to say: the angle which that line makes with the meridian of the former station, reckoned from south around by west, through the whole circle. The sixth column gives the back azimuth of the same line, or the angle which it makes with the meridian of the latter station, reckoned as before; the difference between the azimuths in the fourth and those in the sixth column being 180°, less the inclination of the meridians at the two stations.

The seventh, eighth, and ninth columns give the distances, in metres, yards, and miles, between the stations named in the first and fifth columns. The relation of the metre to the yard used in obtaining these results is, 1 metre = 1.0935696 yard, or 39.368505 United States standard inches.

For each station the azimuths and distances to two other stations are given. In every case the lines so given have actually been observed.

In each section the stations of the primary triangulation are distinguished by being printed in SMALL CAPITALS.

In Section IV a number of points previously published are repeated, with slight changes in their positions, arising from an adjustment of the triangulation between the Bodies Island base and a preliminary base of verification near Beaufort.

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of New Hampshire. Sketch A.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Agamenticus	43 13 22.90	70 41 11.75	....	....	....	....	....	....
Patuccawa	43 07 11.91	71 11 30.38	254 15 13	Agamenticus	74 35 58	42638.0	46627.6	26.49
Isles of Shoals	42 59 13.06	70 36 29.07	166 19 48	Agamenticus	346 16 35	26990.5	29516.1	16.77
Stratham Hill	43 02 20.75	70 53 05.18	284 18 20	Isles of Shoals	104 29 40	23286.3	25465.2	14.47
			109 52 26	Patuccawa	289 39 51	26563.1	29048.6	16.50
Hampton Falls	42 54 42.54	70 53 30.80	133 30 40	Patuccawa	313 18 23	33647.3	36795.7	20.90
			250 05 00	Isles of Shoals	70 16 36	24617.3	26920.7	15.29
Great Boar's Head	42 55 03.61	70 47 24.80	242 33 30	Isles of Shoals	62 40 57	16736.7	18302.8	10.40
			85 33 28	Hampton Falls	265 29 19	8325.7	9104.7	5.17
Hampton	42 56 32.14	70 49 16.82	317 04 32	Great Boar's Head	137 05 48	3729.9	4078.9	2.32
			59 36 11	Hampton Falls	239 33 18	6678.3	7303.2	4.15
Little Boar's Head	42 57 27.07	70 46 12.69	192 57 57	Agamenticus	13 01 21	30268.1	33100.3	18.80
			20 16 42	Great Boar's Head	200 15 53	4718.8	5160.4	2.93
Hampton Academy	42 56 00.23	70 49 46.52	214 22 19	Hampton	34 22 39	1192.9	1304.5	0.74
			64 47 08	Hampton Falls	244 44 35	5622.5	6148.6	3.49
Hampton, Orthodox church spire.	42 56 12.76	70 49 41.32	61 52 38	Hampton Falls	241 50 02	5901.1	6453.3	3.67
			222 52 50	Hampton	42 53 07	816.3	892.7	0.51
Hampton, Baptist church spire.	42 56 15.00	70 49 52.15	60 06 20	Hampton Falls	240 03 51	5720.1	6255.3	3.55
			236 34 16	Hampton	56 34 40	959.8	1049.6	0.60
Hampton, wind-mill	42 56 16.03	70 49 23.48	196 54 15	Hampton	16 54 20	519.4	568.0	0.32
			243 06 17	Little Boar's Head	63 08 27	4848.4	5302.1	3.01
Hampton Falls Academy	42 54 57.87	70 51 34.54	268 11 06	Great Boar's Head	88 13 56	5666.5	6196.7	3.52
			79 50 31	Hampton Falls	259 49 12	2678.7	2929.4	1.66
Hampton Falls, church tower.	42 54 59.03	70 51 33.96	268 32 40	Great Boar's Head	88 35 30	5651.9	6180.7	3.51
			79 08 53	Hampton Falls	259 07 33	2698.0	2950.5	1.68
Seabrook, Orthodox church spire.	42 54 10.22	70 51 45.41	254 24 05	Great Boar's Head	74 27 02	6135.9	6710.0	3.81
			217 33 41	Hampton	37 35 22	5525.4	6042.4	3.43
White Island Light	42 58 00.40	70 37 04.63	199 45 39	Isles of Shoals	19 46 03	2382.4	2605.3	1.48
			85 19 10	Little Boar's Head	265 12 56	12462.3	13628.4	7.74
Smutty Nose Island	42 58 56.87	70 35 51.87	105 08 49	Stratham Hill	284 57 04	24228.6	26495.7	15.05
			120 40 22	Isles of Shoals	300 39 57	979.4	1071.0	0.61
Star Island	42 58 29.05	70 36 26.49	107 38 14	Stratham Hill	287 26 53	23718.6	25938.0	14.73
			177 32 02	Isles of Shoals	357 32 00	1359.1	1486.3	0.84
Star Island Church	42 58 33.60	70 36 30.89	107 23 04	Stratham Hill	287 11 46	23581.3	25787.8	14.65
			181 56 02	Isles of Shoals	1 56 03	1218.3	1332.3	0.76
Jennis Ledge	42 58 26.41	70 45 36.11	192 10 07	Agamenticus	12 13 07	28300.9	30949.0	17.58
			24 21 31	Little Boar's Head	204 21 06	2010.0	2198.1	1.25
Lock's Point	42 59 29.05	70 44 45.51	190 37 05	Agamenticus	10 39 31	26179.4	28629.0	16.27
			272 27 56	Isles of Shoals	92 33 34	11255.9	12309.1	6.99
Foss	43 00 44.02	70 44 00.14	26 18 20	Little Boar's Head	206 16 49	6778.1	7412.3	4.21
			23 57 19	Lock's Point	203 56 48	2531.1	2767.9	1.57
Breakfast Hill	43 00 23.72	70 48 11.22	277 44 24	Isles of Shoals	97 52 23	16088.6	17594.0	10.00
			118 30 39	Stratham Hill	298 27 18	7571.8	8280.3	4.70
Rye, Orthodox church spire	43 00 38.53	70 46 03.44	351 21 51	Jennis Ledge	171 22 10	4123.5	4509.3	2.57
			266 31 06	Foss	86 32 30	2796.9	3058.6	1.74
Rye, Baptist church spire	43 00 42.72	70 46 02.39	351 56 38	Jennis Ledge	171 56 56	4247.9	4645.4	2.64
			269 09 40	Foss Station	89 11 03	2768.3	3027.3	1.72
Pulpit Rock	43 01 56.75	70 42 47.15	185 48 22	Agamenticus	5 49 27	21281.6	23272.9	13.22
			174 49 23	New Castle	354 49 15	3054.0	3339.8	1.91
New Castle	43 03 35.32	70 42 59.33	187 37 35	Agamenticus	7 38 49	18293.1	20004.8	11.37
			80 31 46	Stratham Hill	260 24 52	13905.0	15206.1	8.64
New Castle Light	43 04 14.33	70 42 11.76	76 43 34	Stratham Hill	256 36 08	15195.0	16616.8	9.44
			320 07 21	Isles of Shoals	140 11 15	12107.5	13240.4	7.52
Fort Constitution Flag-staff	43 04 16.26	70 42 13.52	76 28 23	Stratham Hill	256 20 58	15170.0	16589.5	9.43
			184 43 28	Agamenticus	4 44 10	16925.0	18508.7	10.52
Whale's-back Light	43 03 29.91	70 41 27.89	82 21 48	Stratham Hill	262 13 52	15923.2	17413.1	9.89
			319 29 15	Isles of Shoals	139 32 39	10420.1	11395.1	6.47
East end of base, of survey by U. S. top. engineers.	43 02 33.71	70 42 25.95	22 49 32	Pulpit Rock	202 49 18	1237.3	1353.1	0.76
			158 19 59	New Castle	338 19 36	2045.6	2237.2	1.27

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of Maine. Sketch A.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Seward	43 04 09.41	70 40 23.73	329 49 31	Isles of Shoals	149 52 11	10575.3	11564.8	6.57
			73 22 44	New Castle	253 20 57	3674.2	4018.0	2.28
Newmarket	43 03 22.32	70 56 00.94	227 13 46	Agamenticus	47 23 54	27333.8	29891.4	16.98
			348 00 44	Hampton Falls	168 02 27	16394.7	17928.8	10.18
Frost's Hill	43 09 43.25	70 47 02.81	323 32 30	Isles of Shoals	143 39 43	24158.1	26418.6	15.01
			31 00 07	Stratham Hill	210 55 59	15923.6	17413.6	9.89
Wentworth	43 08 22.94	70 51 38.32	85 27 47	Patuccawa	265 14 12	27029.2	29558.3	16.79
			248 15 56	Frost's Hill	68 19 05	6699.5	7326.4	4.16
Great Hill	43 05 21.87	70 45 00.67	63 01 58	Stratham Hill	242 56 27	12304.1	13455.4	7.64
			121 54 01	Wentworth	301 49 29	10584.0	11574.4	6.57
Newington	43 05 50.57	70 49 50.60	95 00 21	Patuccawa	274 45 33	29490.2	32249.6	18.32
			34 13 24	Stratham Hill	214 11 11	7828.6	8561.1	4.86
Newington Church	43 05 52.09	70 49 39.41	35 32 24	Stratham Hill	215 30 04	8012.3	8762.0	4.98
			150 00 35	Wentworth	329 59 14	5375.1	5878.1	3.34
Stratham, Orthodox church spire.	43 01 03.72	70 54 44.83	158 03 58	Newmarket	338 03 06	4610.4	5041.8	2.86
			223 29 47	Stratham Hill	43 30 55	3276.7	3583.3	2.03
Stratham, Baptist church tower.	43 01 38.57	70 54 19.07	144 14 49	Newmarket	324 13 39	3946.1	4315.3	2.45
			232 06 08	Stratham Hill	52 06 58	2119.1	2317.4	1.31
Woodman's Point	43 04 22.71	70 51 14.17	100 51 55	Patuccawa	280 38 04	27992.2	30611.4	17.39
			33 44 02	Stratham Hill	213 42 47	4524.7	4948.1	2.81
Durham	43 05 17.69	70 53 17.76	46 03 05	Newmarket	226 01 13	5128.8	5608.7	3.18
			257 45 11	Newington	77 47 33	4792.2	5240.6	2.98
Durham Spire	43 07 57.14	70 55 01.83	299 00 30	Newington	119 04 03	8045.5	8798.3	5.00
			345 43 47	Stratham Hill	165 45 07	10709.6	11711.7	6.65
Greenland, Orthodox ch. spire.	43 02 10.70	70 49 40.87	93 51 11	Stratham Hill	273 48 52	4634.7	5068.4	2.88
			139 38 30	Durham	319 36 02	7574.2	8282.9	4.70
Greenland Academy	43 02 00.01	70 49 41.52	141 17 21	Durham	321 14 53	7819.0	8550.6	4.85
			325 27 36	Breakfast Hill	145 28 38	3606.8	3944.3	2.24
Brooks	43 06 38.86	70 46 58.25	116 55 36	Wentworth	296 52 25	7098.3	7762.5	4.41
			91 53 45	Patuccawa	271 36 59	33293.3	36408.5	20.68
Bartlett	43 05 23.96	70 46 28.86	95 44 50	Patuccawa	275 27 44	34110.7	37302.4	21.19
			128 19 09	Wentworth	308 15 37	8912.6	9746.6	5.54
Poverty Heights	43 04 55.14	70 46 30.04	61 59 07	Stratham Hill	241 54 37	10130.5	11078.4	6.29
			181 42 35	Bartlett	1 42 36	889.5	972.7	0.55
OSSIPEE	43 35 17.23	70 44 06.54	354 26 43	Agamenticus	174 28 43	40747.8	44560.6	25.32
Fletcher's Neck	43 26 50.91	70 20 11.91	48 48 57	Agamenticus	228 34 33	37774.4	41309.0	23.47
Frost's Hill	43 09 43.25	70 47 02.81	323 32 30	Isles of Shoals	143 39 43	24158.1	26418.6	15.01
Bald Head Cliff	43 13 11.81	70 34 24.79	6 12 29	Isles of Shoals	186 11 04	26032.8	28468.7	16.17
			92 10 22	Agamenticus	272 05 44	9180.7	10049.6	5.71
Sweat's Point	43 07 11.14	70 38 00.35	159 22 14	Agamenticus	339 20 03	12258.5	13405.5	7.61
			352 01 17	Isles of Shoals	172 02 20	14895.5	16289.3	9.25
Cape Neddock	43 10 01.52	70 35 37.86	129 31 59	Agamenticus	309 28 11	9769.0	10683.0	6.07
			3 19 06	Isles of Shoals	183 18 31	20042.4	21917.8	12.45
York	43 08 09.91	70 38 14.67	157 31 34	Agamenticus	337 29 33	10452.8	11430.9	6.49
			103 37 12	Frost's Hill	283 31 11	12274.7	13423.2	7.62
York Church Spire	43 08 39.28	70 38 48.66	58 59 27	Stratham Hill	238 49 42	22618.5	24734.9	14.05
			319 43 08	York	139 43 31	1188.1	1299.3	0.73
York, buoy	43 05 35.10	70 35 09.81	138 50 17	York	318 48 11	6346.9	6940.8	3.94
			150 30 25	Agamenticus	330 26 17	16589.4	18141.7	10.30
Boon Island	43 07 15.99	70 28 17.52	122 59 49	Agamenticus	302 50 59	20830.8	22779.9	12.94
			36 47 09	Isles of Shoals	216 41 33	18594.5	20334.4	11.55
Boon Island Light	43 07 15.74	70 28 15.66	36 54 16	Isles of Shoals	216 48 39	18613.8	20355.5	11.56
			122 57 05	Agamenticus	302 48 14	20870.1	22822.9	12.97
Fairfield Hill	43 23 49.12	70 28 22.12	41 56 36	Agamenticus	221 47 49	25949.3	28377.4	16.12
			135 08 36	Ossipee	314 57 47	30001.7	32809.0	18.64
Cole's Hill	43 20 34.07	70 33 56.92	270 57 13	Kennebunk Point	91 01 32	8507.0	9303.0	5.28
			36 25 22	Agamenticus	216 20 24	16526.3	18072.7	10.26
Wells Neck	43 17 15.01	70 34 03.51	53 28 57	Agamenticus	233 24 03	12024.2	13149.3	7.47
			181 23 00	Cole's Hill	1 23 05	6144.5	6719.4	3.82

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of Maine. Sketch A.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Ogunquit	43 15 23.15	70 35 51.48	334 14 07	Bald Head Cliff	154 15 07	4499.8	4920.9	2.79
			215 11 13	Wells Neck	35 12 27	4223.8	4619.0	2.62
Summit	43 21 44.42	70 27 09.44	137 45 17	Ossipee	317 33 37	33934.1	37109.3	21.08
			156 41 36	Fairfield Hill	336 40 45	4190.1	4582.2	2.60
Boothbey	43 20 52.37	70 29 28.56	143 36 19	Ossipee	323 26 15	33190.9	36296.6	20.62
			242 50 17	Summit	62 51 52	3520.5	3849.9	2.19
Kennebunk Point	43 20 29.31	70 27 39.25	141 05 27	Ossipee	320 54 08	35258.5	38557.6	21.90
			170 54 11	Fairfield Hill	350 53 41	6244.6	6828.9	3.88
Kennebunk, Unitarian ch. spire.	43 23 14.90	70 31 54.71	293 29 27	Summit	113 32 43	7002.7	7658.2	4.35
			143 39 08	Ossipee	323 30 44	27695.9	30287.4	17.21
Kennebunk, Orthodox ch. spire.	43 23 11.48	70 31 53.88	322 40 39	Boothbey	142 42 19	5396.9	5901.9	3.35
			143 45 14	Ossipee	323 36 50	27793.7	30394.4	17.27
Kennebunk Port Observatory.	43 21 20.87	70 27 44.94	44 51 10	Ogunquit	224 45 36	15557.8	17013.6	9.66
			227 43 20	Summit	47 43 44	1080.1	1181.2	0.67
Kennebunk Port, Orthodox church spire.	43 21 44.60	70 28 20.09	42 57 28	Wells Neck	222 53 32	11361.1	12424.2	7.06
			43 42 58	Boothbey	223 42 11	2229.8	2438.4	1.38
Kennebunk Port, Baptist church spire.	43 21 45.02	70 28 13.67	43 26 26	Wells Neck	223 22 26	11469.0	12542.2	7.12
			270 43 04	Summit	90 43 48	1446.3	1581.6	0.90
Cape Porpoise Light	43 21 26.80	70 25 11.26	55 29 54	Agamenticus	235 18 55	26299.9	28760.8	16.34
			101 33 16	Summit	281 31 55	2715.4	2969.5	1.68
Wells Church Spire	43 19 33.30	70 34 18.80	194 43 02	Cole's Hill	14 43 17	1938.8	2120.2	1.20
			259 05 29	Kennebunk Point	79 10 03	9164.4	10021.9	5.69
Stage Island	43 22 14.75	70 24 48.17	121 03 52	Fairfield Hill	301 01 25	5646.5	6174.8	3.51
			73 36 53	Summit	253 35 16	3315.2	3625.4	2.06
Timber Island	43 23 38.60	70 23 31.80	92 51 48	Fairfield Hill	272 48 28	6563.6	7177.8	4.08
			33 36 16	Stage Island	213 35 24	3106.0	3396.6	1.93
Crow Hill	43 22 15.04	70 26 20.10	49 36 57	Summit	229 36 23	1458.1	1594.5	0.90
			235 44 26	Timber Island	55 46 22	4583.1	5012.0	2.85
Ward	43 24 15.59	70 23 48.97	341 17 56	Timber Island	161 18 08	1205.1	1317.9	0.75
			19 39 59	Stage Island	199 39 18	3959.4	4329.9	2.46
Hoyt's Neck	43 24 43.29	70 22 38.86	61 33 08	Ward	241 32 20	1793.8	1961.7	1.11
			219 59 09	Fletcher's Neck	40 00 50	5141.0	5622.0	3.19
Biddeford	43 25 55.91	70 22 17.75	239 01 53	Fletcher's Neck	59 03 20	3299.3	3608.0	2.05
			206 21 41	Stage Island	26 23 24	7617.2	8329.9	4.73
Nason	43 26 55.74	70 26 12.58	122 47 25	Ossipee	302 35 06	28655.1	31336.4	17.80
			7 35 24	Summit	187 34 45	9691.2	10598.0	6.02
Vicinity of Portland.								
MOUNT INDEPENDENCE	43 45 32.17	70 18 53.04	....	....	....	....	....	....
Fletcher's Neck	43 26 50.91	70 20 11.91	182 55 06	Mount Independence	2 56 00	34646.0	37887.8	21.53
Blue Point Hill	43 33 08.28	70 21 14.72	187 51 28	Mount Independence	7 53 06	23174.5	25342.9	14.40
			353 05 18	Fletcher's Neck	173 06 02	11730.9	12828.5	7.29
Stratten Island	43 30 21.27	70 18 20.17	21 09 41	Fletcher's Neck	201 08 25	6960.9	7612.2	4.33
			142 45 55	Blue Point Hill	322 43 55	6474.7	7080.4	4.02
Grandy Hill	43 33 45.22	70 15 37.72	25 44 55	Fletcher's Neck	205 41 47	14191.8	15519.7	8.82
			30 06 28	Stratten Island	210 04 36	7274.0	7954.6	4.52
Richmond Island	43 32 25.24	70 13 58.62	56 56 46	Stratten Island	236 53 46	7008.9	7664.7	4.35
			137 59 13	Grandy Hill	317 58 05	3322.5	3633.3	2.07
John's Hill	43 34 45.00	70 12 30.64	156 49 13	Mount Independence	336 44 49	21730.8	23764.2	13.50
			75 48 31	Blue Point Hill	255 42 29	12133.1	13268.4	7.54
Bramhall's Hill	43 38 46.43	70 16 13.15	164 03 29	Mount Independence	344 01 39	13022.8	14241.4	8.09
			326 10 14	John's Hill	146 12 48	8966.6	9805.6	5.57
Mount Joy	43 35 43.50	70 14 50.95	16 02 29	Grandy Hill	196 01 57	3797.5	4152.8	2.36
			349 07 49	Richmond Island	169 08 25	6229.6	6812.5	3.87
Pleasant Hill	43 35 39.90	70 17 30.32	324 27 31	Grandy Hill	144 28 49	4348.1	4755.0	2.70
			47 07 11	Blue Point Hill	227 04 36	6872.3	7515.4	4.27
Oak Hill, chimney of Capt. J. B. Thornton's house.	43 35 14.65	70 19 41.89	296 42 29	Grandy Hill	116 45 17	6134.4	6708.4	3.81
			28 06 47	Blue Point Hill	208 05 43	4420.3	4833.9	2.75
Bushy-top Pine, on Cape Elizabeth.	43 36 33.31	70 15 58.21	354 55 33	Grandy Hill	174 55 47	5207.1	5694.3	3.23
			51 24 42	Pleasant Hill	231 23 38	2643.0	2890.3	1.64

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of Maine. Sketch A.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Jordan	43 35 35.47	70 15 44.24	258 17 29	Mount Joy	78 18 06	1221.2	1335.5	0.76
			93 17 59	Pleasant Hill	273 16 46	2383.2	2606.2	1.48
White Head	43 38 45.05	70 11 09.30	13 50 00	John's Hill	193 49 04	7628.5	8342.3	4.74
			90 23 30	Bramhall's Hill	270 20 00	6608.5	7226.9	4.10
Moody	43 42 36.51	70 13 14.18	356 09 25	John's Hill	176 09 56	14582.9	15947.4	9.06
			125 35 47	Mount Independence	305 31 53	9320.6	10192.7	5.79
Green Island	43 38 57.54	70 07 06.58	127 39 53	Mount Independence	307 31 45	19961.3	21829.1	12.40
			43 01 27	John's Hill	222 57 44	10654.1	11651.0	6.62
Dyer	43 37 04.53	70 15 11.49	240 14 00	White Head	60 16 47	6252.1	6837.1	3.88
			162 26 54	Mount Independence	342 24 21	16432.5	17970.1	10.21
Hummiewell's House, chimney.	43 36 18.70	70 19 27.36	223 39 40	Bramhall's Hill	43 41 54	6304.6	6894.5	3.91
			294 31 10	Pleasant Hill	114 32 31	2885.3	3155.3	1.79
State Reform School, east tower.	43 38 15.00	70 18 08.78	349 47 07	Pleasant Hill	169 47 34	4863.7	5318.8	3.02
			298 39 53	Dyer	118 41 55	4530.0	4953.9	2.82
Capisick Church Spire	43 39 43.87	70 17 40.16	358 19 17	Pleasant Hill	178 19 24	7532.7	8237.6	4.68
			171 22 34	Mount Independence	351 21 44	10872.2	11889.5	6.75
Bennett's house on Brown's Hill, chimney.	43 37 55.59	70 16 49.00	258 38 02	White Head	78 41 55	7764.9	8491.5	4.82
			207 07 38	Bramhall's Hill	27 08 03	1763.2	1928.2	1.09
Poorduck Church	43 38 04.79	70 14 05.82	114 16 08	Bramhall's Hill	294 14 40	3129.0	3421.8	1.94
			187 50 58	Moody	7 51 34	8464.4	9256.4	5.26
Fort Scammel, chimney of block-house.	43 38 59.36	70 12 25.58	284 29 04	White Head	104 29 57	1765.7	1930.9	1.09
			170 46 45	Moody	350 46 11	6788.9	7424.1	4.21
Peak's Island, west end of Shirling's barn.	43 39 20.49	70 11 22.34	80 51 59	Bramhall's Hill	260 48 38	6599.6	7217.1	4.10
			345 01 33	White Head	165 01 42	1132.3	1238.3	0.70
Woodbury's Yellow House, north chimney.	43 37 16.60	70 13 41.98	129 18 44	Bramhall's Hill	309 17 00	4377.3	4786.9	2.72
			183 36 27	Moody	3 36 46	9891.7	10817.3	6.15
Longfellow's House, east chimney.	43 39 55.91	70 17 06.00	285 16 07	White Head	105 20 13	8286.1	9061.4	5.15
			226 18 13	Moody	46 20 53	7177.1	7848.7	4.46
Knubble at Mt. Misery	43 35 45.75	70 13 20.92	134 27 00	Dyer	314 25 44	3472.5	3797.4	2.16
			234 46 13	Green Island	54 50 31	10269.0	11229.9	6.38
Milton, Dyer's house	43 36 08.70	70 12 42.60	203 25 36	White Head	23 26 40	5258.6	5750.7	3.26
			235 17 45	Green Island	55 21 37	9158.9	10015.9	5.69
Westbrook Academy	43 40 58.87	70 17 26.76	337 14 40	Dyer	157 16 14	7840.1	8573.7	4.87
			338 00 56	Bramhall's Hill	158 01 47	4408.1	4820.6	2.74
Portland, Methodist church spire on Pine street.	43 39 07.95	70 15 42.94	349 30 44	Dyer	169 31 06	3873.3	4235.7	2.41
			276 32 55	White Head	96 36 04	6172.5	6750.1	3.83
Portland, tall dark spire on State street.	43 39 07.51	70 15 36.36	351 38 31	Dyer	171 38 48	3835.8	4194.7	2.38
			276 34 56	White Head	96 38 00	6024.2	6587.9	3.74
Portland, Unitarian church on Park street.	43 39 06.81	70 15 25.18	355 20 48	Dyer	175 20 57	3785.7	4139.9	2.35
			276 39 20	White Head	96 42 17	5772.9	6313.1	3.59
Portland, tall dark tower on High street.	43 39 11 84	70 15 25.17	355 32 05	Dyer	175 32 14	3940.5	4309.2	2.45
			278 10 52	White Head	98 13 49	5792.5	6334.5	3.60
Portland, green spire on Casco street.	43 39 24.49	70 15 24.34	356 10 50	Dyer	176 10 59	4328.5	4733.5	2.68
			206 10 47	Moody	26 12 17	6603.8	7221.7	4.10
Portland, stone church in Congress street.	43 39 29.12	70 15 09.96	26 22	Dyer	180 26 21	4461.9	4879.4	2.77
			284 07 58	White Head	104 10 44	5561.2	6081.6	3.46
Portland, dark spire of third parish church on Congress street.	43 39 32.99	70 15 03.15	47 30 50	Bramhall's Hill	227 30 02	2126.2	2325.2	1.32
			285 44 48	White Head	105 47 27	5444.7	5954.2	3.38
Portland, low tower of Baptist church on Federal street.	43 39 31.36	70 15 00.71	3 03 09	Dyer	183 03 02	4537.3	4961.9	2.82
			285 23 14	White Head	105 25 54	5378.4	5881.7	3.34
Portland, custom-house flagstaff.	43 39 27.56	70 14 57.64	284 21 32	White Head	104 24 10	5282.0	5776.2	3.28
			4 01 20	Dyer	184 01 10	4424.5	4838.5	2.75
Portland, Lowell and Senter's transit.	43 39 24.72	70 14 56.28	283 30 58	White Head	103 33 35	5231.3	5720.8	3.25
			4 30 22	Dyer	184 30 11	4339.8	4745.9	2.69
Portland, church on Middle street, near Willow street.	43 39 30.14	70 14 49.01	285 45 48	White Head	105 48 20	5116.0	5594.7	3.18
			6 23 53	Dyer	186 23 37	4521.6	4944.7	2.81
Portland Light	43 37 21.88	70 12 08.87	246 25 35	Green Island	66 29 03	7390.4	8081.9	4.59
			207 28 34	White Head	27 29 15	2892.9	3163.6	1.80
Little Hog Island, flag in tree.	43 39 55.07	70 12 18.72	68 03 49	Bramhall's Hill	248 01 07	5662.7	6192.6	3.52
			324 14 55	White Head	144 15 43	2662.3	2911.4	1.65

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section I.—Coast of Maine. Sketch A.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Fort Preble, flag-staff	43 38 54.59	70 13 18.05	36 49 50	Dyer	216 48 33	4242.5	4639.5	2.63
			275 48 35	White Head	95 50 04	2900.0	3171.4	1.80
Mackey's Island, flag in tree	43 41 14.03	70 13 40.42	14 51 03	Dyer	194 50 00	6341.5	6934.9	3.94
			192 59 40	Moody	12 59 58	2612.3	2856.7	1.62
Payson's Cottage, chimney	43 40 58.87	70 15 58.01	302 31 47	White Head	122 35 07	7673.7	8391.7	4.77
			230 34 53	Moody	50 36 46	4747.0	5191.2	2.95
Great Hog Island, tree with tall dark top.	43 40 56.97	70 11 32.36	352 46 03	White Head	172 46 19	4103.7	4487.7	2.55
			301 43 53	Green Island	121 46 56	7002.2	7657.4	4.35
Long Island W. End, west end of Cushing's barn.	43 41 02.83	70 09 53.65	21 44 23	White Head	201 43 31	4577.3	5005.6	2.84
			315 54 59	Green Island	135 56 54	5380.9	5884.4	3.34
Littlejohn	43 40 39.14	70 09 36.97	312 55 35	Green Island	132 57 19	4602.4	5033.1	2.86
			30 26 29	White Head	210 25 25	4083.6	4465.7	2.54
Crotch Island	43 41 20.18	70 06 27.05	11 22 42	Green Island	191 22 15	4489.7	4909.8	2.79
			52 53 45	White Head	232 50 30	7930.6	8672.7	4.93
Jewel's Island	43 40 38.17	70 05 33.36	33 55 50	Green Island	213 54 46	3742.3	4092.5	2.32
			65 08 52	White Head	245 05 00	8296.5	9072.8	5.15
Little Green Island	43 39 57.32	70 06 03.51	37 27 25	Green Island	217 26 41	2323.8	2541.2	1.44
			71 59 45	White Head	251 56 15	7205.3	7879.5	4 47
Ram Island, flag in tree	43 38 13.89	70 10 51.35	157 17 35	White Head	337 17 23	1042.2	1139.7	0.65
			255 00 17	Green Island	75 03 03	5214.2	5702.1	3.24
Halfway Rock	43 39 20.30	70 01 53.16	59 19 51	John's Hill	239 12 31	16625.4	18181.0	10.33
			116 47 04	Mount Independence	296 35 19	25553.0	27944.0	15.88
Long Island	43 41 59.12	70 08 12.41	114 41 58	Mount Independence	294 34 36	15721.9	17193.0	9.77
			33 30 12	White Head	213 28 10	7181.1	7853.0	4.46
Falmouth, Rev. Mr. Dame's church.	43 43 32.48	70 14 46.88	123 52 19	Mount Independence	303 49 29	6631.0	7251.5	4.12
			309 46 22	Moody	129 47 26	2699.9	2952.5	1.67
Mark's Island, stone beacon.	43 42 31.57	70 01 33.37	48 31 20	Green Island	228 27 30	9965.6	10898.1	6.19
			103 34 23	Mount Independence	283 22 24	23922.2	26160.6	14.86
Primary Stations.								
MOUNT PLEASANT	44 01 35.17	70 49 00.88	352 16 41.2	Ossipee	172 20 05.9	49137.7	53735.5	30.53
			306 12 04.6	Mount Independence	126 32 59.0	50109.2	54797.9	31.13
CAPE SMALL	43 46 41.65	69 50 22.71	86 57 21.4	Mount Independence	266 37 38.3	38308.7	41893.2	23.80
			109 41 33.3	Mount Pleasant	289 00 53.7	83203.2	90988.6	51.70
SEBATTIS	44 08 36.37	70 04 22.34	24 31 21.6	Mount Independence	204 21 17.3	46921.4	51311.8	29.16
			77 57 08.2	Mount Pleasant	257 26 03.6	60985.1	66691.4	37.89
MOUNT BLUE	44 43 40.24	70 20 11.91	359 03 40.1	Mount Independence	179 04 35.1	107661.2	117735.0	66.90
			26 19 26.9	Mount Pleasant	205 59 16.7	86818.1	94941.7	53.95
RAGGED MOUNTAIN	44 12 43.97	69 08 43.54	81 48 41.6	Mount Pleasant	260 38 52.3	135357.8	148023.3	84.10
			49 21 00.3	Cape Small	228 52 04.4	73651.6	80543.1	45.76

Section II.—Hudson River. Sketch B.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
ROUND HILL	41 06 10.65	73 40 05.79	....	....	....	....	....	....
BUTTERMILK	41 06 33.91	73 48 18.96	273 31 20	Round Hill	93 36 45	11528.4	12607.1	7.17
Didery	40 57 59.97	73 50 13.95	189 36 16	Buttermilk	9 37 32	16078.4	17582.9	9.99
			223 07 37	Round Hill	43 14 16	20756.5	22698.7	12.89
Piermont	41 02 54.68	73 55 18.66	235 20 40	Buttermilk	55 25 16	11903.1	13016.9	7.39
			321 54 15	Didery	141 57 35	11546.7	12627.1	7.17
Hook Mountain	41 07 24.81	73 54 23.30	8 49 15	Piermont	188 48 39	8431.7	9220.7	5.24
			341 29 48	Didery	161 32 32	18369.9	20088.8	11.41
Ryder	41 10 52.99	73 49 29.67	348 20 11	Buttermilk	168 20 58	8159.7	8923.2	5.07
			46 51 30	Hook Mountain	226 48 17	9386.0	10264.3	5.83

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson River. Sketch B.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
High Tor	41 11 13.00	73 57 36.85	273 04 07	Ryder	93 09 28	11369.5	12433.3	7.06
			327 19 11	Hook Mountain	147 21 19	8361.0	9143.3	5.19
Dickerson	41 15 29.68	73 51 42.53	14 04 35	Hook Mountain	194 02 49	15418.1	16860.8	9.58
			46 13 03	High Tor	226 09 10	11436.0	12506.1	7.10
Bear Mount	41 18 36.59	73 59 50.28	314 38 54	Ryder	134 45 43	20328.9	22231.1	12.63
			347 11 52	High Tor	167 13 20	14031.2	15344.1	8.72
Tompkins' Hill	41 23 45.42	73 49 01.57	13 46 13	Dickerson	193 44 27	15742.6	17215.6	9.78
			57 46 30	Bear Mount	237 39 22	17835.2	19504.1	11.08
Crow's Nest	41 24 28.74	73 58 41.67	275 36 42	Tompkins' Hill	95 43 06	13539.3	14806.2	8.41
			8 21 28	Bear Mount	188 20 42	10979.1	12006.4	6.82
Bald Hill	41 30 03.54	73 54 44.24	28 06 06	Crow's Nest	208 03 29	11705.6	12800.9	7.27
			325 40 50	Tompkins' Hill	145 44 37	14117.6	15438.6	8.77
Hook Mount, (2)	41 07 12.84	73 54 47.36	277 30 49	Buttermilk	97 35 04	9139.6	9994.8	5.67
			236 39 10	Hook Mountain	56 39 26	671 9	734.8	0.42
Kieckout	41 05 18.17	73 50 22.16	186 45 13	Ryder	6 45 48	10399.5	11372.6	6.46
			124 47 31	Hook Mountain	304 44 53	6848.9	7489.8	4.25
Long Hill	41 08 24.40	73 50 39.72	70 36 02	Hook Mountain	250 33 35	5528.8	6046.1	3.43
			355 55 07	Kieckout	175 55 18	5758.7	6297.6	3.57
Auser	41 10 28.24	73 51 26.23	36 07 56	Hook Mountain	216 05 59	7004.1	7659.5	4.35
			351 06 48	Kieckout	171 07 31	9680.1	10585.9	6.02
Bald Mount	41 13 31.80	73 49 23.42	1 42 12	Ryder	181 42 08	4901.1	5359.7	3.04
			69 36 57	High Tor	249 31 32	12265.8	13413.5	7.62
Salt Hill	41 14 44.75	73 51 28.89	16 41 18	Hook Mountain	196 39 23	14165.9	15491.4	8.80
			52 43 23	High Tor	232 39 21	10775.5	11783.8	6.69
Spitzenberg	41 15 16.84	73 54 01.06	33 46 16	High Tor	213 43 54	9045.9	9892.3	5.62
			322 08 30	Ryder	142 11 30	10305.0	11269.2	6.40
Dunderberg	41 17 16.30	73 57 51.81	358 13 06	High Tor	178 13 16	11211.9	12261.0	6.96
			345 04 28	Hook Mountain	165 06 40	18880.6	20647.3	11.73
Smith	41 04 40.91	73 54 43.52	259 18 07	Kieckout	79 20 59	6207.3	6788.1	3.85
			248 44 22	Buttermilk	68 48 35	9626.6	10527.4	5.98
Sing Sing, State-house	41 09 11.07	73 51 38.64	114 16 56	High Tor	294 13 00	9157.3	10014.2	5.69
			186 55 31	Auser	6 55 39	2397.7	2622.1	1.49
Bartlett	41 06 39.69	73 51 47.63	48 15 20	Smith	228 13 24	5501.2	6016.0	3.42
			110 58 57	Hook Mountain	290 57 14	3888.0	4251.8	2.41
Bartlett's House Turret	41 06 43.66	73 51 39.50	108 23 19	Hook Mountain	288 21 31	4026.2	4402.9	2.50
			325 36 24	Kieckout	145 37 15	3195.2	3494.2	1.98
Teller's Point	41 10 04.33	73 53 36.64	256 21 10	Auser	76 22 36	3127.6	3420.3	1.94
			332 47 05	Kieckout	152 49 13	9924.0	10852.6	6.16
Green's Wharf	41 06 45.98	73 54 29.16	211 52 19	Auser	31 54 19	8074.2	8829.7	5.02
			295 08 54	Kieckout	115 11 36	6367.9	6963.7	3.95
Tallman's Wharf	41 06 00.02	73 54 31.91	207 36 31	Auser	27 38 33	9337.7	10211.4	5.80
			282 28 00	Kieckout	102 30 44	5969.1	6527.6	3.70
Hook Mountain, painted triangle.	41 07 36.76	73 54 08.10	215 29 35	Auser	35 31 21	6497.7	7105.7	4.03
			309 01 10	Kieckout	129 03 38	6786.8	7421.9	4.21
Lower Rockland	41 08 01.79	73 54 03.74	219 05 37	Auser	39 07 21	5821.4	6366.1	3.62
			314 17 35	Kieckout	134 20 01	7224.5	7900.5	4.49
Upper Rockland	41 09 26.23	73 54 45.96	247 38 57	Auser	67 41 08	5033.1	5504.1	3.13
			321 10 13	Kieckout	141 13 07	9818.8	10737.6	6.10
Barmore Wharf	41 08 34.82	73 54 10.33	227 32 33	Auser	47 34 21	5183.8	5668.9	3.22
			318 42 45	Kieckout	138 45 15	8070.0	8825.1	5.02
Lower Nyac Landing	41 05 19.29	73 54 33.33	204 35 03	Auser	24 37 06	10481.1	11461.8	6.51
			270 18 48	Kieckout	90 21 33	5861.6	6410.1	3.64
Williamson's Wharf	41 06 23.44	73 54 31.91	209 48 49	Auser	29 50 51	8704.1	9518.5	5.41
			289 02 06	Kieckout	109 04 50	6165.7	6742.6	3.83
Tallman	41 05 45.71	73 54 59.94	209 44 41	Auser	29 47 01	10039.2	10978.6	6.23
			277 26 18	Kieckout	97 29 20	6537.7	7149.4	4.06
Nyac, Brush's house	41 06 45.29	73 54 42.25	213 35 27	Auser	33 37 36	8257.4	9030.0	5.13
			293 51 30	Kieckout	113 54 21	6637.0	7258.0	4.12
Fitch's house	41 08 35.82	73 54 29.48	138 00 13	High Tor	317 58 09	6525.7	7136.3	4.05
			230 54 52	Auser	50 56 52	5502.0	6016.8	3.42

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson River. Sketch B.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Stony Point Light-house ..	41 14 26.46	73 57 59.85	308 40 24	Auser..................	128 44 43	11750.3	12849.8	7.30
			354 52 08	High Tor..............	174 52 23	5991.5	6552.1	3.72
Smith's Wharf............	41 05 22.34	73 54 32.48	204 42 05	Auser..................	24 44 07	10387.3	11359.2	6.45
			271 14 13	Kieckout..............	91 16 58	5843.1	6389.8	3.63
Underhill's House.........	41 10 09.13	73 53 36.09	258 58 17	Auser..................	78 59 43	3083.4	3371.9	1.91
			333 14 09	Kieckout..............	153 16 17	10050.1	10990.5	6.24
Chadeavoyne.............	41 11 31.37	73 48 43.33	62 51 43	Auser..................	242 49 56	4265.9	4665.1	2.65
			46 12 41	Hook Mountain........	226 08 57	10984.8	12012.7	6.82
Sarles....................	41 08 55.39	73 46 59.63	35 12 18	Kieckout..............	215 10 05	8198.0	8965.1	5.09
			136 03 27	Ryder..................	316 01 48	5038.7	5510.2	3.13
Piermont Pier.............	41 02 31.68	73 53 29.08	172 02 15	Hook Mountain........	352 01 39	9129.6	9983.9	5.67
			220 20 13	Kieckout..............	40 22 16	6739.2	7369.8	4.18
Piermont Engine House, large cupola.	41 02 26.99	73 54 34.62	181 38 49	Hook Mountain........	1 38 56	9189.9	10049.8	5.71
			228 07 12	Kieckout..............	48 09 58	7913.3	8653.8	4.91
Piermont Engine House, small cupola.	41 02 27.18	73 54 31.96	181 15 36	Hook Mountain........	1 15 42	9182.6	10041.8	5.70
			227 50 57	Kieckout..............	47 53 41	7863.1	8598.9	4.88
Church Spire ..	41 08 56.66	74 01 38.67	233 14 55	High Tor..............	53 17 34	7032.4	7690.4	4.37
			285 33 09	Hook Mountain........	105 37 56	10540.5	11526.8	6.55
Railroad, (26)........	41 06 09.31	73 51 50.48	55 59 13	Smith..................	235 57 19	4872.5	5328.4	3.03
			123 09 58	Hook Mountain........	303 08 17	4258.2	4656.6	2.64
Railroad, (27)............	41 06 57.20	73 51 48.85	44 07 45	Smith..................	224 05 50	5855.1	6403.0	3.64
			103 18 50	Hook Mountain........	283 17 08	3701.9	4048.3	2.30
Railroad, (28)............	41 07 44.51	73 51 45.09	36 20 11	Smith..................	216 18 14	7028.7	7686.4	4.36
			80 39 42	Hook Mountain........	260 37 58	3739.8	4089.7	2.32
Webb's Wharf......... ..	41 06 22.62	73 51 47.61	52 37 40	Smith..................	232 35 44	5166.5	5649.9	3.21
			117 51 21	Hook Mountain........	297 49 38	4107.3	4491.6	2.55
Rockland Court House....	41 08 47.33	73 59 06.30	204 53 02	High Tor..............	24 54 01	4953.4	5416.9	3.08
			291 03 58	Hook Mountain.	111 07 04	7073.6	7735.5	4.39
Lord's Pagoda............	41 02 54.04	73 55 18.22	188 43 12	Hook Mountain........	8 43 48	8449.6	9240.3	5.25
			237 13 12	Kieckout..............	57 16 27	8217.9	8986.8	5.10
Tarrytown Schoolhouse, cupola.	41 04 20.94	73 51 13.66	142 03 33	Hook Mountain.... ...	322 01 28	7192.8	7865.8	4.47
			214 15 01	Kieckout..............	34 15 35	2136.3	2336.2	1.32
De Noyelle...............	41 11 22.02	73 57 20.91	225 51 52	Dickerson..............	45 55 35	10975.1	12002.0	6.82
			274 37 19	Ryder..................	94 42 29	11017.6	12048.5	6.84
Knapp....................	41 13 39.83	73 58 23.65	250 01 41	Dickerson..............	70 06 05	9934.5	10864.1	6.17
			341 01 21	De Noyelle............	161 02 02	4495.3	4915.9	2.79
Colleberg, East	41 13 08.43	73 53 44.62	213 07 18	Dickerson..............	33 08 39	5201.7	5688.4	3.23
			305 06 07	Ryder..................	125 08 55	7262.3	7941.8	4.51
Colleberg, West	41 13 43.62	74 00 23.52	254 51 48	Dickerson..............	74 57 32	12563.1	13738.6	7.80
			315 44 32	De Noyelle............	135 46 32	6097.0	6667.5	3.78
Roye Hook...............	41 17 57.21	73 56 45.05	302 51 32	Dickerson..............	122 54 51	8383.1	9167.5	5.21
			5 31 34	High Tor..............	185 31 00	12527.1	13699.3	7.78
Battle Point..............	41 17 32.80	73 55 49.57	12 02 29	High Tor..............	192 01 18	11979.2	13100.1	7.44
			120 15 51	Roye Hook............	300 15 14	1494.2	1634.0	0.93
Caldwell..................	41 17 23.04	73 57 06.49	260 26 32	Battle Point............	80 27 23	1814.8	1984.6	1.12
			205 19 35	Roye Hook............	25 19 50	1166.1	1275.2	0.72
Kidd's Humbug...........	41 17 10.19	73 57 05.23	197 56 16	Roye Hook............	17 56 29	1524.4	1667.0	0.94
			248 22 53	Battle Point............	68 23 43	1893.4	2070.6	1.17
Johnny Lent..............	41 16 38.13	73 56 06.61	193 13 46	Battle Point............	13 13 57	1732.5	1894.6	1.08
			125 57 15	Kidd's Humbug........	305 56 37	1684.9	1842.6	1.04
Peekskill Spire............	41 17 17.67	73 55 07.07	85 12 46	Kidd's Humbug........	265 11 29	2758.7	3016.8	1.71
			48 38 19	Johnny Lent...........	228 37 41	1845.9	2018.6	1.14
Smoky Hollow	41 17 41.75	73 57 57.25	275 17 51	Battle Point............	95 19 15	2983.2	3262.3	1.85
			254 08 33	Roye Hook............	74 09 22	1746.1	1909.5	1.08
Telegraph.................	41 18 23.68	73 58 16.22	319 03 48	Caldwell...............	139 04 34	2476.0	2707.7	1.54
			291 03 00	Roye Hook............	111 04 00	2272.6	2485.3	1.41
South Beacon	41 28 50.81	73 56 22.35	312 35 46	Tompkins' Hill........	132 40 38	13908.1	15209.5	8.64
			21 48 50	Crow's Nest...........	201 47 19	8706.9	9521.6	5.41
Bull Hill..................	41 26 15.77	73 57 03.15	34 43 30	Crow's Nest...........	214 42 25	4016.4	4392.2	2.49
			292 28 54	Tompkins' Hill........	112 34 13	12106.1	13238.9	7.52

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson River. Sketch B.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Bare Rock	41 22 07.20	73 58 38.24	257 12 16	Tompkins' Hill	77 18 37	13735.9	15021.2	8.53
			178 57 19	Crow's Nest	358 57 18	4366.9	4775.5	2.71
Denning	41 22 18.20	73 54 04.49	122 02 52	Crow's Nest	301 59 48	7594.2	8304.8	4.72
			49 39 17	Bear Mount	229 35 28	10552.2	11539.6	6.56
Hog's Back	41 20 51.13	73 52 48.86	67 05 05	Bear Mount	247 00 27	10641.4	11637.1	6.61
			129 20 45	Crow's Nest	309 16 52	10595.0	11586.4	6.58
Anthony's Nose	41 19 04.10	73 58 11.25	235 45 47	Tompkins' Hill	55 51 51	15444.0	16889.1	9.59
			306 08 30	Dickerson	126 12 47	11203.6	12251.9	6.96
Stevance	41 16 20.69	73 53 52.06	297 32 43	Dickerson	117 34 08	3399.9	3718.0	2.11
			206 11 08	Tompkins' Hill	26 14 20	15290.6	16721.3	9.50
Jacob's Hill	41 18 03.35	73 53 13.55	96 22 39	Bear Mount	276 18 17	9284.8	10153.6	5.77
			147 20 59	Crow's Nest	327 17 22	14124.1	15445.7	8.77
Gouverneur	41 23 37.44	73 55 51.88	54 15 13	Bare Rock	234 13 23	4763.2	5208.9	2.96
			111 52 55	Crow's Nest	291 51 03	4249.3	4646.9	2.64
Plum Bush	41 25 08.66	73 55 41.43	73 37 23	Crow's Nest	253 35 24	4362.7	4770.9	2.71
			4 55 42	Gouverneur	184 55 35	2824.3	3088.6	1.75
Sugar Loaf	41 21 33.32	73 56 31.28	109 30 42	Bare Rock	289 29 18	3130.0	3422.9	1.95
			193 26 41	Gouverneur	13 27 07	3936.4	4304.7	2.44
Alarm Post	41 20 45.02	73 58 26.95	174 05 31	Bare Rock	354 05 24	2548.3	2786.8	1.58
			240 59 44	Sugar Loaf	61 01 01	3073.8	3361.4	1.91
Belcher	41 22 52.14	73 56 15.25	8 42 36	Sugar Loaf	188 42 26	2459.7	2689.9	1.52
			67 21 38	Bare Rock	247 20 04	3600.1	3937.0	2.24
Block House	41 22 56.86	73 57 05.01	277 09 43	Belcher	97 10 16	1165.1	1274.1	0.72
			343 04 43	Sugar Loaf	163 05 06	2693.3	2945.3	1.67
Buttermilk Falls	41 21 52.13	73 57 27.50	194 40 01	Block House	14 40 16	2063.9	2257.0	1.28
			293 56 05	Sugar Loaf	113 56 42	1429.6	1563.4	0.88
Cows' Hook	41 21 05.14	73 57 26.94	66 01 22	Alarm Post	246 00 42	1526.9	1669.8	0.94
			139 07 19	Bare Rock	319 06 32	2531.8	2768.7	1.57
Denning's Landing	41 20 53.18	73 57 06.40	82 21 08	Alarm Post	262 20 15	1889.3	2066.1	1.17
			136 56 09	Bare Rock	316 55 08	3125.4	3417.9	1.94
McHenry North	41 20 22.98	73 57 27.99	153 04 43	Bare Rock	333 03 56	3605.5	3942.9	2.24
			211 16 29	Sugar Loaf	31 17 07	2538.8	2776.4	1.57
McHenry South	41 20 02.37	73 57 49.54	146 32 12	Alarm Post	326 31 47	1577.2	1724.8	0.98
			212 57 10	Sugar Loaf	32 58 02	3343.8	3656.7	2.08
Fort Montgomery	41 19 27.14	73 58 49.41	192 15 37	Alarm Post	12 15 52	2458.7	2688.8	1.52
			232 00 50	McHenry South	52 01 30	1766.2	1931.5	1.09
Highland Hill	41 19 29.38	73 58 02.76	86 21 33	Fort Montgomery	266 21 02	1087.0	1188.7	0.67
			166 26 59	Alarm Post	346 26 43	2400.3	2624.9	1.49
Frants	41 20 31.24	73 57 56.58	290 57 13	McHenry North	110 57 32	711.6	778.2	0.44
			225 59 01	Sugar Loaf	45 59 57	2756.6	3014.5	1.71
West Point Observatory Dome.	41 23 25.59	73 57 00.98	129 48 17	Crow's Nest	209 47 10	3043.8	3328.6	1.89
			210 09 07	Plum Bush	30 10 00	3677.2	4021.3	2.28
Fort Putnam	41 23 21.59	73 57 32.64	258 11 47	Gouverneur	78 12 54	2391.1	2614.8	1.49
			336 52 37	Sugar Loaf	156 53 18	3631 3	3971.1	2.26
Warner's Landing	41 24 01.42	73 56 46.83	300 05 13	Gouverneur	120 05 49	1475.3	1613.4	0.91
			355 28 33	Sugar Loaf	175 28 43	4582.4	5011.2	2.85
Philip's Landing	41 23 19.74	73 56 28.82	53 21 15	Bare Rock	233 19 49	3748.3	4099.0	2.33
			124 36 35	Crow's Nest	304 35 07	3748.5	4099.3	2.33
Kosciuszko's Monument	41 23 38.39	73 56 51.12	271 12 59	Gouverneur	91 13 38	1376.3	1505.1	0.85
			353 11 06	Sugar Loaf	173 11 19	3885.3	4248.9	2.41
West Point Flag-staff	41 23 36.50	73 57 11.22	269 05 27	Gouverneur	89 06 19	1843.3	2015.8	1.14
			246 16 09	Sugar Loaf	166 16 36	3911.2	4277.2	2.43
West Point Lantern	41 23 42.71	73 56 44.81	277 32 03	Gouverneur	97 32 38	1240.2	1356.2	0.77
			209 01 50	Plum Bush	29 02 33	3032.3	3316.0	1.88
Warner	41 24 04.88	73 56 33.99	310 52 13	Gouverneur	130 52 41	1293.6	1414.6	0.80
			211 48 37	Plum Bush	31 49 12	2315.2	2531.8	1.44
Stony Point	41 25 28.55	73 57 47.78	321 50 51	Gouverneur	141 52 08	4358.1	4765.9	2.70
			281 48 13	Plum Bush	101 49 37	2997.1	3277.5	1.86
Rose	41 24 45.95	73 57 56.43	188 41 29	Stony Point	8 41 34	1329.3	1453.7	0.82
			257 23 38	Plum Bush	77 25 08	3212.1	3512.7	1.99

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section II.—Hudson River. Sketch B.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Constitution Island........	41 24 21.73	73 57 16.12	160 22 32	Stony Point............	340 22 11	2188.6	2393.4	1.36
			236 37 50	Plum Bush	56 38 52	2632.7	2879.1	1.64
Cold Spring Spire.........	41 25 02.31	73 57 08.26	8 18 02	Constitution Island.....	188 17 57	1265.2	1383.6	0.78
			264 26 47	Plum Bush	84 27 44	2025.5	2215.0	1.26

Section III.—Chesapeake Bay. Sketch C.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
WOLFTRAP...............	37 24 00.74	76 14 24.32	....	....	....	....	....	....
ROSEMARY	37 19 54.83	76 00 29.21	....	....	....	....	....	....
NEW POINT COMFORT.....	37 18 00.82	76 16 20.64	194 27 27	Wolftrap	14 28 38	11457.5	12529.6	7.12
			261 23 17	Rosemary	81 32 54	23686.2	25902.5	14.72
BACK RIVER POINT	37 05 08.61	76 15 53.95	183 36 50	Wolftrap	3 37 44	34967.2	38239.1	21.73
			219 46 15	Rosemary	39 55 34	35581.6	38911.0	22.11
COSTIN	37 10 35.35	75 59 08.61	67 59 31	Back River Point.......	247 49 25	26777.8	29283.4	16.64
			137 49 26	Wolftrap	317 40 11	33540.6	36679.0	20.84
CAPE HENRY WEST.	36 55 33.88	76 01 19.34	129 24 12	Back River Point.......	309 15 25	27951.6	30567.0	17.37
			186 37 08	Costin.................	6 38 27	27974.0	30591.5	17.38
CAPE CHARLES..	37 07 19.32	75 57 53.92	163 02 46	Costin.................	343 02 00	6317.2	6908.3	3.92
			13 09 35	Cape Henry West......	193 07 31	22329.5	24418.9	13.87
OLD POINT COMFORT......	37 00 46.60	76 17 40.69	291 34 42	Cape Henry West......	111 44 32	26115.2	28558.8	16.23
			236 26 47	Costin.................	56 37 57	32914.3	35994.1	20.45
Upshur....	37 24 07.76	75 58 27.83	20 58 01	Rosemary...............	200 56 47	8349.1	9130.3	5.19
			89 33 11	Wolftrap	269 23 30	23523.0	25724.0	14.62
Tazewell	37 15 27.49	76 01 04.87	128 51 54	Wolftrap	308 43 49	25249.9	27612.5	15.69
			101 54 45	New Point Comfort	281 45 30	23047.0	25203.5	14.32
Cherry Stone.............	37 17 06.11	76 01 13.42	356 02 39	Tazewell...............	176 02 44	3047.3	3332.4	1.89
			94 23 32	New Point Comfort	274 14 25	22406.2	24502.7	13.92
Cherry Grove.............	37 18 19.10	76 00 55.88	117 57 46	Wolftrap	297 49 35	22509.3	24615.5	13.99
			88 39 39	New Point Comfort	268 30 18	22778.3	24909.7	14.15
Painted Tree	37 12 27.44	76 00 34.87	59 15 50	Back River	239 06 35	26405.7	28876.5	16.41
			328 22 29	Costin.................	148 23 21	4057.5	4437.2	2.52
Fisherman's Island........	37 06 06.49	75 58 32.59	11 56 58	Cape Henry West......	191 55 18	19930.4	21795.3	12.38
			173 52 53	Costin.................	353 52 31	8334.9	9114.8	5.18
Smith's Island Light-house	37 07 47.69	75 52 12.14	26 29 45	Cape Henry East..... ..	206 25 03	26017.0	28451.4	16.17
			30 55 18	Cape Henry West......	210 49 48	26383.7	28852.4	16.39
Smith's Island East........	37 07 50.95	75 52 01.95	26 53 24	Cape Henry East.......	206 48 38	26219.7	28673.1	16.29
			31 16 38	Cape Henry West......	211 11 02	26569.5	29055.6	16.51
Smith's Island West	37 06 28.76	75 54 53.31	82 47 20	Fisherman's Island.....	262 45 08	5456.9	5967.5	3.39
			25 19 52	Cape Henry West......	205 16 00	22327.6	24416.7	13.87
Cherry Point..............	37 31 00.36	76 17 26.91	189 33 28	Windmill Point........	9 34 12	10674.7	11673.5	6.63
			260 59 56	Sandy Point	81 12 50	31529.2	34479.4	19.59
Stove Point	37 32 23.06	76 19 23.83	210 10 48	Windmill Point........	30 12 43	9229.0	10092.6	5.73
			311 36 02	Cherry Point...........	131 37 13	3839.1	4198.3	2.39
Brick House Tract........	37 32 43.38	76 18 32.99	332 56 15	Cherry Point...........	152 56 55	3566.2	3899.9	2.22
			63 20 59	Stove Point............	243 20 28	1396.2	1526.8	0.87
Burton	37 30 13.81	76 19 43.35	200 31 58	Brick House Tract.....	20 32 41	4923.8	5384.5	3.06
			246 48 15	Cherry Point...........	66 49 38	3644.8	3985.8	2.27
Narrow's Point	37 29 33.08	76 18 24.66	123 01 05	Burton	303 00 17	2304.8	2520.5	1.43
			207 47 03	Cherry Point...........	27 47 39	3041.4	3326.0	1.89
Cedar Dell................	37 32 36.84	76 20 07.69	265 01 36	Brick House Tract.....	85 02 34	2332.9	2551.2	1.45
			352 16 56	Burton	172 17 11	4449.1	4865.4	2.77
Mobjack Bay.								
Hog Island	37 15 47.75	76 22 44.69	246 31 31	New Point Comfort	66 35 24	10310.5	11275.3	6.41
			332 45 09	Back River Point.......	152 49 17	22153.8	24226.7	13.67

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section III.—Chesapeake Bay. Sketch C.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Rock Point	37 18 36.77	76 23 06.84	276 17 21	New Point Comfort	96 21 27	10063.1	11004.7	6.25
			354 01 17	Hog Island	174 01 30	5238.6	5728.8	3.26
White's Point	37 22 03.42	76 20 56.79	317 42 35	New Point Comfort	137 45 23	10105.5	11051.1	6.28
			26 41 31	Rock Point	206 40 12	7129.0	7796.1	4.43
Thomas	37 21 52.62	76 19 58.73	103 07 40	White's Point	283 07 05	1466.8	1604.1	0.91
			37 30 09	Rock Point	217 28 15	7608.0	8319.9	4.73
Isle of Wight	37 22 56.94	76 22 48.45	3 13 58	Rock Point	183 13 47	8032.4	8784.0	4.99
			300 58 48	White's Point	120 59 56	3204.2	8504.0	1.99
Ware River Point	37 20 36.82	76 24 09.45	337 23 05	Rock Point	157 23 43	4008.7	4383.8	2.49
			240 36 09	White's Point	60 38 06	5440.7	5949.8	3.38
Ware Neck	37 22 04.10	76 24 09.33	346 27 59	Rock Point	166 28 37	6573.3	7188.4	4.09
			270 14 20	White's Point	90 16 17	4737.0	5180.3	2.94
Bare Neck	37 21 10.84	76 19 31.94	48 11 41	Rock Point	228 09 30	7121.5	7787.9	4.42
			127 36 29	White's Point	307 35 37	2656.6	2905.2	1.65
Windmill	37 21 41.22	76 26 12.37	256 52 47	Ware Neck	76 54 02	8760.5	9580.2	5.44
			303 16 12	Ware River Point	123 17 27	3618.1	3956.6	2.25
Vaughan	37 22 33.07	76 25 02.83	257 26 40	Isle of Wight	77 28 01	3386.6	3703.5	2.10
			338 35 27	Rock Point	158 36 37	7823.5	8555.6	4.86
Lone Point	37 24 28.01	76 24 38.23	316 06 36	Isle of Wight	136 07 43	3895.0	4259.5	2.42
			350 53 17	Ware Neck	170 53 35	4492.5	4912.9	2.79
Pepper Point	37 19 41.32	76 18 15.87	74 30 17	Rock Point	254 27 21	7434.3	8129.9	4.62
			137 54 15	White's Point	317 52 37	5905.1	6457.6	3.67
SOUTHERN PART.								
Cow Island Point	37 10 05.65	76 21 13.91	168 01 33	Hog Island	348 00 38	1078.0	1178.9	0.67
			206 14 24	New Point Comfort	26 17 21	1633.4	1786.2	1.02
Thoroughfare	37 13 20.69	76 24 58.64	216 03 03	Hog Island	36 04 24	5607.8	6132.5	3.49
			317 18 43	Cow Island Point	137 20 59	8176.6	8941.7	5.08
Toos Point	37 13 44.12	76 22 47.94	77 22 27	Thoroughfare	257 21 08	3301.3	3610.2	2.05
			181 12 23	Hog Island	1 12 25	3811.8	4168.5	2.37
Green Point	37 12 00.53	76 23 23.67	136 32 51	Thoroughfare	316 31 53	3404.0	3722.5	2.12
			187 48 27	Hog Island	7 48 50	7069.7	7731.2	4.39
Bay Point	37 09 22.90	76 23 08.29	182 49 04	Hog Island	2 49 18	11877.5	12988.9	7.38
			244 58 38	Cow Island Point	64 59 47	3116.5	3408.1	1.94
York Point	37 10 28.64	76 23 14.94	283 20 43	Cow Island Point	103 21 56	3068.5	3355.6	1.91
			355 26 26	Bay Point	175 26 30	2033.0	2223.2	1.26
Drum Island	37 09 06.25	76 19 40.33	128 25 33	Cow Island Point	308 24 37	2946.5	3222.2	1.83
			196 36 51	New Point Comfort	16 38 52	17197.7	18806.9	10.69
Plum Tree	37 07 21.42	76 17 17.39	257 21 51	Costin	77 32 48	27521.8	30097.0	17.10
			333 16 36	Back River Point	153 17 26	4582.9	5011.7	2.85
Plum Tree Marsh	37 06 40.47	76 18 21.62	307 49 01	Back River Point	127 50 30	4616.5	5048.5	2.87
			231 28 04	Plum Tree	51 28 43	2026.6	2216.2	1.26
New Point Comfort Light-house.	37 17 59.56	76 16 22.22	194 35 43	Wolf Trap	14 36 55	11504.9	12581.4	7.15
			261 18 31	Rosemary	81 28 10	23730.3	25950.7	14.75
Old Point Comfort Light-house.	37 00 02.09	76 18 05.69	204 14 46	Old Point Comfort	24 15 01	1504.8	1645.6	0.93
			288 17 19	Cape Henry West	108 27 24	26228.4	28682.6	16.30
Cape Henry Light-house	36 55 28.62	76 00 11.56	95 32 20	Cape Henry West	275 31 39	1685.4	1843.1	1.05
			110 46 53	Old Point Comfort	290 36 22	27737.1	30332.4	17.23
Cape Henry East	36 55 12.02	76 00 01.11	109 11 41	Cape Henry West	289 10 49	2049.9	2241.7	1.27
			187 58 25	Cape Charles	7 59 42	22637.6	24755.8	14.07
Willoughby's Point	36 57 27.61	76 15 06.18	279 39 23	Cape Henry West	99 47 40	20755.4	22697.5	12.90
			224 10 13	Costin	44 19 50	33897.6	37069.4	21.06
Pleasure House Point	36 55 23.35	76 08 05.43	268 07 05	Cape Henry West	88 11 09	10054.6	10995.4	6.25
			205 12 51	Costin	25 18 15	31083.1	33991.5	19.31
Fort Monroe Flag-staff	37 00 01.78	76 18 13.59	288 08 14	Cape Henry West	108 18 24	26410.8	28882.1	16.41
			235 16 23	Costin	55 27 54	34362.8	37578.1	21.34
HAMPTON ROADS, AND NEAR NORFOLK.								
Sewall's Point	36 56 58.28	76 19 03.11	196 08 36	Old Point Comfort	16 09 25	7327.0	8012.6	4.55
			261 12 41	Willoughby's Point	81 15 03	5930.3	6485.2	3.68

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section III.—Near Norfolk. Sketch C.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Bate's Farm	37 00 29.11	76 20 30.33	262 39 22 341 37 50	Old Point Comfort Sewall's Point	82 41 04 161 38 43	4227.9 6847.1	4623.5 7487.8	2.63 4.25
Cely	36 59 02.64	76 23 16.36	248 51 25 301 26 37	Old Point Comfort Sewall's Point	68 54 47 121 29 09	8896.0 7343.6	9728.4 8030.7	5.53 4.56
Segur	37 00 41.26	76 19 21.70	356 10 17 266 12 57	Sewall's Point Old Point Comfort	176 10 28 86 13 57	6888.4 2502.2	7533.0 2736.3	4.28 1.56
Hampton Spire	37 01 29.44	76 20 31.20	287 22 53 345 23 11	Old Point Comfort Sewall's Point	107 24 36 165 24 04	8637.3 4416.2	9445.5 4829.4	5.37 2.74
Newport News	36 57 48.84	76 24 24.02	281 04 48 229 27 07	Sewall's Point Bate's Farm	101 08 01 49 29 28	8089.6 7602.2	8846.6 8313.6	5.03 4.72
Free School Tract	36 54 16.55	76 25 43.58	243 15 49 202 25 49	Sewall's Point Cely	63 19 49 22 27 18	11093.2 9540.6	12131.2 10433.3	6.89 5.93
Craney Island	36 53 19.47	76 20 51.15	161 15 00 103 41 04	Cely Free School Tract	341 13 33 283 38 08	11171.1 7450.1	12216.4 8147.2	6.94 4.63
Tanner's Point	36 54 11.85	76 19 08.57	145 38 58 57 33 50	Cely Craney Island	325 36 29 237 32 48	10859.1 3009.1	11875.2 3290.7	6.75 1.87
Pig Point	36 54 15.48	76 26 21.16	207 18 11 245 07 24	Cely Sewall's Point	27 20 02 65 11 48	11945.2 9962.2	13063.6 10894.4	7.42 6.19
Lambert	36 52 23.94	76 19 02.92	122 34 27 177 35 26	Craney Island Tanner's Point	302 33 22 357 38 23	3179.9 3328.9	3477.4 3640.4	1.98 2.07
Lovett	36 51 36.90	76 20 14.80	164 06 45 230 49 50	Craney Island Lambert	344 06 23 50 50 33	3287.3 2285.6	3594.9 2510.4	2.04 1.43
Buena Vista	36 51 51.93	76 18 32.49	79 39 01 142 38 27	Lovett Lambert	259 38 00 322 38 08	2575.9 1241.7	2816.9 1357.9	1.60 0.77
Bishop	36 51 12.86	76 19 11.61	115 20 12 218 49 09	Lovett Buena Vista	295 19 34 38 49 32	1731.7 1545.5	1893.7 1690.1	1.08 0.96
Colley	36 51 17.08	76 17 49.72	86 20 19 135 23 49	Bishop Buena Vista	266 19 30 315 23 24	2032.6 1508.6	2222.8 1649.8	1.26 0.94
Scotch Creek	36 50 39.83	76 18 56.72	160 05 47 235 19 08	Bishop Colley	340 05 39 55 19 48	1082.9 2018.3	1184.2 2207.2	0.67 1.25
Pinner's Point	36 51 10.74	76 18 48.61	197 27 25 262 22 04	Buena Vista Colley	17 27 34 82 22 40	1330.7 1471.7	1455.1 1609.4	0.83 0.92
Portsmouth, Catholic ch. spire.	36 50 03.37	76 17 54.43	182 56 34 126 03 46	Colley Scotch Creek	2 56 37 306 03 09	2274.9 1909.0	2487.8 2087.6	1.37 1.19
Portsmouth, navy-yard flag-staff.	36 49 32.03	76 17 25.90	169 40 23 132 53 21	Colley Scotch Creek	349 40 09 312 52 26	3291.5 3071.1	3599.5 3358.5	2.04 1.91
Portsmouth Hospital	36 50 45.52	76 17 54.53	186 59 07 120 08 10	Colley Pinner's Point	6 59 10 300 07 37	980.1 1548.9	1071.8 1693.8	0.61 0.96
Fort Norfolk	36 51 19.62	76 18 06.65	147 16 25 75 14 56	Buena Vista Pinner's Point	327 16 09 255 14 31	1183.6 1074.6	1294.4 1175.2	0.74 0.67
Sunny Side	36 51 05.07	76 20 27.39	243 05 10 197 38 10	Buena Vista Lovett	63 06 19 17 38 18	3191.4 1029.3	3490.0 1125.6	1.98 0.64
Town Point	36 50 41.97	76 17 26.36	98 54 10 151 52 28	Hospital Colley	278 53 54 331 52 14	706.2 1227.0	772.3 1341.8	0.44 0.76
Grices	36 50 16.29	76 17 36.40	153 30 03 197 25 38	Hospital Town Point	333 29 52 17 25 44	1006.7 829.8	1100.9 907.5	0.62 0.52
Norfolk City Hall	36 50 46.33	76 17 01.40	43 07 04 88 55 05	Grices Hospital	223 06 43 268 54 33	1268.4 1316.3	1387.1 1439.5	0.79 0.82
Norfolk Baptist Church	36 50 57.07	76 16 55.22	58 54 15 114 33 40	Town Point Colley	238 53 56 294 33 07	901.0 1484.1	985.3 1623.0	0.56 0.92
Quarantine	36 54 00.09	76 18 34.24	69 44 16 29 26 20	Craney Island Lovett	249 42 54 209 25 20	3613.3 5067.6	3951.4 5541.8	2.25 3.15
Sewall's Tree	36 56 45.73	76 19 18.78	19 47 05 125 42 13	Craney Island Colley	199 46 10 305 39 51	6755.9 7234.5	7388.1 7911.4	4.20 4.50
APPOMATTOX RIVER.								
West Base	37 14 10.78	77 22 36.02	....	....	....	....	....	....
East Base	37 14 27.21	77 21 35.28	71 18 42	West Base	251 18 09	1580.1	1728.0	0.98
Finn	37 14 43.60	77 23 09.71	320 36 42 282 14 11	West Base East Base	140 37 02 102 15 08	1308.7 2381.2	1431.1 2604.0	0.81 1.48

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section III.—Appomattox River. Sketch C.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Roslyn	37 14 25.44	77 23 34.86	287 17 56	West Base	107 18 31	1519.0	1661.1	0.94
			227 54 45	Finn	47 55 00	835.1	913.2	0.52
Friend	37 14 45.15	77 22 18.98	72 00 29	Roslyn	251 59 43	1966.1	2150.1	1.22
			87 48 49	Finn	267 48 18	1251.0	1368.0	0.78
Archer	37 15 34.25	77 22 38.57	322 57 15	East Base	142 57 53	2588.8	2831.0	1.61
			342 18 55	Friend	162 19 07	1588.7	1737.4	0.99
Walthall	37 15 48.54	77 20 57.82	45 40 22	Friend	225 39 33	2796.0	3057.6	1.74
			79 56 57	Archer	259 55 56	2521.0	2756.9	1.57
Hare	37 16 35.49	77 22 01.72	25 41 15	Archer	205 40 53	2094.7	2290.7	1.30
			312 35 39	Walthall	132 36 18	2138.1	2338.2	1.33
Gilliam	37 16 57.11	77 20 55.27	1 41 56	Walthall	181 41 55	2114.5	2312.4	1.31
			67 51 02	Hare	247 50 22	1766.8	1932.1	1.10
Brick House	37 17 15.04	77 21 47.56	15 57 58	Hare	195 57 49	1268.0	1386.6	0.79
			293 13 25	Gilliam	113 13 57	1401.3	1532.4	0.87
Heth	37 17 55.29	77 20 37.38	13 48 36	Gilliam	193 48 26	1846.6	2019.4	1.15
			54 20 09	Brick House	234 19 27	2127.5	2326.6	1.32
Port Walthall	37 18 27.50	77 21 48.39	299 34 58	Heth	119 35 41	2010.9	2199.1	1.25
			359 28 26	Brick House	179 28 27	2233.6	2442.6	1.39
Buram	37 18 30.63	77 20 03.54	37 24 26	Heth	217 24 05	1371.6	1499.9	0.85
			140 33 01	Cobb	320 32 36	1596.3	1749.7	0.99
Cobb	37 19 10.62	77 20 44.74	49 42 06	Port Walthall	229 41 27	2054.8	2247.1	1.28
			355 32 03	Heth	175 32 07	2329.1	2547.0	1.45
Strachan	37 19 01.73	77 19 17.39	97 16 03	Cobb	277 15 10	2167.9	2370.7	1.35
			49 51 12	Buram	229 50 44	1486.6	1625.7	0.93
Bland	37 18 28.77	77 18 14.82	91 14 07	Buram	271 13 01	2677.7	2924.7	1.66
			123 24 23	Strachan	303 23 45	1845.4	2018.1	1.15
Cedar Grove	37 19 04.98	77 18 29.49	85 08 23	Strachan	265 07 54	1183.5	1294.2	0.74
			342 03 52	Bland	162 04 01	1173.2	1283.0	0.73
Comer	37 18 28.49	77 17 14.54	121 22 28	Cedar Grove	301 21 43	2161.4	2363.6	1.34
			90 20 48	Bland	270 20 11	1484.3	1623.2	0.92
Rae	37 19 37.66	77 17 20.29	32 18 19	Bland	212 17 46	2512.3	2747.4	1.56
			356 11 54	Comer	176 11 57	2137.0	2337.0	1.33
City Point	37 18 59.12	77 16 23.68	71 08 00	Bland	251 06 53	2891.8	3162.4	1 80
			52 58 30	Comer	232 57 59	1568.3	1715.0	0.98
Bolling's House	37 13 47.25	77 23 49.35	196 52 41	Roslyn	16 52 50	1230.3	1345.4	0.76
			248 07 33	West Base	68 08 17	1947.7	2130.0	1.21
Petersburg, Catholic church	37 13 35.75	77 24 08.44	208 22 58	Roslyn	28 23 15	1741.0	1903.9	1.08
			244 37 45	West Base	64 38 41	2521.1	2757.0	1.57
Petersburg, Methodist ch.	37 13 36.87	77 23 53.89	207 09 14	Archer	27 10 00	4066.8	4447.3	2.53
			197 23 15	Roslyn	17 23 26	1568.8	1715.6	0.98
Petersburg, Presbyterian church spire.	37 13 46.13	77 24 03.56	250 52 36	East Base	70 54 06	3867.6	4229.5	2.40
			250 35 38	West Base	70 36 31	2287.5	2501.5	1.42
Petersburg Court-house	37 13 47.85	77 23 57.71	205 55 10	Roslyn	25 55 24	1288.4	1409.0	0.80
			234 00 56	Friend	54 01 56	3006.7	3288.0	1.87
Dead Tree, at Gilliam's	37 16 52.95	77 21 03.33	69 29 20	Hare	249 28 45	1535.6	1679.3	0.95
			159 09 30	Port Walthall	339 09 03	3118.5	3410.3	1.94

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IV.—Seacoast South of Bodie's Island. Sketch D.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
South End of Bodie's Island Base.	35 48 34.03	E. 0 38 25.44	....	....	....	....	....	....
Fifth Mile Stone..........	35 49 57.40	0 37 40.89	336 28 22	South End of Base.....	156 28 48	2801.6	3063.8	1.74
South Duck Island........	35 47 40.11	0 36 04.94	244 45 40	South End of Base.....	64 47 02	3899.3	4264.2	2.42
			209 38 41	Fifth Mile Stone	29 39 37	4868.3	5323.8	3.02
Bodie's Island Light-house.	35 47 20.56	0 39 23.77	147 06 54	South End of Base.....	327 06 20	2696.5	2948.8	1.68
			96 53 48	South Duck Island.....	276 51 52	5028.4	5498.9	3.12
Midget	35 47 32.96	0 39 40.78	134 52 15	South End of Base.....	314 51 30	2668.4	2918.1	1.66
			92 20 49	South Duck Island.....	272 18 43	5423.7	5931.2	3.37
Green Island	35 45 57.84	0 39 13.59	165 54 18	South End of Base.....	345 53 50	4963.1	5427.5	3.08
			193 06 36	Midget..................	13 06 52	3009.7	3291.3	1.87
Wreck Safford............	35 45 39.37	0 40 56.19	102 27 36	Green Island...........	282 26 36	2639.1	2886.0	1.64
			151 35 26	Midget..................	331 34 41	3979.8	4352.2	2.47
Salt Pump................	35 46 48.87	0 39 49.28	321 52 28	Wreck Safford.........	141 53 07	2722.2	2976.9	1.69
			29 41 12	Green Island...........	209 40 51	1810.1	1979.5	1.12
Eagle Nest Point..........	35 44 10.60	0 40 17.55	154 04 36	Green Island...........	334 03 59	3674.6	4018.4	2.28
			119 32 03	Wreck Safford.........	19 32 26	2902.8	3174.4	1.80
Gar Island................	35 45 10.56	0 39 54.45	144 50 33	Green Island...........	324 50 09	1782.1	1948.9	1.11
			342 33 39	Eagle Nest Point.......	162 33 53	1936.7	2117.9	1.20
Ethridge's House	35 44 32.66	0 41 16.05	65 10 53	Eagle Nest Point.......	245 10 19	1619.4	1770.9	1.01
			166 21 46	Wreck Safford.........	346 21 34	2115.5	2313.5	1.31
Brig Adams	35 43 56.45	0 41 44.76	101 15 43	Eagle Nest Point.......	281 14 51	2234.3	2443.4	1.39
			158 57 44	Wreck Safford.........	338 57 16	3398.4	3716.4	2.11
Pea Island................	35 42 37.50	0 40 41.34	168 13 56	Eagle Nest Point.......	348 13 42	2930.6	3204.8	1.82
			213 13 29	Brig Adams............	33 14 06	2908.5	3180.7	1.81
Little Pea Island..........	35 43 14.27	0 40 33.65	166 53 03	Eagle Nest Point.......	346 52 54	1782.6	1949.4	1.11
			233 57 29	Brig Adams............	53 58 11	2209.8	2416.6	1.37
Pea Island Main..........	35 43 06.41	0 41 20.57	201 30 48	Brig Adams............	21 31 02	1657.6	1812.7	1.03
			47 54 37	Pea Island.............	227 54 14	1328.9	1453.3	0.82
New Inlet, North Point...	35 42 00.60	0 42 20.36	114 33 47	Pea Island............	294 32 49	2736.4	2992.5	1.70
			165 56 07	Brig Adams............	345 55 46	3680.5	4024.9	2.29
Jack Shoal................	35 41 09.05	0 41 13.98	163 14 59	Pea Island............	343 14 40	2846.8	3113.2	1.77
			226 23 57	New Inlet, North Point.	46 24 36	2304.1	2519.9	1.43
New Inlet, South Point...	35 41 03.97	0 42 35.58	94 22 01	Jack Shoal............	274 21 13	2057.4	2249.9	1.28
			167 38 20	New Inlet, North Point.	347 38 11	1786.7	1953.9	1.11
SEACOAST FROM NEW INLET TO CAPE HATTERAS.								
South of New Inlet Signal.	35 40 16.89	0 42 45.88	124 49 48	Jack Shoal.......	304 48 54	2814.7	3078.1	1.75
			168 39 02	New Inlet, North Point.	348 38 47	3259.9	3564.9	2.02
Loggerhead Inlet..........	35 38 14.83	0 42 49.18	155 58 28	Jack Shoal............	335 57 33	5878.3	6428.3	3.65
			178 44 16	South of New Inlet....	358 44 14	3762.3	4114.3	2.34
Loggerhead Shoal.........	35 37 59.49	0 42 13.60	242 09 20	Loggerhead Inlet.......	62 09 41	1012.3	1107.0	0.63
			190 51 04	South of New Inlet....	10 51 23	4311.7	4715.2	2.68
Chickamicomico North ...	35 36 11.38	0 43 43.37	145 52 08	Loggerhead Shoal......	325 51 16	4025.2	4401.8	2.50
			160 17 08	Loggerhead Inlet.......	340 16 37	4041.4	4419.6	2.51
Windmill..................	35 35 52.65	0 43 03.47	175 18 36	Loggerhead Inlet.......	355 18 28	4396.4	4807.8	2.73
			240 07 11	Chickamicomico North.	60 07 35	1158.3	1266.7	0.72
Chickamicomico Main....	35 34 46.87	0 43 19.76	192 51 17	Chichamicomico North.	12 51 30	2671.3	2921.3	1.66
			168 33 54	Windmill	348 33 45	2068.4	2261.9	1.29
Chickamicomico, (2)......	35 35 08.14	0 43 49 67	139 42 45	Windmill...............	319 42 18	1798.5	1966.8	1.12
			48 57 31	Chickamicomico Main..	228 57 14	998.4	1091.8	0.62
Chickamicomico, (3)......	35 34 17.73	0 43 46.93	142 42 29	Chickamicomico Main..	322 42 13	1128.9	1234.5	0.70
			182 32 45	Chickamicomico, (2)...	2 32 46	1555.2	1700.7	0.97
Chickamicomico, (4)......	35 32 45.10	0 43 33.09	174 53 24	Chickamicomico Main..	354 53 16	3767.3	4119.8	2.34
			186 57 36	Chickamicomico, (3)...	6 57 45	2875.5	3144.6	1.79
Opening Marsh...........	35 33 05.77	0 42 54.34	210 50 19	Chickamicomico, (3)...	30 50 50	2582.6	2824.3	1.61
			303 08 02	Chickamicomico, (4)...	123 08 24	1165.3	1274.3	0.72
Wreck Dolphin...........	35 31 20.35	0 43 05.89	174 53 07	Opening Marsh.........	354 53 00	3261.6	3566.8	2.03
			194 41 49	Chickamicomico, (4)...	14 42 05	2700.0	2952.6	1.68
No Egg Point.............	35 31 47.72	E. 0 42 22.53	225 08 29	Chickamicomico, (4)...	45 09 10	2506.9	2741.5	1.56
			307 39 08	Wreck Dolphin	127 39 33	1379.9	1509.0	0.86

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IV.—Seacoast from New Inlet to Cape Hatteras. Sketch D.

Name or station.	Latitude.	Longitude.	Azimuth.	To station –	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Cedar Hammock Island...	35 30 37 96	E. 0 42 01.51	193 50 08	No Egg Point..........	13 50 20	2213.7	2420.8	1.38
			231 08 42	Wreck Dolphin	51 09 20	2082.8	2277.7	1.29
Bay Signal	35 29 49.66	0 42 47.83	141 53 58	Cedar Hammock Island.	321 53 31	1891.5	2068.5	1.18
			189 14 43	Wreck Dolphin........	9 14 54	2831.7	3096.7	1.76
Myrtle Signal............	35 28 17.07	0 42 33.86	169 22 00	Cedar Hammock Island.	349 21 41	4417.6	4831.0	2.74
			92 55 53	Gull Island............	272 54 15	4270.6	4670.2	2.65
Gull Island..............	35 28 24.13	0 39 44.07	240 15 37	Bay Signal.............	60 17 24	5316.0	5813.4	3.30
			219 53 27	Cedar Hammock Island.	39 54 47	5376.2	5879.3	3.34
Little Hill................	35 26 20.20	0 42 26.08	183 06 57	Myrtle Signal	3 07 02	3606.9	3944.4	2.24
			133 11 26	Gull Island.............	313 09 53	5581.1	6103.3	3.47
Drain Island.............	35 25 56.91	0 41 48.74	194 45 09	Myrtle Signal	14 45 36	4466.3	4884.2	2.78
			232 41 47	Little Hill..............	52 42 09	1183.9	1294.7	0.74
Bald Beach...............	35 25 19.04	0 42 23.33	143 13 40	Drain Island............	323 13 19	1457.3	1593.7	0.91
			182 06 30	Little Hill.............	2 06 32	1885.9	2062.4	1.17
Terrapin Point............	35 24 46.32	0 41 43.95	183 10 43	Drain Island...........	3 10 45	2178.7	2382.6	1.35
			224 34 31	Bald Beach............	44 34 54	1415.2	1547.6	0.88
Barnes' Signal............	35 24 27.20	0 42 18.23	124 16 45	Terrapin Point.........	304 16 25	1046.3	1144.2	0.65
			184 36 34	Bald Beach............	4 36 37	1602.5	1752.4	1.00
Bog Channel..............	35 23 56.45	0 41 32.10	191 00 49	Terrapin Point.........	11 00 56	1565.6	1712.1	0.97
			230 50 53	Barnes' Signal.........	50 51 19	1500.7	1641.1	0.94
Bog Opening.............	35 23 17.55	0 41 58.10	151 18 26	Bog Channel...........	331 18 11	1366.6	1494.5	0.85
			193 18 33	Barnes' Signal.........	13 18 45	2205.5	2411.9	1.37
Old Tree..................	35 22 43.91	0 40 27.18	183 10 24	Bog Channel...........	3 10 27	2238.9	2448.4	1.39
			216 57 47	Bog Opening...........	36 58 05	1297.5	1418.9	0.81
Stowe.....................	35 22 27.92	0 41 46.57	135 13 12	Old Tree	315 13 00	694.4	759.4	0.43
			190 46 29	Bog Opening...........	10 46 36	1557.1	1702.8	0.97
Mill Creek................	35 22 04.23	0 41 06.70	202 55 11	Old Tree	22 55 23	1327.6	1451.8	0.82
			234 02 31	Stowe..................	54 02 54	1243.1	1359.4	0.77
Scarborough..............	35 21 17.06	0 41 18.74	168 11 21	Mill Creek.............	348 11 14	1484.9	1623.9	0.92
			197 49 52	Stowe	17 50 08	2293.5	2508.1	1.43
Lookout, (1)..............	35 21 08.84	0 40 32.66	206 43 15	Mill Creek.............	26 43 34	1910.9	2089.7	1.19
			257 42 39	Scarborough............	77 43 05	1190.6	1302.0	0.74
Lookout, (2)..............	35 20 38.43	0 40 59.75	143 52 46	Lookout, (1)...........	323 52 30	1160.3	1268.9	0.72
			201 55 59	Scarborough...........	21 56 10	1283.5	1403.6	0.81
Barnes' Mill..............	35 20 04.44	0 40 18.91	189 55 16	Lookout, (1)...........	9 55 24	2014.9	2203.4	1.25
			224 32 54	Lookout, (2)...........	44 33 17	1470.0	1607.6	0.91
Lookout, (3)..............	35 20 07.11	0 40 58 21	85 15 06	Barnes' Mill...........	265 14 37	995.9	1089.1	0.62
			182 18 24	Lookout, (2)...........	2 18 25	965.8	1056.2	0.60
Long Point...............	35 18 38.96	0 40 21.33	178 40 11	Barnes' Mill	358 40 10	2634.7	2881.2	1.64
			198 55 22	Lookout, (3)...........	18 55 43	2871.8	3140.5	1.79
Jardella..................	35 18 12.47	0 40 56.07	164 47 01	Barnes' Mill............	344 46 40	3575.7	3910.3	2.22
			132 55 35	Long Point	312 55 15	1198.6	1310.8	0.74
Log.......................	35 16 54.91	0 40 50.83	166 54 55	Long Point	346 54 37	3291.9	3599.9	2.05
			183 10 12	Jardella................	3 10 15	2393.8	2617.8	1.49
Palmetto..................	35 16 10.54	0 39 44.93	191 21 57	Long Point.............	11 22 17	4665.1	5101.6	2.90
			230 36 39	Log.....................	50 37 18	2154.7	2356.3	1.34
Last Signal..........	35 15 51.32	0 40 45.35	111 12 13	Palmetto...............	291 11 38	1637.8	1791.1	1.02
			184 02 38	Log.....................	4 02 41	1904.3	2148.1	1.22
SEACOAST FROM CAPE HATTERAS TO BEAUFORT HARBOR.								
Cape Hatteras Light-house	35 15 11.28	0 40 09.33	161 20 37	Palmetto.....	341 20 23	1927.4	2107.7	1.20
			216 25 23	Last Signal............	36 25 45	1533.4	1676.9	0.95
King's Point..............	35 16 11.93	0 35 16.53	226 48 28	Barnes' Mill............	46 51 23	10472.8	11452.8	6.51
			284 09 01	Cape Hatteras Light....	104 11 50	7632.7	8346.9	4.74
Jannet's Mill	35 16 16.79	0 38 52.92	88 26 55	King's Point...........	268 24 50	5470.4	5982.3	3.40
			197 11 50	Barnes' Mill	17 12 40	7343.7	8030.9	4.56
Bare Hill.................	35 13 25.60	0 32 37.81	218 02 22	King's Point...........	38 03 54	6508.9	7118.0	4.04
			254 02 28	Cape Hatteras Light....	74 06 49	11870.3	12981.0	7.38
Egg Shoal........	35 15 29.65	E. 0 28 27.88	262 46 39	King's Point...........	82 50 35	10409.6	11383.6	6.47
			301 09 13	Bare Hill...............	121 11 37	7384.8	8075.8	4.59

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IV.—Seacoast from Cape Hatteras to Beaufort Harbor. Sketch D.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Porpoise	35 12 25.62	E. 0 30 11.80	243 23 54	Bare Hill	63 25 18	4129.0	4515.4	2.56
			227 49 23	King's Point	47 52 19	10391.3	11363.6	6.46
Duran's Point	35 14 02.82	0 30 35.23	129 44 24	Egg Shoal	309 43 11	4186.1	4577.8	2.60
			290 17 51	Bare Hill	110 19 02	3304.7	3613.9	2.05
East Inlet	35 11 52.77	0 27 50.59	188 01 34	Egg Shoal	8 01 56	6749.2	7380.7	4.19
			254 09 54	Porpoise	74 11 16	3712.2	4059.6	2.31
West Inlet	35 11 08.53	0 26 22.45	247 42 47	Porpoise	67 44 59	6268.8	6855.4	3.89
			201 30 09	Egg Shoal	21 31 21	8648.9	9458.2	5.37
Legged Lump	35 12 17.78	0 21 33.56	286 15 21	West Inlet	106 18 08	7612.6	8324.9	4.73
			240 31 33	Egg Shoal	60 35 32	12028.8	13154.3	7.47
Wells' Creek	35 10 07.11	0 23 15.50	248 11 55	West Inlet	68 13 43	5099.1	5576.2	3.17
			147 25 12	Legged Lump	327 24 13	4778.8	5226.0	2.97
Great Swash	35 08 52.74	0 19 01.33	250 21 13	Wells' Creek	70 23 39	6823.3	7461.8	4.24
			211 21 08	Legged Lump	31 22 36	7399.5	8091.9	4.60
Clark's Reef	35 09 45.56	0 18 06.95	265 06 36	Wells' Creek	85 09 34	7830.6	8563.3	4.87
			228 04 38	Legged Lump	48 06 37	7022.8	7679.9	4.36
First Hammock Hill	35 07 14.19	0 15 10.45	223 45 05	Clark's Reef	43 46 47	6458.5	7062.8	4.01
			242 31 29	Great Swash	62 33 42	6586.2	7202.5	4.09
Our Reef	35 08 39.01	0 12 53.24	267 22 14	Great Swash	87 25 46	9325.8	10198.4	5.79
			306 57 01	First Hammock Hill	126 58 20	4346.7	4753.4	2.70
Ocracoke Light-house	35 06 31.25	0 12 15.58	253 20 44	First Hammock Hill	73 22 25	4621.1	5053.5	2.87
			193 36 39	Our Reef	13 37 01	4050.7	4429.7	2.52
Middle Ground	35 05 33.18	0 11 00.97	243 44 59	First Hammock Hill	63 47 23	7042.6	7701.6	4.38
			206 23 32	Our Reef	26 24 37	6393.1	6991.3	3.97
Beacon Island	35 06 02.42	0 08 37.88	283 57 12	Middle Ground	103 58 34	3734.1	4083.5	2.32
			233 14 40	Our Reef	53 17 07	8067.2	8822.0	5.01
East Portsmouth	35 03 54.80	0 08 38.18	230 01 20	Middle Ground	50 02 42	4719.3	5160.9	2.93
			179 53 22	Beacon Island	359 53 22	3932.5	4300.5	2.44
Shell Island	35 06 10.24	0 06 35.34	274 25 44	Beacon Island	94 26 54	3112.3	3403.5	1.93
			323 17 09	East Portsmouth	143 18 19	5205.4	5692.5	3.23
Portsmouth Castle	35 05 50.06	0 07 05.59	260 44 22	Beacon Island	80 45 15	2368.0	2589.6	1.47
			326 33 20	East Portsmouth	146 34 13	4256.2	4654.5	2.64
Portsmouth Steeple	35 04 08.82	0 07 44.81	201 00 07	Beacon Island	21 00 37	3749.8	4100.7	2.33
			154 49 13	Shell Island	334 48 33	4134.5	4521.4	2.57
South Portsmouth	35 01 58.95	E. 0 05 38.61	190 30 36	Shell Island	10 31 09	7875.5	8612.4	4.89
			231 52 06	East Portsmouth	51 53 49	5783.4	6324.6	3.59
Harbor Island	34 59 16.58	W. 0 01 52.53	225 14 09	Shell Island	45 19 01	18113.6	19808.5	11.25
			246 20 16	South Portsmouth	66 24 35	12483.5	13651.6	7.76
Wade	34 59 02.90	E. 0 02 10.21	224 13 39	South Portsmouth	44 15 39	7572.6	8281 2	4.71
			93 56 20	Harbor Island	273 54 01	6170.0	6747.3	3.83
Chadwick	34 55 59.18	W. 0 01 13.90	170 51 04	Harbor Island	350 50 42	6161.2	6737.7	3.83
			222 25 50	Wade	42 27 47	7671.7	8389.5	4.77
Lupton's Mill	34 57 14.61	0 05 11.17	233 15 43	Harbor Island	53 17 37	6285.7	6873.9	3.91
			291 05 33	Chadwick	111 07 49	6453.2	7057.0	4.01
Long Point	34 56 17.55	0 05 14.81	222 54 38	Harbor Island	42 56 34	7534.1	8239.1	4.68
			275 16 16	Chadwick	95 18 34	6139.4	6713.9	3.81
Hog Island	34 59 01.95	0 04 46.99	264 09 59	Harbor Island	84 11 39	4447.1	4863.2	2.76
			7 56 04	Long Point	187 55 48	5114.7	5593.3	3.18
Horse Island	34 53 10.14	0 05 00.20	176 19 38	Long Point	356 19 28	5786.4	6327.8	3.60
			227 46 59	Chadwick	47 49 09	7754.0	8479.5	4.82
Lookout	34 55 23.33	0 06 22.87	261 57 29	Chadwick	82 00 28	7918.2	8659.1	4.92
			332 54 47	Horse Island	152 55 34	4609.4	5040.7	2.86
Hall's Point	34 54 24.90	0 07 19.22	222 16 48	Long Point	42 17 59	4692.1	5131.1	2.92
			303 07 18	Horse Island	123 08 37	4214.4	4608.7	2.62
White Point	34 53 09.56	0 08 20.98	219 11 31	Long Point	39 13 18	7475.4	8174.9	4.65
			269 46 56	Horse Island	89 48 51	5097.8	5574.8	3.17
Cow Pen	34 50 45.92	0 08 01.74	173 42 02	White Point	353 41 51	4452.7	4869.4	2.77
			226 02 21	Horse Island	46 04 05	6403.3	7002.5	3.98
Mill Point	34 51 23.60	W. 0 11 17.04	233 50 42	White Point	53 52 23	5536.1	6054.1	3.44
			283 09 16	Cow Pen	103 11 08	5094.7	5571.4	3.17

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section IV.—Seacoast from Cape Hatteras to Beaufort Harbor. Sketch D.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Cedar Inlet	34 49 00.68	W.0 09 53.08	154 09 48	Mill Point	334 09 00	4893.0	5350.8	3.04
			221 05 23	Cow Pen	41 06 27	4303.3	4706.0	2.67
Mill	34 52 16.43	0 10 47.89	203 26 48	Cow Pen	123 28 23	5058.2	5531.5	3.14
			246 59 52	Cedar Inlet	167 00 23	6190.4	6769.6	3.85
Piney Point	34 49 38.99	0 13 25.03	225 14 17	Mill Point	45 15 30	4578.4	5006.8	2.85
			282 20 44	Cedar Inlet	102 22 45	5513.3	6029.2	3.43
Great Island	34 46 31.20	0 12 23.69	164 55 33	Piney Point	344 54 58	5992.5	6553.2	3.72
			219 43 12	Cedar Inlet	39 44 38	5989.0	6549.4	3.72
Davis' Shore	34 46 49.39	0 16 29.16	221 49 51	Piney Point	41 51 36	7014.8	7671.2	4.36
			275 06 46	Great Island	95 09 06	6265.7	6852.0	3.89
Horse Point	34 43 29.53	0 15 05.50	160 56 53	Davis' Shore	340 56 05	6515.3	7125.0	4.05
			216 18 33	Great Island	36 20 05	6947.5	7597.6	4.32
Bell's Point	34 43 44.78	0 18 28.11	207 59 37	Davis' Shore	28 00 45	6442.7	7045.6	4.00
			275 11 28	Horse Point	95 13 24	5175.5	5659.8	3.22
Davis' Island	34 45 13.89	0 17 49.76	19 33 36	Bell's Point	199 33 14	2914.1	3186.8	1.81
			214 50 56	Davis' Shore	34 51 42	3585.8	3921.3	2.23
Lone Signal	34 40 48.11	0 17 25.37	163 39 31	Bell's Point	343 38 55	5672.9	6203.7	3.53
			215 34 28	Horse Point	35 35 48	6116.0	6688.3	3.80
Shell Point	34 40 56.36	0 20 02.13	204 44 30	Bell's Point	24 45 23	5714.1	6248.8	3.55
			273 38 06	Lone Signal	93 39 35	3998.0	4372.1	2.48
Willis Mill	34 43 05.00	0 19 33.39	10 27 15	Shell Point	190 26 59	4030.6	4407.8	2.50
			263 39 04	Horse Point	83 41 37	6856.9	7498.5	4.26
Cape Lookout	34 37 50.40	0 20 26.96	186 17 42	Shell Point	6 17 56	5764.7	6304.1	3.58
			220 09 46	Lone Signal	40 11 29	7166.4	7837.0	4.45
Shackelford	34 39 37.79	0 23 21.21	244 27 02	Shell Point	64 28 55	5616.4	6141.9	3.49
			306 42 03	Cape Lookout	126 43 42	5535.0	6052.9	3.44
Cape Lookout Light-house.	34 37 19.73	0 19 57.94	129 25 47	Shackelford	309 23 51	6699.8	7326.7	4.16
			211 09 52	Lone Signal	31 11 19	7504.1	8206.3	4.66
Lynch	34 42 28.30	0 26 05.61	286 59 53	Shell Point	107 03 20	9674.0	10579.2	6.01
			321 27 07	Shackelford	141 28 41	6716.3	7344.8	4.17
Shackelford Base, west end	34 40 45.77	0 27 18.01	210 14 49	Lynch	30 15 30	3657.3	3999.5	2.27
			289 08 28	Shackelford	109 10 43	6381.5	6978.6	3.97
Shackelford Base, east end	34 40 19.79	0 25 44.99	289 27 31	Shackelford	109 28 53	3882.4	4245.7	2.41
			108 40 45	West Base	288 39 52	2499.2	2733.1	1.55
North Harkers Island	34 42 41.51	0 23 48.69	352 57 13	Shackelford	172 57 29	5703.9	6237.6	3.54
			56 12 47	West Base	236 10 48	6410.4	7010.2	3.93
Fort Macon	34 41 43.55	0 29 15.77	300 42 08	West Base	120 43 15	3486.1	3812.3	2.17
			254 04 51	Lynch	74 06 39	5031.7	5502.5	3.13
Guthries	34 42 45.15	0 27 52.93	346 25 03	West Base	166 25 23	3784.3	4138.4	2.46
			48 00 24	Fort Macon	227 59 37	2836.7	3102.1	1.76
Arendell	34 43 10.11	0 30 53.16	317 05 47	Fort Macon	137 06 42	3640.7	3981.4	2.26
			279 30 20	Guthries	99 32 03	4649.7	5084.8	2.89
Maffitt	34 41 43.20	0 30 52.56	179 40 32	Arendell	359 40 32	2677.9	2928.5	1.66
			287 56 21	West Base	107 58 23	5740.0	6277.1	3.57
Fisherman's Lookout	34 41 10.24	0 27 17.23	162 44 51	Guthries	342 44 31	3062.6	3349.2	1.90
			100 30 49	Maffitt	280 28 47	5573.3	6094.8	3.46
Carrot Island Signal	34 42 19.09	0 27 07.37	105 19 15	Arendell	285 17 06	5956.4	6513.7	3.70
			5 22 16	West Base	185 22 10	2888.0	3158.2	1.80
Middle Marsh	34 41 32.60	0 26 00.30	53 50 00	West Base	233 49 16	2449.9	2679.1	1.52
			127 55 48	Guthries	307 54 44	3632.7	3972.6	2.26
Fort Macon Flag-staff	34 41 43.08	0 29 16.79	137 33 57	Arendell	317 33 02	3633.6	3973.6	2.26
			300 16 56	West Base	120 18 04	3501.1	3828.7	2.18
Beaufort Academy Spire	34 43 03.17	0 28 25.14	27 42 38	Fort Macon	207 42 09	2768.6	3027.7	1.72
			93 15 39	Arendell	273 14 15	3771.8	4124.7	2.34
Beaufort Steam Saw-mill	34 43 14.56	0 28 38.50	87 43 04	Arendell	267 41 47	3428.6	3749.4	2.13
			18 41 24	Fort Macon	198 41 03	2960.5	3237.5	1.84
Large House in Lenoxville	34 42 34 72	0 25 34.70	38 04 22	West Base	218 03 23	4264.0	4663.0	2.65
			78 55 13	Maffitt	258 52 12	8242.8	9014.1	5.12
Beaufort, court-house cupola.	34 43 08.76	W.0 28 21.75	339 47 04	West Base	159 47 40	4695.0	5134.3	2.92
			90 37 57	Arendell	270 36 31	3852.4	4212.9	2.39

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Savannah River. Sketch E, No. 4.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Beaufort, commandant's house.	34 41 39.76	W.0 29 40.55	233 38 55	Guthries	53 39 56	3399.9	3718.0	2.11
			93 18 29	Maffitt	273 17 48	1835.6	2007.4	1.14
Phenix	34 40 46.99	0 28 00.71	271 58 34	West Base	91 58 58	1087.4	1·89.2	0.68
			111 36 38	Maffitt	291 35 00	4704.0	5144.2	2.92
Maffitt's East Base	34 40 34.94	0 26 44.67	118 48 39	Fort Macon	298 47 13	4388.5	4799.1	2.73
			108 27 21	Maffitt	288 25 00	6650.7	7273.0	4.13
Maffitt's West Base	34 40 44.70	0 27 19.38	108 23 35	Maffitt	288 21 24	5717.2	6252.2	3.55
			226 42 09	West Base	46 42 10	47.7	52.2	0.03
Bogue Signal	34 41 48.54	0 32 02.31	275 17 36	Maffitt	95 18 16	1782.4	1949.2	1.11
			214 59 15	Arendell	34 59 54	3067.8	3354.9	1.91
Fish Hut, west end of Carrot island.	34 42 07.10	0 26 08.37	35 15 45	West Base	215 15 05	3069.0	3356.2	1.91
			113 46 51	Guthries	293 45 52	2908.0	3180.1	1.81
Thoroughfare Marsh	34 43 07.42	0 29 45.51	343 40 36	Fort Macon	163 40 53	2692.7	2944.7	1.67
			92 45 42	Arendell	272 45 03	1723.2	1884.4	1.07
Buoy	34 40 04.89	W.0 27 21.08	183 32 48	West Base	3 32 50	1262.0	1380.1	0.78
			119 23 07	Maffitt	299 21 07	6176.5	6754.4	3.84

Section V.—Savannah River. Sketch E, No. 4.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Union Ferry Causeway. North Base.	32 06 36.68	81 02 36.77	....	....	....	....	....	....
Union Ferry Causeway. South Base.	32 05 35.81	81 03 06.90	202 50 36	North Base	22 50 52	2034.6	2225.0	1.26
Cheves	32 06 24.49	81 04 34.42	303 09 35	South Base	123 10 22	2740.8	2997.3	1.70
			263 02 52	North Base	83 03 55	3106.7	3397.2	1 93
Daniell	32 06 36.20	81 03 09.00	358 18 12	South Base	178 18 13	1860.8	2034.9	1.17
			80 51 34	Cheves	260 50 49	2267.9	2480.1	1.43
Fort Jackson	32 04 57.88	81 01 59.85	162 21 29	North Base	342 21 09	3193.4	3492.2	1.97
			123 36 30	South Base	303 35 54	2110.8	2308.3	1.31
Savannah Exchange	32 04 53.36	81 05 16.85	248 59 58	South Base	69 01 07	3649.4	3990.9	2.27
			201 37 09	Cheves	21 37 31	3019.1	3301.5	1.88
Savannah, Presbyterian ch. spire.	32 04 37.39	81 05 24.18	224 04 30	Daniell	44 05 42	5094.1	5570.9	3.16
			263 16 04	Fort Jackson	83 17 53	5394.9	5899.7	3.35
Fig Island Light-house	32 04 58.24	81 03 35.16	270 14 53	Fort Jackson	90 15 44	2499.0	2732.8	1.55
			206 46 59	North Base	26 47 30	3396.6	3714.4	2.11
Steam Saw Mill	32 05 22.32	81 05 55.24	264 36 46	South Base	84 38 15	4432.8	4847.6	2.75
			227 53 24	Cheves	47 54 07	2856.0	3123.2	1.77
Pennyworth Chimney	32 06 15.17	81 05 22.51	288 49 18	South Base	108 50 30	3756.3	4107.8	2.34
			259 30 32	Daniell	79 31 43	3559.3	3892.4	2.21
Flag in Tree	32 07 52.79	81 03 13.30	398 01 29	Cheves	218 00 46	3452.1	3775.1	2.14
			357 15 57	Daniell	177 15 59	2361.7	2582.7	1.48
Daniell's Tall Chimney	35 05 38.32	81 03 45.63	138 02 03	Cheves	318 01 37	1912.6	2091.6	1.19
			208 18 30	Daniell	28 18 49	2024.8	2214.2	1.26
Habersham's Winnowing House.	32 04 15.07	81 02 45.19	222 02 17	Fort Jackson	42 02 41	1775.4	1941.5	1.10
			167 06 21	South Base	347 06 09	2551.1	2789.8	1.59
Shad's Old Chimney	32 05 34.77	81 00 52.88	90 31 46	South Base	270 30 35	3514.0	3842.8	2.18
			125 00 15	North Base	304 59 20	3324.7	3635.8	2.06
Jos. Huger's Tall Chimney.	32 07 27.00	81 04 57.97	342 13 21	Cheves	162 13 34	2021.8	2211.0	1.26
			298 42 40	Daniell	118 43 38	3256.7	3561.4	2.02
Hamilton's Chimney	32 07 54.46	81 05 47.30	351 51 17	Savannah Exchange	171 51 33	5634.4	6161.6	3.50
			300 08 50	Daniell	120 10 14	4798.4	5247.4	2.98
King	32 07 42.89	81 07 17.93	328 41 47	Savannah Exchange	148 42 51	6110.7	6682.5	3.80
			285 26 46	North Base	105 29 16	7646.2	8361.6	4.75
Smith	32 08 41.06	81 05 48.01	312 41 25	Daniell	132 42 50	5670.7	6201.3	3.52
			353 21 16	Savannah Exchange	173 21 33	7060.2	7720.8	4.39

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section V.—Savannah River. Sketch E, No. 4.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Potter	32 09 04.87	81 08 46.73	278 53 20	Smith	98 54 55	4739.9	5183 4	2.94
			317 19 34	King	137 20 21	3433.5	3754.8	2.13
Heyward	32 09 57.73	81 06 45.77	327 20 41	Smith	147 21 12	2804.8	3067.2	1.74
			62 49 07	Potter	242 48 03	3562.8	3896.2	2.21
Drakie	32 10 33.94	81 09 10.80	286 20 57	Heyward	106 22 14	3959.6	4330.1	2.46
			347 03 08	Potter	167 03 21	2814.9	3078.3	1.75
Argyle	32 12 25.04	81 07 58.32	29 01 39	Drakie	209 01 00	3913.0	4279.1	2.43
			337 16 10	Heyward	157 16 49	4918.9	5319.2	3.06
Pritchard	32 12 37.32	81 09 19.69	356 29 32	Drakie	176 29 37	3807.1	4163.3	2.36
			280 03 48	Argyle	100 04 31	2164.2	2366.7	1.36
Argyle Tree	32 09 00.42	81 07 37.86	347 39 34	King	167 39 45	2444.1	2672.8	1.52
			281 41 54	Smith	101 42 52	2939.5	3214.6	1.83
Onslow Tree	32 09 53.33	81 08 13.64	30 09 18	Potter	210 09 00	1726.0	18875.1	1.07
			129 52 43	Drakie	309 52 13	1951.2	2133.8	1.21
Taylor	32 10 15.75	81 06 54.38	53 26 33	Potter	233 25 33	3664.7	4007.6	2.27
			98 55 03	Drakie	278 53 51	3617.3	3955.8	2.24
Manigault's Mill	32 10 26.85	81 07 15,04	43 34 26	Potter	223 33 37	3485.0	3811.1	2.16
			94 07 32	Drakie	274 06 30	3040.3	3324.8	1.89
Red Mill	32 11 01.35	81 07 02.10	37 23 09	Potter	217 22 13	4514.8	4937.2	2.80
			75 56 51	Drakie	255 55 43	3474.4	3799.5	2.16
Mulberry Grove Tree	32 11 42.02	81 09 24.39	350 21 49	Drakie	170 21 56	2126.8	2325.8	1.32
			239 32 54	Argyle	59 33 40	2614.8	2859.5	1.62
Winckler's Chimney	32 12 11.32	81 08 40.06	127 39 09	Pritchard	307 38 48	1310.7	1433.4	0.81
			248 52 30	Argyle	68 52 52	1171.9	1281.5	0.73
Proctor	32 06 10.11	81 00 53.31	38 06 36	Fort Jackson	218 06 01	2827.1	3091.6	1.76
Rock Point	32 05 35.77	80 59 09.47	75 22 18	Fort Jackson	255 20 47	4617.4	5049.4	2.87
			111 14 10	Proctor	291 13 15	2920.6	3193.9	1.81
Cooper	32 03 45.26	81 00 32.15	212 29 34	Rock Point	32 30 18	4035.6	4413.2	2.51
			134 12 24	Fort Jackson	314 11 37	3208.0	3508.3	1.99
McQueen	32 02 54.56	80 57 01.83	146 01 24	Rock Point	326 00 16	5988.1	6548.3	3.73
			105 49 14	Cooper	285 47 22	5733.4	6269.9	3.56
Norton	32 05 01.93	80 54 59.45	99 03 06	Rock Point	279 00 53	6637.6	7258.7	4.12
			39 17 44	McQueen	219 16 39	5068.6	5542.9	3.12
Fort Pulaski	32 01 41.04	80 53 15.85	156 17 48	Norton	336 16 53	6757.7	7390.0	4.20
			110 55 12	McQueen	290 53 12	6346.0	6939.8	3.95
Mungen	32 04 52.49	80 52 15.71	93 53 06	Norton	273 51 39	4303.5	4706.2	2.67
			14 58 53	Fort Pulaski	194 58 21	6103.9	6675.0	3.79
Tybee Light	32 01 21.35	80 50 33.23	98 06 39	Fort Pulaski	278 05 13	4310.0	4713.3	2.68
			105 45 01	McQueen	285 41 35	10590.6	11581.6	6.58
McKay's House, Flag	32 05 16.70	81 00 55.88	70 56 11	Fort Jackson	250 55 37	1774.8	1940.9	1.10
			182 20 46	Proctor	2 20 47	1646.2	1800.2	1.02
Flag in Pine Tree	32 06 41.67	81 00 35.71	34 36 56	Fort Jackson	214 36 11	3884.1	4247.5	2.41
			25 23 37	Proctor	205 23 28	1076.1	1176.8	0.67
Flag in Palmetto Tree	32 03 54.03	81 00 27.04	128 56 28	Fort Jackson	308 55 39	3128.8	3421.6	1.93
			26 22 29	Cooper	206 22 26	301.7	329.9	0.19
Iron Beacon, South Carolina.	32 05 41.63	80 59 18.40	72 21 18	Fort Jackson	252 19 52	4442.3	4858.0	2.76
			105 33 17	Daniell	285 31 14	6274.4	6861.5	3.90
Iron Beacon, Long Island	32 04 44.39	80 58 58.27	94 59 50	Fort Jackson	274 58 14	4779.6	5226.8	2.97
			169 28 59	Rock Point	349 28 53	1609.4	1760.0	0.99
Wooden Beacon	32 04 29.45	80 58 23.89	98 48 18	Fort Jackson	278 46 24	5730.4	6266.6	3.56
			149 40 30	Rock Point	329 40 06	2366.6	2588.0	1.49
Square Beacon	32 02 21.58	80 53 29.99	343 27 50	Fort Pulaski	163 27 57	1302.2	1424.0	0.81
			100 22 28	McQueen	280 20 36	5649.3	6177.9	3.51

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Florida Reef. Sketch F, No. 3.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Cape Florida	25 39 52.18	0 00 00.00						
Soldier Key	25 35 23.23	W. 0 00 18.22	183 30 49	Cape Florida	3 30 57	8291.1	9066.9	5.15
Shoal Point	25 38 18.35	0 06 52.97	255 54 10	Cape Florida	75 57 09	11873.8	12984.8	7.38
			296 02 54	Soldier Key	116 05 44	12261.9	13409.3	7.62
Ragged Key, (1)	25 32 30.69	0 00 49.68	136 33 49	Shoal Point	316 31 12	14740.3	16119.5	9.16
			189 25 15	Soldier Key	9 23 30	5380.6	5884.1	3.34
Black Point	25 32 07.51	0 09 27.60	200 42 10	Shoal Point	20 43 17	12199.1	13340.6	7.58
			267 08 48	Ragged Key, (1)	87 12 31	14477.7	15832.4	9.00
Elliott's Key, (1)	25 29 04.25	0 01 14.43	187 39 45	Soldier Key	7 40 09	11766.3	12867.3	7.31
			186 12 23	Ragged Key, (1)	6 12 34	6390.3	6988.2	3.97
Elliott's Key, (2)	25 24 51.81	0 02 51.29	140 28 07	Black Point	320 25 16	17385.1	19011.8	10.80
			199 12 32	Elliott's Key, (1)	19 13 14	8222.3	8991.6	5.11
Christmas Point	25 23 23.09	0 04 18.48	151 51 26	Black Point	331 49 13	18300.2	20012.5	11.37
			221 44 52	Elliott's Key, (2)	41 45 30	3659.1	4001.5	2.27
Cæsar's Creek Bank	25 22 54.98	W. 0 02 24.83	105 14 21	Christmas Point	285 13 33	3292.3	3600.4	2.05
			168 22 34	Elliott's Key, (2)	348 22 23	3670.1	4013.5	2.28
Swash Channel	25 38 44.06	E. 0 01 03.46	20 14 30	Soldier Key	200 13 55	6587.2	7203.5	4.09
			139 49 47	Cape Florida	319 49 20	2743.1	2999.8	1.70
Fowey Rocks	25 35 23.05	0 03 33 21	144 19 37	Cape Florida	324 18 05	10195.5	11149.4	6.34
			90 03 24	Soldier Key	270 01 44	6457.7	7062.0	4.01
Little Soldier Key Channel	25 33 40.02	0 00 02.54	34 18 54	Ragged Key, (1)	214 18 31	2585.7	2827.6	1.61
			169 39 27	Soldier Key	349 39 18	3227.2	3529.2	2.01
Triumph Reef	25 28 36.80	0 02 34.27	97 31 12	Elliott's Key, (1)	277 29 34	6442.5	7045.3	4.00
			158 57 00	Soldier Key	338 55 46	13399.6	14653.4	8.33
Long Reef	25 26 45.45	E. 0 02 02.86	127 46 04	Elliott's Key, (1)	307 44 39	6970.1	7622.3	4.33
			66 58 09	Elliott's Key, (2)	246 56 03	8931.4	9767.1	5.55
Bowell's Bank	25 30 23.75	W. 0 00 00.78	40 01 24	Elliott's Key, (1)	220 00 52	3198.4	3497.6	1.99
			160 43 31	Ragged Key, (1)	340 43 10	4135.2	4522.2	2.57
Bache's Shoals	25 28 53.95	E. 0 00 21.97	96 39 01	Elliott's Key, (1)	276 38 20	2710.5	2964.1	1.68
			163 18 00	Ragged Key, (1)	343 17 29	6960.1	7611.4	4.33
Ragged Key, (2)	25 31 16.00	W. 0 01 02.22	309 00 09	Triumph Reef	129 01 42	7780.7	8508.8	4.83
			331 43 18	Bache's Shoals	151 43 54	4963.0	5427.4	3.08
Sands' Cut	25 29 33.01	W. 0 01 15.15	293 53 28	Bache's Shoals	113 54 10	2966.6	3244.2	1.84
			358 42 11	Elliott's Key, (1)	178 42 11	887.7	970.8	0.55
Old Rhodes	25 20 56.21	W. 0 05 00.31	194 30 12	Christmas Point	14 30 30	4668.0	5104.8	2.90
			206 26 32	Elliott's Key, (2)	26 27 28	8096.6	8854.2	5.03
Ajax Reef	25 24 09.05	E. 0 01 24.73	100 26 07	Elliott's Key, (2)	280 24 17	7274.2	7954.8	4.52
			153 55 03	Elliott's Key, (1)	333 53 55	10110.3	11056.3	6.28
Pacific Reef	25 22 13.29	E. 0 00 53.56	127 49 50	Elliott's Key, (2)	307 48 14	7954.8	8699.2	4.94
			76 32 23	Old Rhodes	256 29 51	10173.3	11125.2	6.32
Seagrape Point	25 28 00.90	W. 0 01 46.92	204 59 42	Elliott's Key, (1)	24 59 56	2147.4	2348.4	1.33
			323 05 45	Ajax Reef	143 07 07	8919.8	9754.4	5.54
Point Adelli	25 27 09.09	0 02 02.17	200 38 20	Elliott's Key, (1)	20 38 41	3783.1	4137.0	2.35
			18 00 07	Elliott's Key, (2)	197 59 46	4441.0	4856.6	2.76
Margotfish Shoals	25 26 52.81	0 01 21.49	182 47 36	Elliott's Key, (1)	2 47 39	4045.9	4424.4	2.51
			33 58 55	Elliott's Key, (2)	213 58 16	4489.4	4909.5	2.79
Sawyer's Cove	25 25 43.48	0 02 49.41	292 14 16	Ajax Reef	112 16 05	7672.8	8390.7	4.77
			1 53 27	Elliott's Key, (2)	181 53 26	1590.9	1739.7	0.99
Petrel Point	25 24 36.08	0 02 59.97	303 55 53	Pacific Reef	123 57 32	7867.8	8604.0	4.89
			342 28 39	Cæsar's Creek Bank	162 28 55	3262.3	3567.5	2.03
Channel Stake	25 23 01.63	0 02 18.37	101 08 00	Christmas Point	281 07 09	3421.6	3741.7	2.13
			164 48 59	Elliott's Key, (2)	344 48 45	3512.7	3841.4	2.18
Coral Cove	25 21 42.56	0 04 55.39	242 05 30	Cæsar's Creek Bank	62 06 35	4762.1	5207.7	2.96
			5 30 53	Old Rhodes	185 30 51	1432.5	1566.6	0.89
Cæsar's Creek Point	25 22 54.56	0 04 24 20	15 29 53	Old Rhodes	195 29 38	3778.7	4132.3	2.35
			190 18 42	Christmas Point	10 18 44	892.2	975.7	0.55
Point No Point	25 24 08.76	0 03 33.80	41 37 27	Christmas Point	221 37 08	1880.1	2056.0	1.17
			228 21 42	Petrel Point	48 21 57	1265.1	1383.4	0.77
Old Rhodes Bank	25 20 27.57	W. 0 04 16.25	214 28 20	Cæsar's Creek Bank	34 29 08	5502.2	6017.0	3.42
			179 20 14	Christmas Point	359 20 13	5400.9	5906.3	3.36

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Florida Reef. Sketch F, No. 3.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Master Key	25 23 31.62	W.0 04 41.01	292 38 47	Christmas Point	112 38 57	682.1	746.0	0.42
			337 36 35	Cæsar's Creek Point	157 36 42	1233.5	1348.9	0.77
Turtle Reef	25 16 52.32	0 03 10.04	186 27 41	Cæsar's Creek Point	6 28 00	11229.8	12280.6	6.98
			182 02 02	Elliott's Key, (2)	2 02 10	14762.5	16143.9	9.17
Angelfish Creek	25 19 56.29	0 06 02.92	223 30 39	Old Rhodes	43 31 06	2542.1	2780.0	1.58
			319 29 12	Turtle Reef	139 30 26	7444.4	8141.0	4.63
Palo Alto	25 20 20.93	0 05 55.22	234 44 12	Old Rhodes	54 44 36	1880.3	2056.2	1.17
			15 50 06	Angelfish Creek	195 50 03	788.0	861.7	0.49
Angelfish Key	25 19 21.79	0 06 22.34	225 20 12	Cæsar's Creek Bank	45 21 54	9333.7	10207.1	5.80
			218 17 04	Old Rhodes	38 17 39	3701.3	4047.7	2.30
El Camino	25 16 45.67	0 08 05.63	219 57 58	Cæsar's Creek Bank	40 00 24	14830.3	16217.9	9.22
			213 54 12	Old Rhodes	33 55 31	9288.8	10158.0	5.77
Carysfort Reef Light	25 13 15.25	0 03 20.00	184 56 26	Cæsar's Creek Bank	4 56 50	17903.7	19578.9	11.13
			129 01 33	El Camino	308 59 31	10285.7	11248.2	6.39
Point Perry	25 18 00.57	0 07 22.64	286 32 11	Turtle Reef	106 33 59	7371.1	8060.9	4.58
			216 21 41	Old Rhodes	36 22 42	6711.6	7339.7	4.17
Point Elizabeth	25 14 14.68	0 09 36.95	245 50 33	Turtle Reef	65 53 18	11862.9	12972.2	7.37
			279 48 40	Carysfort Reef Light	99 51 21	10706.7	11708.5	6.65
Largo North	25 18 54.26	0 07 00.42	231 29 47	Angelfish Key	51 30 03	1360.8	1488.1	0.85
			20 37 06	Point Perry	200 36 56	1765.0	1930.1	1.10
Basin Bank	25 12 19.62	0 06 25.01	123 23 41	Point Elizabeth	303 22 20	6433.8	7035.8	4.00
			161 01 25	El Camino	341 00 42	8656.9	9466.9	5.38
Basin Hill	25 13 05.60	0 10 24.11	211 50 08	Point Elizabeth	31 50 28	2501.8	2735.9	1.56
			281 55 19	Basin Bank	101 57 01	6840.5	7480.6	4.23
Point Mary	25 11 39.98	0 11 15.64	208 41 57	Basin Hill	28 42 19	3003.4	3284.4	1.87
			210 07 14	Point Elizabeth	30 07 56	5503.1	6018.0	3.42
Sound Point	25 10 04.78	0 11 37.92	203 45 40	Point Elizabeth	23 46 31	8401.2	9187.3	5.23
			244 38 27	Basin Bank	64 40 40	9692.9	10599.9	6.02
The Elbow	25 08 32.02	0 06 15.98	107 35 06	Sound Point	287 32 49	9455.9	10340.7	5.87
			177 55 56	Basin Bank	357 55 52	7007.5	7663.2	4.35
Grecian Shoals	25 07 22.12	0 08 33.11	134 02 56	Sound Point	314 01 37	7199.5	7873.2	4.47
			201 23 37	Basin Bank	21 24 32	9831.0	10750.9	6.11
Garden Cove, (1)	25 10 52.79	0 11 51.17	214 25 08	Point Mary	34 25 23	1759.9	1924.6	1.09
			345 53 46	Sound Point	165 53 52	1523.1	1665.6	0.95
Garden Cove, (2)	25 09 59.09	0 12 27.68	211 44 24	Garden Cove, (1)	31 44 39	1943.0	2124.8	1.21
			262 49 51	Sound Point	82 50 12	1404.3	1535.7	0.87
Julia Island, (1)	25 09 39.35	0 12 13.18	146 14 30	Garden Cove, (2)	326 14 24	730.4	798.7	0.45
			231 36 23	Sound Point	51 36 38	1259.9	1377.8	0.78
Julia Island, (2)	25 09 27.05	0 12 49.34	212 40 30	Point Mary	32 41 10	4859.3	5314.0	3.02
			211 41 06	Garden Cove, (1)	31 41 31	3099.9	3390.0	1.93
Great Mangroves	25 09 54.64	0 12 49.00	218 52 57	Point Mary	38 53 37	4163.7	4553.3	2.61
			222 08 09	Garden Cove, (1)	42 08 33	2412.7	2638.5	1.50
Point Willie	25 08 10.32	0 12 54.90	234 53 08	Basin Bank	54 55 54	13342.1	14590.5	8.29
			211 28 19	Sound Point	31 28 52	4129.0	4515.5	2.56
Julia Island, (3)	25 09 08.15	0 12 07.98	205 47 13	Sound Point	25 47 26	1935.2	2116.3	1.20
			36 27 17	Point Willie	216 26 57	2211.9	2418.8	1.37
Largo Sound	25 07 57.10	0 14 31 04	230 58 21	Sound Point	50 59 35	6240.1	6824.0	3.88
			261 23 55	Point Willie	81 24 36	2723.2	2978.0	1.69
Lower Sound Point	25 06 18.73	0 14 37.91	259 10 15	Grecian Shoals	79 12 50	10403.8	11377.3	6.46
			183 38 05	Largo Sound	3 38 06	3032.5	3316.3	1.88
Magg's Cove	25 08 55.10	0 12 48.35	250 26 50	Julia Island, (3)	70 27 07	1199.7	1311.9	0.75
			7 35 37	Point Willie	187 35 34	1389.9	1519.9	0.86
French Reef	25 02 06.01	0 11 40.78	147 27 22	Lower Sound Point	327 26 07	9224.8	10087.9	5.73
			169 30 24	Point Willie	349 29 53	11400.5	12467.3	7.08
Dry Rocks	25 02 34.63	0 12 47.74	178 53 12	Point Willie	358 53 09	10330.8	11297.5	6.42
			155 53 06	Lower Sound Point	335 52 19	7554.5	8261.4	4.69
Hull Key	25 08 28.95	0 13 49.17	290 39 00	Point Willie	110 39 23	1624.3	1776.3	1.01
			50 07 02	Largo Sound	230 06 44	1528.2	1671.2	0.94
Lesbos	25 07 44.53	W.0 14 12.72	127 00 33	Largo Sound	307 00 25	642.7	702.8	0.40
			205 45 16	Hull Key	25 45 26	1517.5	1659.5	0.94

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Card's Sound. Sketch F, No. 3.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Petite Coquille	25 07 30.88	W.0 14 03.20	135 58 15	Largo Sound	315 58 03	1122.0	1227.0	0.70
			192 23 59	Hull Key	12 24 05	1829.3	2000.5	1.13
Elba	25 07 27.70	0 14 43.60	239 05 43	Lesbos	59 05 56	1007.9	1102.2	0.63
			265 03 13	Petite Coquille	85 03 30	1135.7	1242.0	0.71
Julia Island, (4)	25 07 46.90	0 13 14.66	345 54 45	French Reef	165 55 25	10813.3	11825.1	6.72
			217 30 24	Point Willie	37 30 32	908.3	993.3	0.56
Julia Island, (5)	25 07 13.16	0 13 45.65	339 40 27	French Reef	159 41 20	10077.3	11020.2	6.26
			41 09 31	Lower Sound Point	221 09 09	2224.5	2432.6	1.38
Point Charles	25 04 30.86	0 17 14.03	295 29 21	French Reef	115 31 42	10348.6	11316.9	6.43
			295 35 16	Dry Rocks	115 37 09	8275.4	9049.7	5.15
Pickle's Reef	24 59 21.88	0 15 30.63	163 03 01	Point Charles	343 02 17	9938.4	10868.3	6.17
			186 34 08	Lower Sound Point	6 34 30	12910.0	14118.0	3.02
Excelsior	25 05 22.59	0 16 32.21	241 39 03	Lower Sound Point	61 39 51	3638.4	3978.9	2.26
			309 23 20	Dry Rocks	129 24 55	8140.9	8902.6	5.06
Rodriguez Bank	25 02 51.04	0 17 25.79	186 07 28	Point Charles	6 07 33	3089.0	3378.0	1.92
			197 50 44	Excelsior	17 51 07	4898.7	5357.1	3.04
Tartarus	25 06 45.37	0 15 38.10	295 55 14	Lower Sound Point	115 55 40	1874.8	2050.2	1.16
			30 45 48	Excelsior	210 45 25	2963.9	3241.2	1.85
Avernus	25 06 11.35	0 16 06.71	264 46 42	Lower Sound Point	84 47 20	2498.1	2731.8	1.55
			25 27 57	Excelsior	205 27 46	1661.6	1817.1	1.05
Styx	25 06 01.55	0 15 24.73	57 37 25	Excelsior	237 36 56	2238.7	2448.2	1.39
			104 22 20	Avernus	284 22 02	1214.1	1327.7	0.75
Sands' Point	25 30 08.37	0 2 02.90	....	....	....	....	....	....
Black Point	25 32 07.51	0 9 27.64	286 25 24	Sands' Point	106 28 36	12946.4	14157.8	8.04
Turkey Point	25 26 17.13	0 9 39.89	181 48 43	Black Point	1 48 48	10786.4	11795.7	6.70
			240 49 57	Sands' Point	60 53 14	14613.6	15981.0	9.08
Rubicon Point	25 23 45.24	0 5 28.39	156 37 52	Black Point	336 36 09	16840.5	18416.3	10.46
			123 38 30	Turkey Point	303 36 42	8438.8	9228.4	5.25
Long Arsenicker Key	25 22 34.43	0 8 38.74	247 45 55	Rubicon Point	67 47 16	5747.5	6285.3	3.57
			165 59 37	Turkey Point	345 59 11	7058.3	7718.7	4.39
Card's Point	25 19 20.43	0 11 12.39	229 43 29	Rubicon Point	49 45 56	12601.5	13780.6	7.83
			215 43 56	Long Arsenicker Key	35 45 02	7354.2	8042.3	4.57
Snapper Point	25 19 24.01	0 8 04.83	88 48 27	Card's Point	268 47 07	5246.4	5737.3	3.26
			208 33 26	Rubicon Point	28 34 33	9146.1	10001.7	5.68
Pumpkin Key	25 19 36.35	0 8 18.42	84 15 39	Card's Point	264 14 24	4889.5	5347.1	3.04
			174 04 54	Long Arsenicker Key	354 04 45	5508.7	6024.2	3.42
Mangrove Point	25 21 47.12	0 9 39.03	330 44 22	Pumpkin Key	150 44 56	4611.9	5043.5	2.86
			30 02 51	Card's Point	210 02 11	5213.9	5701.8	3.24
Comorant Point	25 17 22.75	0 11 04.46	203 00 39	Long Arsenicker Key	23 01 41	10419.4	11394.2	6.47
			233 23 20	Snapper Point	53 24 46	6258.2	6843.7	3.89
Little Card's Point	25 17 42.43	0 13 03.25	225 47 37	Card's Point	45 48 24	4325.0	4729.6	2.69
			249 27 08	Snapper Point	69 29 16	8912.3	9746.2	5.54
Mahogany Point	25 23 35.02	0 9 34.45	178 15 02	Turkey Point	358 15 00	4986.1	5452.6	3.10
			267 24 34	Rubicon Point	87 26 20	6883.8	7527.9	4.27
Turtle Point	25 25 07.35	0 10 06.55	288 01 23	Rubicon Point	108 03 22	8175.1	8940.0	5.08
			332 26 59	Long Arsenicker	152 27 37	5306.8	5803.3	3.30
North Arsenicker	25 23 44.41	0 7 49.89	269 41 27	Rubicon Point	89 42 28	3954.8	4324.8	2.46
			2 58 59	Snapper Point	182 58 53	8022.9	8773.6	4.99
West Arsenicker	25 24 17.62	0 8 37.97	154 46 41	Turkey Point	334 46 14	4060.3	4440.2	2.52
			0 23 27	Long Arsenicker	180 23 27	3175.3	3472.4	1.97
Broad Creek	25 20 58.98	0 6 12.56	125 42 50	Long Arsenicker	305 41 49	5032.3	5503.2	3.13
			104 24 13	Mangrove Point	284 22 43	5959.5	6517.2	3.70
Shark Point	25 20 37.63	0 10 33.96	221 51 41	Long Arsenicker	41 52 30	4825.9	5277.5	3.00
			215 41 07	Mangrove Point	35 41 31	2632.4	2878.7	1.64
Angelfish Creek	25 20 06.30	0 7 13.98	152 32 03	Long Arsenicker	332 31 29	5137.0	5617.7	3.19
			127 25 12	Mangrove Point	307 24 09	5106.0	5583.8	3.17
Old Rhodes, (1)	25 22 46.69	0 5 56.81	29 51 32	Snapper Point	209 50 37	7190.2	7863.0	4.47
			34 03 55	Pumpkin Key	214 02 54	7069.0	7730.4	4.39
Old Rhodes, (2)	25 22 23.98	W.0 5 57.80	32 40 54	Snapper Point	212 40 03	6578.4	7193.9	4.09
			37 19 26	Pumpkin Key	217 18 29	6485.0	7091.8	4.03

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section VI.—Card's Sound. Sketch F, No. 3.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Barnes' Point	25 17 06.30	W.0 12 30.45	207 52 40	Card's Point	27 53 13	4668.9	5105.8	2.90
			240 17 11	Snapper Point	60 19 05	8552.7	9353.0	5.31
East Arsenicker	25 22 24.47	0 7 54.63	68 30 57	Mangrove Point	248 30 12	3136.6	3430.1	1.95
			44 19 38	Card's Point	224 18 13	7914.2	8654.8	4.92
Monday Point	25 17 45.34	0 9 34.97	137 02 40.	Card's Point	317 01 58	3997.7	4371.8	2.48
			219 42 09	Snapper Point	39 42 48	3946.3	4315.5	2.45
Wednesday Point	25 18 19.05	W.0 8 55.11	215 08 26	Snapper Point	35 08 47	2443.6	2672.3	1.52
			169 08 30	Mangrove Point	349 08 11	6518.2	7128.1	4.05

Section IX.—Coast southwest of Galveston. Sketch I.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Island East Base	29 12 52.58	W.6 54 38.11	....	....	....	....	....	....
Virginia Point	29 19 12.62	6 52 12.44	18 35 17	Island East Base	198 34 05	16818.9	18392.7	10.45
Black Point	29 14 51.60	6 58 53.86	297 55 47	Island East Base	117 57 52	7817.6	8549.1	4.86
			180 43 52	Highland Bayou	0 43 55	11741.1	12839.7	7.29
Rattlesnake	28 58 37.69	7 14 05.00	183 19 01	Cottonwood	3 19 02	10992.7	12021.3	6.83
			230 50 55	Peninsula	50 52 47	8054.7	8808.4	5.01
Oyster Creek	28 59 30.87	7 16 24.98	205 20 16	Cottonwood	25 21 35	10331.9	11298.7	6.42
			251 01 10	Peninsula	71 04 10	10610.6	11603.4	6.60
Market-house in Galveston.	29 18 26.70	6 46 13.93	98 20 12	Virginia Point	278 17 17	9775.7	10690.4	6.07
			52 57 15	Island East Base	232 53 09	17060.1	18656.4	10.60
Belle	29 14 17.46	6 51 03.69	168 27 45	Virginia Point	348 27 11	9273.0	10141.7	5.76
			65 43 36	Island East Base	245 41 51	6352.7	6947.1	3.95
Morris	29 10 53.98	6 57 13.06	159 35 42	Black Point	339 34 53	7805.5	8535.8	4.85
			228 53 12	Island East Base	48 54 28	5554.3	6074.0	3.45
Velasco	28 56 27.85	7 16 45.55	185 38 59	Oyster Creek	5 39 09	5662.1	6191.9	3.52
			227 23 22	Rattlesnake	47 24 40	5905.1	6457.6	3.67
Brazos	28 57 33.07	7 19 49.65	236 46 43	Oyster Creek	56 48 23	6622.5	7242.1	4.12
			291 55 31	Velasco	111 57 00	5373.8	5876.6	3.34
Jupiter	28 54 47.50	7 19 22.22	233 55 58	Velasco	53 57 13	5248.3	5739.3	3.26
			171 42 35	Brazos	351 42 21	5150.6	5632.5	3.20
Bryan	28 56 09.95	7 24 03.73	249 34 54	Brazos	69 36 57	7340.1	8026.9	4.56
			288 23 36	Jupiter	108 25 53	8035.5	8787.3	4.99
Bernard	28 51 41.94	7 24 49.41	237 10 44	Jupiter	57 13 23	10545.6	11532.3	6.55
			188 31 34	Bryan	8 31 56	8342.8	9123.4	5.18
Tom	28 57 29.21	7 15 35.13	160 11 57	Oyster Creek	340 11 33	3981.1	4353.6	2.47
			45 16 26	Velasco	225 15 52	2684.0	2935.1	1.67
McNeel	28 53 46.23	7 29 27.23	243 11 09	Bryan	63 13 45	9815.5	10733.9	6.10
			296 55 32	Bernard	116 57 46	8443.9	9234.0	5.25
Mound	28 54 51.73	7 21 12.57	45 10 19	Bernard	225 08 34	8285.6	9060.9	5.15
			117 27 34	Bryan	297 26 11	5223.8	5712.6	3.26
Cedar Lake	28 49 13.96	7 29 24.30	179 27 30	McNeel	359 27 29	8381.8	9166.1	5.21
			238 32 26	Bernard	58 34 38	8732.9	9550.0	5.42
Uzzell	28 50 40.96	7 26 41.85	58 42 13	Cedar Lake	238 40 55	5153.9	5636.2	3.21
			141 51 14	McNeel	321 49 54	7253.1	7931.8	4.51
Rhodes	28 50 03.97	7 34 18.90	280 53 26	Cedar Lake	100 55 48	8133.0	8894.0	5.05
			229 05 56	McNeel	49 08 17	10453.9	11432.0	6.50
Cany	28 46 12.12	7 34 52.87	187 21 04	Rhodes	7 21 20	7196.2	7869.6	4.47
			237 50 16	Cedar Lake	57 52 54	10522.0	11506.6	6.54
Kenner	28 49 00.55	7 38 20.84	268 20 16	Cedar Lake	88 24 35	14551.6	15913.2	9.04
			312 34 47	Cany	132 36 28	7660.6	8377.4	4.78
Lone Tree	28 48 57.80	W.7 36 36.87	331 03 08	Cany	151 03 58	5827.9	6373.2	3.62
			91 43 33	Kenner	271 42 43	2820.1	3084.0	1.75

UNITED STATES COAST SURVEY—GEOGRAPHICAL POSITIONS.

Section IX.—Coast southwest of Galveston. Sketch I.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Prairie	28 46 55.03	W.7 40 24.48	220 56 23	Kenner	40 57 22	5115.6	5594.3	3.18
			278 19 58	Cany	98 22 38	9090.3	9940.9	5.65
Sargent	28 43 43.83	7 39 44.37	169 31 46	Prairie	349 31 26	5985.4	6545.5	3.72
			239 59 07	Cany	60 01 27	9131.0	9985.4	5.67
Canal	28 45 59.43	7 37 45.03	37 48 20	Sargent	217 47 23	5282.6	5776.9	3.28
			111 36 11	Prairie	291 34 54	4650.9	5086.1	2.89
Bath	28 41 02.55	7 45 02.43	214 46 54	Prairie	34 49 08	13213.8	14450.2	8.21
			240 04 23	Sargent	60 06 55	9957.7	10889.4	6.19
Smith	28 42 28.35	7 42 18.27	200 36 00	Prairie	20 36 55	8770.4	9591.1	5.45
			240 53 58	Sargent	60 55 12	4778.9	5226.1	2.97
Ranch	28 44 14.23	7 42 53.14	219 09 28	Prairie	39 10 39	6384.6	6982.0	3.97
			280 20 28	Sargent	100 21 59	5206.5	5693.7	3.24
Live Oak	28 44 42.30	W.7 44 39.47	239 24 42	Prairie	59 26 45	8033.2	8784.9	4.99
			282 39 02	Sargent	102 41 24	8206.2	8974.0	5 10

Section X.—Bay of San Francisco. Sketch J, No. 6.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
North End of Base*	37 51 45.17	122 16 19.30	....	....	....	....	....	....
South End of Base	37 49 08.31	122 14 55.49	157 02 36	North Base	337 01 44	5251.8	5743.2	3.26
Yerba Buena	37 48 33.77	122 20 56.50	228 56 03	North Base	48 58 53	8985.8	9826.6	5.58
			263 05 37	South Base	83 09 18	8893.0	9725.1	5.53
Point Avisadera	37 43 30.68	122 20 48.91	219 42 37	South Base	39 46 13	13527.9	14793.7	8.41
			178 51 44	Yerba Buena	358 51 40	9339.5	10213.4	5.80
Rocky Island	37 53 45.52	122 20 18.75	302 21 33	North Base	122 24 00	6928.4	7576.7	4.31
			5 29 12	Yerba Buena	185 28 49	9654.7	10558.1	6.00
Angel Island Peak	37 51 39.71	122 24 49.97	269 11 02	North Base	89 16 15	12482.4	13650.4	7.76
			239 38 18	Rocky Island	59 41 04	7678.9	8397.4	4.77
Presidio Hill	37 47 35.91	122 26 49.65	258 18 09	Yerba Buena	78 21 45	8820.6	9645.9	5.48
			201 15 52	Angel Island Peak	21 17 05	8065.3	8820.0	5.01
Presidio Observatory, (transit.)	37 47 36.15	122 26 15.00	89 31 01	Presidio Hill	269 30 40	847.8	927.1	0.53
			161 11 53	Point de los Cavallos	89 31 01	4904.1	5363.1	3.05
Point San Jose	37 48 23.60	122 24 39.63	266 41 29	Yerba Buena	86 43 46	5466.4	5977.9	3.40
			177 36 18	Angel Island Peak	357 36 12	6050.8	6617.0	3.76
Lime Point Bluff	37 49 37.49	122 27 52.68	295 44 18	Point San Jose	115 46 16	5242.0	5732.5	3.26
			229 50 09	Angel Island Peak	49 52 01	5843.5	6390.3	3.63
Fort Point	37 48 27.06	122 27 35.18	271 24 33	Point San Jose	91 26 21	4295.1	4697.0	2.67
			324 45 53	Presidio Hill	144 46 21	1930.4	2111.0	1.20
Point Lobos	37 47 12.33	122 29 05.63	257 39 33	Presidio Hill	77 40 56	3405.0	3723.6	2.12
			201 44 01	Lime Point Bluff	21 44 46	4817.5	5268.3	2.99
Bird Rock	37 49 42.49	122 25 25.67	27 46 03	Presidio Hill	207 45 23	4409.6	4822.2	2.74
			335 09 17	Point San Jose	155 09 34	2680.1	2930.9	1.67
Alcatraz Island	37 49 34.08	122 24 20.61	99 15 29	Bird Rock	279 14 49	1611.8	1762.6	1.00
			12 04 59	Point San Jose	192 04 47	2222.2	2430.1	1.38
Telegraph Hill	37 48 06.43	122 23 19.42	105 06 11	Point San Jose	285 05 22	2032.0	2222.1	1.26
			151 01 39	Alcatras Island	331 01 01	3088.9	3377.9	1.92
Point Diablo	37 49 12.50	122 28 59.73	304 06 21	Fort Point	124 07 13	2497.4	2731.1	1.55
			2 13 50	Point Lobos	182 13 46	3707.4	4054.3	2.30
Point Bonita	37 49 10.04	122 30 50.54	285 28 58	Fort Point	105 30 58	4958.3	5422.3	3.08
			324 43 22	Point Lobos	144 44 26	4444.7	4860.6	2.76
Point de los Cavallos	37 50 06.73	122 27 19.64	309 04 47	Point San Jose	129 06 25	5041.9	5513.7	3.13
			351 01 55	Presidio Hill	171 02 13	4706.9	5147.3	2.93
Angel Island Northwest	37 51 37.87	122 25 39.86	346 10 45	Point San Jose	166 11 22	6167.5	6744.6	3.83
			40 58 14	Point de los Cavallos	220 57 13	3720.7	4068.9	2 31

* The triangulation of San Francisco bay depends on a preliminary base near Point San Jose, 941.3 metres or 0.58 mile in length.

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—Bay of San Francisco. Sketch J, No. 6.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Saucelito	37 51 20.33	122 27 48.14	260 12 05	Angel Island Northwest.	80 13 24	3181.6	3479.3	1.98
			342 55 50	Point de los Cavallos	162 56 07	2373.4	2595.5	1.48
Peninsula Hill	37 52 11.45	122 26 57.23	298 41 27	Angel Island Northwest.	118 24 14	2155.6	2357.3	1.34
			38 17 38	Sancelito Point	218 17 07	2007.9	2195.8	1.25
Strawberry Hill	37 52 43.58	122 28 53.74	289 10 20	Peninsula Hill	109 11 32	3014.5	3296.6	1.87
			328 00 04	Sancelito Point	148 00 44	3026.1	3309.2	1.88
Angel Island Southeast	37 51 27.93	122 24 25.36	3 30 49	Point San Jose	183 30 40	5693.2	6225.9	3.54
			56 07 35	Lime Point Bluff	236 05 28	6105.8	6677.1	3.79
Contra Costa, (3)	37 53 02.95	122 17 48.83	109 43 36	Rocky Island	289 42 04	3890.9	4255.0	2.42
			28 57 10	Yerba Buena	208 55 15	9481.8	10369.0	5.89
Shag Rock	37 50 02.86	122 25 26.08	24 17 31	Presidio Hill	204 16 40	4969.7	5434.7	3.09
			77 42 16	Lime Point Bluff	257 40 46	3669.0	4012.3	2.28
Stony Hill	37 44 02.42	122 22 03.30	191 03 03	Yerba Buena	11 03 44	8523.6	9321.2	5.30
			133 13 39	Presidio Hill	313 10 44	9614.0	10513.6	5.97
San Antonio Point	37 48 20.24	122 17 27.56	28 56 00	Point Antonio	208 53 57	10190.9	11144.5	6.33
			94 41 12	Yerba Buena	274 39 04	5127.3	5607.1	3.19
San Antonio Creek	37 47 27.02	122 13 22.34	56 22 22	Point Avisadera	236 17 49	13132.2	14361.0	8.16
			100 32 02	Yerba Buena	280 27 24	11298.1	12355.3	7.02
Middle Point	37 46 32.12	122 16 38.24	47 42 01	Point Avisadera	227 39 28	8298.7	9075.2	5.16
			120 42 54	Yerba Buena	300 40 16	7347.2	8034.7	4.56
San Quentin Rock	37 46 23.35	122 21 55.90	342 51 23	Point Avisadera	162 52 04	5564.1	6084.7	3.46
			199 52 00	Yerba Buena	19 52 36	4275.3	4675.3	2.66
Richmond Point	37 54 40.18	122 22 03.17	36 14 13	Angel Island Peak	216 12 31	6896.8	7542.1	4.29
			303 26 36	Rocky Island	123 27 40	3057.0	3343.1	1.90
Molate Island	37 55 42.72	122 24 49.99	359 59 46	Angel Island Peak	179 59 46	7491.8	8192.8	4.65
			298 35 04	Rocky Island	118 37 51	7546.0	8252.1	4.69
High Hill	37 56 30.67	122 23 07.16	15 39 00	Angel Island Peak	195 37 57	9314.8	10186.4	5.79
			321 03 12	Rocky Island	141 04 55	6544.9	7157.3	4.07
Point San Quentin	37 56 36.16	122 27 57.73	271 20 31	High Hill	91 23 30	7095.8	7759.8	4.41
			333 20 06	Angel Island Peak	153 22 01	10225.3	11182.1	6.35
Contra Costa, (4)	37 55 00.72	122 20 29.53	353 31 15	Rocky Island	173 31 22	2333.1	2551.4	1.45
			125 47 00	High Hill	305 45 23	4744.0	5187.9	2.95
Bluff Point	37 53 16.67	122 25 45.10	212 48 26	High Hill	32 50 03	7116.6	7782.5	4.42
			152 14 07	Point San Quentin	332 12 46	6950.7	7601.1	4.32
California City Point	37 54 45.80	122 27 27.98	243 03 55	High Hill	63 06 35	7142.4	7810.7	4.44
			167 57 02	Point San Quentin	347 56 44	3478.7	3804.2	2.16
Cote Maderia	37 55 53.18	122 29 05.64	231 22 24	Point San Quentin	51 23 06	2122.5	2321.1	1.32
			311 02 43	California City Point	131 03 43	3162.8	3458.7	1.96
Marin Island	37 57 50.67	122 27 00.04	293 26 04	High Hill	113 28 27	6196.5	6776.3	3.85
			31 30 54	Point San Quentin	211 30 19	2694.3	2946.4	1.67
Point San Pedro	37 59 13.41	122 26 04.09	319 15 59	High Hill	139 17 48	6619.5	7238.9	4.11
			29 47 03	Point San Quentin	209 45 53	5585.1	6107.7	3.47
Molate Point	37 56 47.47	122 24 14.64	86 21 20	Point San Quentin	266 19 03	5457.4	5968.0	3.39
			149 18 38	Point San Pedro	329 17 31	5232.3	5721.9	3.25
Point San Pablo	37 57 52.04	122 24 38.22	64 21 35	Point San Quentin	244 19 33	5402.6	5908.1	3.36
			140 08 12	Point San Pedro	320 07 19	3268.5	3574.3	2.03
San Rafael Creek	37 58 15.26	122 28 14.29	352 27 30	Point San Quentin	172 27 40	3081.9	3370.3	1.91
			240 33 29	Point San Pedro	60 34 49	3648.1	3989.4	2.27
Cove	37 58 54.47	122 27 20.63	11 59 27	Point San Quentin	191 59 04	4359.0	4766.9	2.71
			252 37 57	Point San Pedro	72 38 44	1956.9	2140.0	1.22
San Pablo Bay.								
Marsh Island	37 57 33.62	122 22 55.81	8 07 51	High Hill	188 07 44	1960.5	2143.9	1.22
			123 49 10	Point San Pedro	303 47 14	5529.6	6047.0	3.43
Castro	37 58 44.02	122 21 00.16	37 01 49	High Hill	217 00 31	5148.8	5630.6	3.20
			96 59 31	Point San Pedro	276 56 24	7471.3	8170.4	4.64
Point Penole	38 00 40.57	122 20 59.64	22 00 24	High Hill	201 59 06	8308.9	9086.4	5.16
			70 08 11	Point San Pedro	250 05 04	7898.3	8637.3	4.91
Petaluma Creek	38 06 10.38	122 28 23.85	313 09 40	Point Penole	133 14 14	14853.9	16243.8	9.23
			345 08 34	Point San Pedro	165 10 00	13299.0	14543.4	8.26

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—San Pablo Bay. Sketch J, No. 6.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Long Pond	38 07 37.98	122 18 36.44	15 11 11	Point Penole	195 09 43	13333.5	14581.1	8.28
			35 05 14	Point San Pedro	215 00 38	19001.3	20779.2	11.81
Grove	38 00 43.54	122 28 17.52	179 07 23	Petaluma Point	359 07 19	10077.5	11020.5	6.26
			270 27 19	Point Penole	90 31 49	10681.0	11680.4	6.64
Long Point	38 02 45.31	122 29 28.02	287 11 29	Point Penole	107 16 42	12980.2	14194.8	8.07
			193 53 17	Petaluma Creek	13 53 56	6512.9	7122.3	4.05
Tolay Creek	38 07 57.00	122 23 50.69	63 44 02	Petaluma Creek	243 41 13	7420.7	8115.1	4.61
			342 46 14	Point Penole	162 47 59	14085.9	15403.9	8.75
Sonoma Creek	38 08 24.08	122 21 01.38	69 06 26	Petaluma Creek	249 01 53	11537.6	12617.2	7.17
			359 49 45	Point Penole	179 49 46	14289.9	15627.0	8.88
Vallejo, (3)	38 04 09.75	122 12 24.14	125 19 21	Long Pond	305 15 31	11111.9	12151.6	6.90
			62 52 53	Point Penole.	242 47 35	14126.5	15448.3	8.78
Lone Tree Point	38 02 16.75	122 15 20.39	154 15 54	Long Pond	334 13 53	10995.4	12024.2	6.83
			70 18 39	Point Penole	250 15 10	8788.5	9610.8	5.46
Wilson	38 00 40.93	122 17 57.29	89 52 13	Point Penole	269 50 21	4447.5	4863.6	2.76
			175 45 36	Long Pond	355 45 12	12892.7	14099.1	8.01
Mare Island Southeast	38 04 34.35	122 14 16.87	285 25 09	Vallejo, (3)	105 26 19	2850.1	3116.8	1.77
			20 03 20	Lone Tree Point	200 02 41	4515.7	4938.3	2.81
Vallejo, (1)	38 05 15.38	122 13 45.58	31 05 23	Mare Island Southeast	211 05 04	1477.0	1615.2	0.92
			315 32 42	Vallejo, (3)	135 33 32	2833.9	3099.1	1.76
Mare Island Northwest	38 05 19.19	122 15 03.90	273 31 24	Vallejo, (1)	93 32 12	1912.1	2091.0	1.19
			320 20 27	Mare Island Southeast	140 20 56	1795.8	1963.8	1.12
Abbott	38 03 10.52	122 13 34.88	158 23 54	Mare Island Southeast	338 23 28	2779.7	3039.8	1.73
			223 20 52	Vallejo, (3)	43 21 36	2511.6	2746.6	1.56
Bush Hill	38 02 57.90	122 11 20.79	145 07 31	Vallejo, (3)	325 06 52	2700.3	2953.0	1.68
			96 47 51	Abbott	276 46 28	3291.9	3599.9	2.05
North Bay	38 03 57.14	122 09 50.84	50 13 05	Bush Hill	230 12 10	2853.7	3120.7	1.78
			95 57 20	Vallejo, (3)	275 55 45	3756.7	4108.2	2.33
Karquines Point	38 02 33.50	122 09 48.52	178 44 52	North Bay	358 44 51	2579.3	2820.7	1.60
			108 30 03	Bush Hill	288 29 06	2372.0	2594.0	1.47
Monument Hill	38 03 32.34	122 08 25.35	48 11 28	Karquines Point	228 10 37	2720.7	2975.3	1.69
			110 09 30	North Bay	290 08 37	2219.6	2427.3	1.38
Martinez	38 01 06.86	122 07 42.84	131 04 58	Karquines Point	311 03 40	4065.4	4445.8	2.53
			166 59 28	Monument Hill	346 59 02	4603.2	5033.9	2.86
Army Point	38 03 00.31	122 06 49.15	20 31 31	Martinez	200 30 58	3734.4	4083.9	2.32
			79 18 46	Karquines Point	259 16 55	4450.5	4866.9	2.77
Suisun Point	38 02 01.21	122 06 07.26	51 17 43	Martinez	234 16 44	2870.6	3139.2	1.79
			129 51 24	Monument Hill	309 49 59	4384.7	4795.0	2.72
Island Point	38 01 47.75	122 05 27.64	69 05 06	Martinez	249 03 43	3529.9	3860.1	2.19
			138 23 09	Army Point	318 22 19	2992.0	3272.0	1.86
Benicia, cross on church	38 03 10.88	122 08 23.81	345 21 06	Martinez	165 21 31	3951.7	4321.4	2.46
			60 50 48	Karquines Point	240 49 56	2364.9	2586.2	1.47
COAST NEAR SAN FRANCISCO.								
Point Lobos, (2)	37 47 06.17	122 28 56.05	253 28 12	Presidio Hill	73 29 29	3225.6	3527.4	2.00
			198 22 29	Lime Point Bluff	18 23 08	4915.8	5375.8	3.05
Sand Knoll	37 45 34.71	122 28 39.95	215 59 49	Presidio Hill	35 50 57	4609.5	5040.8	2.86
			172 02 45	Point Lobos, (2)	352 02 35	2846.9	3113.3	1.77
Black Ridge	37 45 10.75	122 27 11.98	186 57 35	Presidio Hill	6 57 49	4508.3	4930.2	2.80
			144 24 52	Point Lobos, (2)	324 23 48	4375.6	4785.0	2.72
Round Top	37 46 04.85	122 27 29.92	131 53 35	Point Lobos, (2)	311 52 42	2831.1	3096.0	1.76
			199 20 03	Presidio Hill	19 20 28	2975.2	3253.6	1.85
Black Bluff	37 43 07.16	122 29 14.12	183 25 58	Point Lobos, (2)	3 26 09	7381.3	8072.0	4.59
			218 06 54	Black Ridge	38 08 09	4843.1	5296.3	3.01
Abbey Hill	37 41 20.00	122 25 14.28	157 57 11	Black Ridge	337 55 59	7675.0	8393.2	4.77
			119 22 21	Black Bluff	299 19 54	6739.5	7370.1	4.19
Green Bluff	37 41 18.80	122 28 43.23	167 14 36	Black Bluff	347 14 17	3425.3	3745.8	2.13
			197 20 42	Black Ridge	17 21 38	7491.5	8192.5	4.65
Cattle Hill	37 36 24.36	122 27 55.77	203 27 45	Abbey Hill	23 29 24	9936.5	10866.3	6.17
			172 41 56	Green Bluff	252 41 27	9151.0	10007.3	5.69

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section X.—Coast near San Francisco. Sketch J, No. 6.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Richardson	37 51 01.76	122 28 54.26	180 14 04	Strawberry Hill	0 14 04	3138.9	3432.6	1.95
			233 04 48	Peninsula Hill	53 06 00	3577.9	3912.7	2.22
Cayote Ridge	37 51 57.74	122 32 07.53	253 22 03	Strawberry Hill	73 24 02	4942.1	5404.5	3.07
			290 03 05	Richardson	290 03 05	5029.1	5499.7	3.13
High Bluff	37 50 39.57	122 32 13.42	261 59 08	Richardson	82 01 10	4916.3	5376.3	3.05
			183 25 07	Cayote Ridge	3 25 11	2414.0	2639.9	1.50
Read	37 55 06.95	122 30 00.45	339 45 22	Strawberry Hill	159 46 03	4710.6	5151.4	2.93
			28 02 11	Cayote Ridge	208 00 53	6607.9	7226.2	4.11
Table Mountain	37 55 24.40	122 34 46.66	299 52 20	Strawberry Hill	119 55 57	9945.0	10875.5	6.18
			328 35 44	Cayote Ridge	148 37 22	7463.4	8161.8	4.64
Table Mountain Peak	37 55 42.95	122 33 38.68	308 26 33	Strawberry Hill	128 29 28	8889.5	9721.3	5.52
			342 12 41	Cayote Ridge	162 13 37	7291.3	7973.5	4.53
Duxbury	37 52 40.06	122 34 39.17	289 23 02	Cayote Ridge	109 24 35	3928.6	4296.2	2.44
			177 55 56	Table Mountain	357 55 51	5069.6	5544.0	3.15
Frank's Lagoon	37 51 42.65	122 34 05.94	260 51 28	Cayote Ridge	80 52 41	2931.1	3205.4	1.82
			305 15 02	High Bluff	125 16 11	3368.3	3683.5	2.09

Section XI.—Columbia River. Sketch K.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Base on Baker's Bay. East End	46 18 12.74	123 57 43.01						
Base on Baker's Bay. West End	46 18 52.11	123 59 55.78	293 08 56	East Base	113 10 31	3089.7	3378.8	1.92
Cape Disappointment	46 16 44.05	124 01 47.43	242 20 43	East Base	62 23 39	5904.4	6456.9	3.67
			211 08 04	West Base	31 09 25	4619.4	5051.6	2.87
Baker's Bay	46 16 27.50	123 55 49.17	93 50 52	Cape Disappointment	273 46 33	7686.4	8405.6	4.78
			143 08 44	East Base	323 07 22	4061.2	4441.2	2.52
Scarboro' Hill	46 15 20.44	123 54 14.54	140 01 43	East Base	319 59 12	6943.6	7593.3	4.31
			104 57 10	Cape Disappointment	284 51 43	10034.6	10973.5	6.23
Point Adams	46 12 30.42	123 56 55.80	141 26 53	Cape Disappointment	321 23 22	10017.0	10954.3	6.22
			213 20 12	Scarboro' Hill	33 22 08	6284.0	6872.0	3.90
Cape Hancock, astronomical station.	46 16 35.24	124 02 00.90	319 07 15	Point Adams	139 10 55	9992.2	10927.2	6.21
			282 58 32	Scarboro' Hill	103 04 09	10249.0	11207.9	6.37
Sand Island	46 14 34.69	123 58 31.76	188 48 23	East Base	8 48 58	6812.6	7450.1	4.23
			255 35 41	Scarboro' Hill	75 38 47	5687.2	6219.4	3.53
Astor Point	46 11 27.62	123 49 31.74	101 33 25	Point Adams	281 28 05	9714.9	10623.9	6.04
			139 53 42	Scarboro' Hill	319 50 18	9401.6	10281.3	5.84
Tansy Point	46 11 22.54	123 54 35.16	124 48 59	Point Adams	304 47 17	3671.9	4015.5	2.28
			268 35 21	Astor Point	88 39 00	6507.3	7116.2	4.04
Priest's House, cross	46 14 43.51	123 53 26.76	13 17 55	Tansy Point	193 17 06	6375.3	6971.8	3.96
			47 29 25	Point Adams	227 26 54	6078.2	6646.9	3.78
Smith's Point	46 10 47.97	123 50 40.57	102 00 21	Tansy Point	281 57 32	5140.2	5621.2	3.19
			151 26 11	Scarboro' Hill	331 23 37	9579.6	10475.9	5.95
Marsh Point, (1)	46 09 51.85	123 51 45.96	127 40 29	Tansy Point	307 38 27	4582.9	5011.7	2.85
			218 56 43	Smith's Point	38 57 30	2228.2	2436.7	1.38
Skeppernawin Creek	46 10 24.06	123 53 39.76	146 39 44	Tansy Point	326 39 04	2161.3	2363.5	1.34
			259 06 00	Smith's Point	79 08 09	3911.2	4277.2	2.43
Young's River	46 09 48.44	123 49 09.23	91 48 31	Marsh Point	271 46 38	3364.1	3678.9	2.09
			133 09 07	Smith's Point	313 08 01	2687.9	2939.4	1.67
Lewis and Clark River	46 09 29.82	123 50 51.67	120 16 22	Marsh Point	300 15 43	1349.0	1475.2	0.84
			185 35 00	Smith's Point	5 35 08	2424.2	2651.0	1.50
Point Ellice	46 14 28.50	123 51 28.11	62 35 40	Point Adams	242 31 43	7911.6	8651.9	4.92
			335 55 28	Astor Point	155 56 52	6116.1	6688.4	3.80
Gray's Point	46 15 25.18	123 45 02.41	32 09 38	Astor Point	212 06 24	10848.7	11863.8	6.74
			66 28 35	Point Ellice	246 23 56	9011.1	9854.3	5.60

UNITED STATES COAST SURVEY.—GEOGRAPHICAL POSITIONS.

Section XI.—Columbia River. Sketch K.

Name or station.	Latitude.	Longitude.	Azimuth.	To station—	Back azimuth.	Distance.	Distance.	Distance.
	° ′ ″	° ′ ″	° ′ ″		° ′ ″	*Metres.*	*Yards.*	*Miles.*
Tongue Point Neck	46 12 16.70	123 45 07.46	75 03 08	Astor Point	254 59 57	5865.0	6413.8	3.64
			116 33 04	Point Ellice	296 28 29	9115.5	9968.5	5.66
Tongue Point	46 12 46.18	123 44 33.60	109 37 17	Point Ellice	289 32 18	9426.7	10308.8	5.86
			174 47 19	Gray's Point	354 46 58	6789.3	7424.6	4.22
Cliff Point	46 15 44.86	123 49 28.58	00 29 23	Astor Point	180 29 21	7942.2	8685.4	4.93
			318 56 03	Tongue Point Neck	138 59 11	8520.4	9317.7	5.29
Astoria flag-staff	46 11 18.53	123 48 42.07	148 46 19	Point Ellice	328 44 19	6860.3	7502.2	4.26
			206 24 37	Gray's Point	26 27 16	10572.7	11562.0	6.57
Upper Astoria	46 11 32.73	123 47 17.16	135 17 00	Point Ellice	315 13 58	7640.3	83551.1	4.75
			197 43 03	Gray's Point	17 44 41	9479.2	10366.2	5.89
Shorte's Chimney	46 11 46.96	123 46 07.93	126 02 43	Point Ellice	305 58 52	8482.6	9276.3	5.27
			189 16 29	Gray's Point	9 17 16	8703.6	9518.0	5.41
Yellow Bluff	46 16 31.03	123 39 51.00	41 06 57	Tongue Point	221 03 33	9210.3	10072.1	5.72
			88 28 46	Gray's Point	268 25 01	6668.9	7292.9	4.14
Gray's Bay	46 17 17.99	123 42 47.45	290 58 52	Yellow Bluff	111 00 59	4045.4	4423.9	2.51
			15 10 13	Tongue Point	195 08 56	8694.0	9507.5	5.40
Gray's River	46 17 53.33	123 40 24.79	344 06 25	Yellow Bluff	164 06 49	2641.7	2888.9	1.64
			70 20 43	Gray's Bay	250 19 00	3241.9	3545.2	2.02
Alamicut River	46 18 03.13	123 41 59.19	316 00 39	Yellow Bluff	136 02 12	3951.3	4321.0	2.46
			36 32 11	Gray's Bay	216 31 36	1734.6	1896.9	1.08
Rocky Point	46 15 36.19	123 35 51.31	64 55 17	Tongue Point	244 49 00	12359.2	13515.7	7.68
			97 21 33	Gray's Point	277 14 55	11896.3	13009.4	7.39
John Day Point	46 10 52.03	123 43 28.00	168 52 58	Gray's Point	348 51 50	10482.5	11463.4	6.51
			228 04 48	Rocky Point	48 10 18	13143.3	14273.1	8.17
Settler's Point	46 10 30.42	123 39 42.34	147 58 40	Gray's Point	327 54 49	12922.9	14132.1	8.03
			123 53 56	Tongue Point	303 50 28	7520.8	8224.5	4.67
Indian Point	46 10 43.79	123 37 11.74	111 47 28	Tongue Point	291 42 09	10198.8	11153.1	6.34
			190 48 07	Rocky Point	10 49 05	9190.6	10050.6	5.71
Rock Knoll	46 16 01.78	123 39 15.21	48 30 41	Tongue Point	228 26 51	9109.7	9962.1	5.66
			344 54 20	Indian Point	164 55 49	10167.7	11119.1	6.32
Channel Station	46 13 11.38	123 36 21.74	13 14 35	Indian Point	193 13 59	4681.3	5119.3	2.91
			85 49 39	Tongue Point	265 43 44	10569.8	11558.8	6.57
Pillar Hill Tree	46 16 03.64	123 33 26.59	66 57 42	Tongue Point	246 49 40	15534.6	16988.2	9.65
			26 03 42	Indian Point	206 00 59	10990.4	12018.8	6.83
Jim Crow Point	46 15 37.83	123 32 57.69	89 14 24	Rocky Point	269 12 19	3718.1	4066.0	2.31
			30 58 38	Indian Point	210 55 35	10585.3	11575.8	6.58
Marsh Point, (2)	46 13 41.78	123 33 32.22	191 39 25	Jim Crow Point	11 39 50	3658.4	4000.7	2.27
			139 52 06	Rocky Point	319 50 26	4621.2	5053.6	2.87
Cathlamet Point	46 13 57.95	123 30 07.18	56 40 13	Indian Point	236 35 07	10897.2	11916.9	6.77
			112 24 08	Rocky Point	292 20 00	7970.6	8716.4	4.95
Three Tree Point	46 16 01.57	123 30 18.98	356 12 37	Cathlamet Point	176 12 45	3825.1	4183.0	2.38
			77 50 34	Jim Crow Point	257 48 39	3476.6	3801.9	2.16
Pillar Rock	46 15 28.71	123 34 19.94	22 43 45	Indian Point	202 41 41	9536.0	10428.3	5.93
			297 20 28	Cathlamet Point	117 23 31	6096.2	6666.6	3.79

APPENDIX No. 8.

List of capes, headlands, harbors, and anchorages on the Western coast of the United States, of which the geographical positions have been determined, topographical surveys made, and charts and sketches issued, to date of report of 1852.

1	False Dungeness	Position determined.		
2	Scarboro' or Nee-ah harbor	Position determined.		
3	Cape Flattery	Position determined.		
4	Cape Disappointment	Position determined	Topographical survey made	Sketch issued.
5	Point Adams		Topographical survey made.	
6	Cape Orford, Ewing harbor	Position determined.		
7	Trinidad bay	Position determined		Sketch issued.
8	Humboldt bay	Position determined		Sketch issued.
9	Fort Point		Topographical survey made.	
10	Alcatraz Island		Topographical survey made	Sketch issued.
11	Mare Island Straits		Topographical survey made	Sketch issued.
12	Presidio, San Francisco bay	Position determined.		
13	Santa Cruz	Position determined		Sketch issued.
14	Point Pinos, Monterey harbor	Position determined	Topographical survey made	Preliminary chart.
15	San Simeon	Position determined		Sketch issued.
16	San Luis Obispo	Position determined		Sketch issued.
17	Point Concepcion	Position determined		Sketch issued.
18	Santa Barbara	Position determined.		
19	Prisoners' harbor	Position determined.		
20	Cuyler's harbor	Position determined		Sketch issued.
21	San Pedro	Position determined	Topographical survey made.	
22	San Nicolas	Position determined.		
23	Santa Catalina	Position determined		Sketch issued.
24	San Clemente	Position determined		Sketch issued.
25	Point Loma, San Diego	Position determined	Topographical survey made	Preliminary chart.

APPENDIX No. 9.

Report of Lieut. Comg. M. Woodhull, United States Navy, assistant in the Coast Survey, to the Superintendent, on the location of surf-boats on the coast of Maine and New Hampshire.

COAST SURVEY STATION, NEAR PHILLIPS, MAINE, *October* 24, 1853.

SIR: I have the honor to enclose the report of Lt. Comg. M. Woodhull, U. S. Navy, assistant in the Coast Survey, on the location of surf-boats on the coast of Maine and New Hampshire; made in pursuance of instructions to me by the department.

After a careful examination of the localities formerly preferred by him, and visiting others in their vicinity, Lieut. Comg. Woodhull has succeeded in obtaining suitable persons to take charge of the boats, under the bond required by the Treasury Department, at Seal Harbor, near Whitehead light, Maine; Southwest Harbor, Mount Desert, Maine; Millbridge, Narraguagus Bay, Maine; and Isle of Shoals, near Portsmouth, New Hampshire.

He desired to place boats at Cape Small Point harbor, mouth of the Kennebec, Maine, and at Wood island, Saco bay, Maine, and finding no one willing to give the required bond, posted the notice provided in that case by the instructions of the department.

A boat shed should be built over these boats for their preservation, and a wooden railway be made to haul them up readily. I would also recommend that authority be procured from Congress to pay a small annual sum for the care of the boats, as is done by the Massachusetts Humane Society, providing for their inspection once or twice each year, or else a bounty, such as is proposed by Lieut. Comg. Woodhull.

I am in correspondence with Lieut. Comg. Stellwagen, United States Navy, assistant in the Coast Survey, in regard to his inquiries into the location of surf-boats within the hydrographic section in which he is engaged, (the coast of Massachusetts and Rhode Island,) and will communicate further with the department as soon as the matter is matured.

With the report of Lieut. Comg. Woodhull, I enclose the bonds referred to.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent of Coast Survey.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

U. S. SCHOONER "GALLATIN," *Plymouth, October* 15, 1853.

SIR: Your order of September 26, directing me to make examination of certain localities selected for the purpose of making them life-boat stations, has been executed. I left on the first instant, and only returned yesterday. The duty was both arduous and difficult, and, owing to the peculiar insufficiency of the law creating these boats, I was successful only in part in obtaining persons to take charge of them. The following is the result:

Whitehead light was not considered, on examination, a suitable point for the purpose, owing to the natural difficulties of position and the impossibility of manning the boat, if everything else was favorable. I concluded to place the boat at a small settlement in *Seal harbor*, about one and a half mile from Whitehead light—the place is called St. Georges. Mr. Fogg signed the bond demanded by the Secretary of the Treasury. I was obliged, however, to promise that a boat-house would be erected at this point, as otherwise the boat could not be kept in ready serviceable order. I really hope that the department will see the propriety of it, and order the house to be built. Enclosed is the bond.

The next site selected was Southwest harbor, on Mount Desert. Before selecting this site I visited Cranberry islands, but could not find any one willing to take charge of a boat; and, besides, there was the usual difficulty of these outside places, of getting a sufficient number of persons together to man and manage it. I examined Bass harbor and two or three other points, and finally settled down on Southwest harbor. Mr. Henry H. Clarke undertook the charge and safe-keeping of one of these boats, and I forward you his bond, agreeably to the directions of the Secretary of the Treasury.

The next site selected was at Millbridge, in Narraguagus bay. I cannot say that I am altogether satisfied with this selection; but as I could not do better, and as the people urged the necessity of having a life-boat in that locality, I concluded, after examining Petit Menan island and point, and also Pond island, to gratify them. The facts are, with the exception of the light-house keepers and their families, the Petit Menan and Pond islands are uninhabited. Petit Menan Point is so sparsely inhabited that I did not see more than half a dozen houses, and those from at least one to two miles apart; besides, the people are poor, and disinclined to assume responsibility or more cares. I granted the care of one of the boats to two young persons of respectability and property, J. T. Wallace and A. R. P. Wallace, of Millbridge. Their bond, properly signed, is enclosed.

While at Rockland and at Mount Desert, I made efforts to get a conveyance to the Martinicus islands, but was unsuccessful, and, after losing two days, gave it up. At the entrance of the Kennebec I was most unsuccessful in finding a responsible and respectable man who was sufficiently moved by the interests of humanity to take the care of one of the boats. I visited Parker's Head, but, owing to its position, did not consider it a suitable locality, as was the case with Hannewell Point. I finally decided upon Cape Small Point harbor, as the very best site for the object. I saw several persons and endeavored to urge them to take one of the boats, but, I am sorry to say, without the least effect. I, however, published the notice directed by the Secretary of the Treasury, and left with Captain Abernethy Lowell a blank bond in case he changed his mind and might desire to have a boat located in his neighborhood.

At Wood Island harbor my success was as little as in my previous efforts. This is certainly one of the localities that ought to be furnished with a life-boat, and the persons I talked with on the subject admitted the necessity of such assistance during the terrible winter storms, but I could not find any one willing to give the required bond. They were willing to take the boat, and would promise to use it, but would not bind themselves to repair it, or to be responsible for its care; so I published the directions of the Secretary of the Treasury, and left a blank bond.

I visited Boone island, but found it totally unfit for a life-boat station, being entirely uninhabited, save by the light-house keeper and family.

The "Isle of Shoals," I think, is the very best locality that could be selected for the purpose, inhabited as it is by a hardy, daring people, ready with heart and hand to aid a shipwrecked seaman. I found no difficulty in getting a reliable person to assume the charge and responsibility of such a boat, and obtained from him the required bond, which I send you, signed by Lemuel B. Caswell, of the "Isle of Shoals."

This, sir, is the result of my visit and examination. I wish it might have been more fortunate; but as I could only use persuasion, I must be satisfied with the success I obtained. I think Congress should provide some compensation for the people who undertake the use and care of these life-boats, not as a direct pay, but as a bounty on lives and property saved. A small allowance would have a good tendency, and might be the means of saving many valuable lives. I would also suggest the necessity of these boats being provided with sails, particularly on this coast, as they would aid in approaching a distant point of disaster. There is scarcely a moment on this coast that sails would not be useful; and, besides, this means of propulsion is more favorable than perhaps a long, wearisome pull with oars. I would urge this on the notice of those having charge of the matter.

All of which is respectfully submitted.

Yours, respectfully,

M. WOODHULL, *Lieutenant Commanding.*

Prof. A. D. Bache, *Superintendent of Coast Survey, Phillips, Me.*

APPENDIX No. 10.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the report of Lieut. Comg. H. S. Stellwagen, United States Navy, assistant in the Coast Survey, in regard to the location of surf-boats on the coast of Massachusetts.

Coast Survey Station, near Phillips, Maine, *November* 18, 1853.

Sir: I have the honor to enclose to the department a report from Lieutenant H. S. Stellwagen, United States Navy, assistant in the Coast Survey, in regard to the location of surf-boats on the coast of Massachusetts, accompanied by a printed list and sketch showing the location of the boats of the Massachusetts Humane Society, and by two bonds signed by persons willing to take charge of boats at Nausett light-house and Glades House, Cohassett. I would commend this report to the attention of the department, and, being unacquainted with its general views in the matter, scarcely venture to make definite recommendations under the new circumstances of the case.

It appears to me, however, that the coast of Massachusetts being already well supplied with life-boats and subsidiary apparatus, under excellent regulations by this noble society, other parts of the coast may be furnished. If, however, the number of boats selected for the coast of Massachusetts should be placed there, I think it would be judicious to put them under the control of this society, if the law permit it.

Should these boats be available for other parts of the coast, an officer might again visit the coast of New Hampshire and Maine, and make selection of as many points as there were boats provided, where the conditions prescribed by the department would be accepted.

The desire to make no mistake in this matter, under the new aspect of things produced by the information obtained by Lieutenant Stellwagen, has delayed my report until this time. The subject has been one of conference and correspondence between Lieutenant Stellwagen and myself, which has only just terminated in the report of that officer.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. James Guthrie, *Secretary of the Treasury.*

PHILADELPHIA, *November* 12, 1853.

SIR: I have received your letter of the 9th instant, and respectfully submit the following report concerning the location of life-boats on the coast of Massachusetts.

I visited, according to your instructions, the light-house stations at Nausett and Cohassett, and at each place found that boats had already been placed by the Massachusetts Humane Society, and subsequently learned officially from R. B. Forbes, esq., and other officers of that society, that some forty or forty-one boats are stationed at intervals along the coast of the State, occupying nearly every suitable and required spot. My own observation at Cape Cod, Gloucester, Cape Ann, Marblehead, Nantucket, &c., confirms the statement. And I can add, that in addition to the care of selection of places, great judgment is shown in the construction and equipment of the boats and life-preservers, and that howitzers for throwing lines, and all the modern inventions for assisting shipwrecked crews to land, and numerous houses furnished with fuel, &c., for their preservation and comfort on reaching shore, have been provided by that admirable society, which also pays for the keeping of all the apparatus in good order, and causes a frequent inspection by Captain R. B. Forbes of all the details, with liberal power to repair and improve and re-arrange what may be necessary.

I have sent you a sketch showing the stations occupied, and also printed lists of them.

I have lately been favored by a visit from Captain Forbes. He agrees that all the most important sites are occupied, and says it would require careful consideration to select others. I read to him the instructions to show him the views of the Treasury Department on the subject, and he evinced great interest and zeal in it. He made the very proposition that I previously mentioned to you, viz: that the department should place the boats under the care of the society, which would take the proper care of them, use them to the best advantage, and accept them on the terms proposed.

I am clearly of the opinion that it would be decidedly the best course to pursue, should it be determined to devote the four boats, as originally proposed, to the service of the Massachusetts coast; as that may be decided by the greater necessity of other points on the Atlantic sea-board, such as the coast of New Jersey, where so many wrecks occur, the vicinity of Cape Hatteras, &c., and the number of boats at the disposal of the department, or already placed at the latter points, of which I have not the means of information. Should the life-boats be few in proportion to the necessities, it should be borne in mind that the Massachusetts Humane Society have received a donation of $5,000 from the general government of the United States some time since.

I forwarded to you agreements signed by suitable persons at Nausett and Cohassett. But I must observe, that, to have them take the proper care, some allowance should be made. The use of the boats would be of no service to individuals, except in cases of shipwreck, as they would require so many persons to launch, manage, and haul them up. They could only be brought into service in some great event in the neighborhood, calling people together and exciting them, as the calls of humanity and the prospect of some gain always do our much defamed seacoast men and wreckers, whose skill, daring, and success are themes of admiration to all who have the best opportunities of judging them.

No difficulty would be found in getting persons to watch over the boats, ventilate and clean them; but it could hardly be expected that they should be at the expense of painting them or building boat sheds. The sheds and wheels for transportation to spots for launching, (which spots vary with direction of gale,) should be furnished as part of the fixtures of the boats. Rough sheds might be built, and trucks provided, for about one hundred or one hundred and fifty dollars each boat, and I recommend that they be provided.

Very respectfully, your obedient servant,

H. S. STELLWAGEN,
Lieutenant United States Navy, Assistant in Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey, near Phillips, Maine.

APPENDIX No. 11.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting extracts from a letter of Lieut. Comg. H. S. Stellwagen, United States Navy, assistant in the Coast Survey, in relation to a rock in the harbor of Gloucester, Massachusetts.

COAST SURVEY STATION, *November* 22, 1853.

SIR: I have the honor to transmit, for the consideration of the Light-house Board, the accompanying extracts from a letter of Lieutenant Commanding H. S. Stellwagen, United States Navy, assistant in the Coast Survey, in relation to a rock in the harbor of Gloucester, Massachusetts, with the additional recommendation that a buoy be placed upon it as early as practicable, unless its removal is soon provided for. I would request that this letter and its enclosures may be transmitted to the Light-house Board.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

PHILADELPHIA, *November* 20, 1853.

SIR: * * * * * * * * * *

The rock is very small in diameter, and rises very abruptly. We anchored the boat and took about a hundred soundings the apex could just be found with a lead or pole, and at a distance of four or five feet the depth would increase from nine and ten feet suddenly to twenty and twenty-one.

You will perceive that it is in the track of vessels which enter by hundreds into the inner harbor, particularly in the fishing season off the coast. The rock I think can be easily removed by a blast, and should be attended to soon. The harbor is so good and so important as to merit great consideration.

Only a sufficient number of soundings have been copied on the tracing to show the general depth, &c., in the neighborhood of the rock.

* * * * * * * * *

Very respectfully, your obedient servant,

H. S. STELLWAGEN,
Lieut. Comg. United States Navy, Assistant in Coast Survey.

Prof. A. D. BACHE, *Superintendent Coast Survey.*

APPENDIX No. 12.

Letter from the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting extracts from the report of Lieut. Comg. H. S. Stellwagen, United States Navy, assistant in the Coast Survey, upon the discovery of soundings of thirty-six fathoms to the eastward of Fippenies Ledge, east of Boston.

COAST SURVEY STATION, NEAR PHILLIPS, MAINE, *November* 16, 1853.

SIR: I have the honor to inform the department, that having been apprized by George W. Blunt, esq., of New York, of the supposed existence of a bank of forty fathoms about ninety miles east by compass from Boston light, the hydrographic party employed on the Nantucket shoals was instructed to search for it and determine its position.

In accordance with these instructions, Lieut. Comg. H. S. Stellwagen, United States Navy, assistant in the Coast Survey, in charge of that party, despatched Lieut. T. B. Huger, in the schooner "George Steers," one of the vessels of the party, for that purpose. The report of that officer is enclosed herewith, from which it will be seen that soundings of thirty-six fathoms were had near the spot designated, in latitude 42° 47′ N., and longitude 69° 13′ W., where one hundred fathoms appear upon the charts. The surface of the spot giving these soundings is about three miles in extent north and south, and two east and west, with thirty-eight and forty fathoms around it. This bank is probably Fippenies bank, the true position of which is further to the eastward than is laid down in the charts. A further examination will be made as soon as the season permits.

I would respectfully request authority to publish this notice.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

UNITED STATES SURVEYING SCHOONER "GEORGE STEERS,"
Gloucester, Mass., October 19, 1853.

SIR: In obedience to your order of the 12th instant, I proceeded, by courses laid down in a letter from Mr. Blunt, (to Prof. Bache,) in search of the shoal spot to the southward and eastward of Fippenies bank. I commenced sounding on line No. 1 about 10 a. m. on the 16th, but found no bottom with seventy-five fathoms line up and down until between 5 and 6 p. m., when I found seventy fathoms on line No. 6, having in the mean time run over the shoal spot as marked by you on the diagram. The wind being light and variable, I made the best traverse I could, and sounding as often as practicable with the small number of men I had, but found no bottom again until a little after meridian on the 17th, when I struck forty fathoms, and endeavored to follow the line of soundings. I was struck with a strong tide rip, in appearance the same as those off the Nantucket shoals, trending to the northward and westward. I ran one line along the eastern edge, sounding in thirty-six, thirty-eight, and forty fathoms; another line through the middle of it; and, before leaving the ground, a line on the southern edge. I am disposed to think that there are several different knolls, with a depth varying from thirty to seventy fathoms, not now laid down on the chart. The character of the bottom, as far as I was able to obtain it, was coarse sand in the thirty fathoms water, and soft mud in the deeper water.

I remain, respectfully, &c., your obedient servant,

T. B. HUGER, *Lieut. U. S. Navy.*

Lieut. Comg. H. S. STELLWAGEN,
United States Navy, Assistant in Coast Survey.

APPENDIX No. 13.

Report of George A. Fairfield, Esq., sub-assistant in the Coast Survey, to the Superintendent, upon the location of a tide-gauge on the beach at Siasconsett, on the outside of Nantucket island, Massachusetts.

NANTUCKET, *September* 18, 1853.

DEAR SIR: Your letter of the 12th was received last night, on my return from Hyannis.

In accordance with your request, I make the following report of my operations in establishing the tide-gauge at Siasconsett.

My first object was to select the most suitable place for laying the pipe. As the beach for a mile or two from Siasconsett presented the same appearance, and as you wished it placed as near the village as practicable, I determined to lay it directly opposite, though the shore there is very unfavorable. There is a bluff of about thirty feet in height, against which the sea breaks sometimes in violent storms. From this bluff the beach, which is of coarse sand, slopes very gradually for about one hundred feet, and then falls off very steep to the water. Just beyond low-water mark the beach again falls off, and forms a ridge.

I made one or two changes in the plan sent to me, namely: Instead of leaving the outer or seaward end of the pipe turned up, with a large strainer upon it, I carried the pipe out straight, and let it project about eight or ten feet beyond the ridge below low-water mark, and in place of the large strainer, which would present a great surface to the water. I plugged up the end of the iron pipe, and drilled four rows of holes in the pipe, about two inches apart, and wound a piece of fine copper netting, with a mesh of about 1-12th of an inch, around the pipe, so as to cover all the holes, and secured it firmly with large copper wire. The advantage of this arrangement is the small surface for the sea to act upon, the impossibility, almost, of this filter ever clogging up with sand or seaweed, and it does away with the necessity of having a screw-pile to steady it. The other change was in the vertical part. As the pipe was only two inches in diameter, I found, by trial, that a float of that diameter, capable of supporting the staff, which only weighs one pound, would have to be nearly three feet in length, which of course would require that the horizontal pipe be three feet lower than would otherwise be necessary. Instead, therefore, of using the iron pipe for the vertical part, I had a wooden float box made, water-tight, six inches diameter inside, and screwed the iron pipe into it near the bottom. By this means I got a copper float that would support the staff in two inches of water. The pipe is of wrought iron, in lengths of about ten feet, screwed together with iron couplings.

I commenced at the seaward end to lay the pipe. I screwed four lengths of it together; and, stopping the inner end with an iron screw-plug, to prevent the sand from getting in, I succeeded without much difficulty in getting them down below low-water level. But the next day, when we went to dig down to screw on another length, we found it to be impossible, for this reason: we could not keep the end of the pipe already laid clear enough of sand to enable us to screw on another length; for the moment we got down to the level of the water the sand was all alive, and as fast almost as one shovelful was taken out another would run in. Although we had the trench planked up at the sides and ends, the sand would run in underneath, and the surf would break over. And in that way we were prevented from getting any more lengths on. As we were working in two or three feet of water, we had to go entirely by the sense of feeling; and any sand at all in the thread of the screw would prevent it from working. I saw at once that I should encounter the same difficulty with every length, and determined to begin at the inner end, and work out.

For more than a week after this the surf ran so high that I could do nothing. Finally, I succeeded in taking up the four lengths already laid, and commenced digging at the inner end. We had to move an immense mass of sand, for the trench had to be dug thirty feet wide at the top, and about twelve or fifteen deep; and the sand had to be shovelled over three or four times in order to get it out, and to prevent the sides from caving in. As soon as we reached water—which we did before we got down to the level of the sea—we planked up the sides, and made a sort of coffer-dam, which we kept digging under and sinking. I saw that I could never get it down in separate lengths, neither could I lay it all in one piece, on account of the surf rushing in upon us if I opened the outer end of the trench, which served as a bulkhead to keep the surf out.

I therefore had a flexible joint made, by taking a piece of lead pipe four feet long, and soldering an iron coupling to each end of it. I then screwed together two lengths of pipe, and screwed one end into the wooden float-box, and on the other end screwed the flexible joint; then screwed another length of pipe on the other end of the flexible joint; and then, bending the lead pipe at right-angles, so that the third length of iron pipe was vertical, I placed box, pipe and all, in the trench, and by digging and working the quicksand from under it, and putting weight on the pipe, I succeeded in getting it down below the level of low water.

I then took up my planking, and extended the trench so as to take in three or four more lengths of pipe. After having dug down until the men were up to their middle nearly in water, I screwed on more pipe and another flexible joint, and bent the first joint back again, so that the pipe was straight. By using two of these joints, I laid pipe enough to enable me to lay all the rest in one piece at the next digging. After getting it all down in this manner the surf broke in, and washed the sand all in again, and filled up the trench.

Within a day or two after this we had a very remarkable low course of tides. At high water the staff read about what it generally does at low water. There was not more than a foot rise and fall. At the same time, I was told, at New Bedford the tides were very high. The fishermen here said they had never seen such low tides. The consequence was, that at low water the float box was dry. As I had laid the outer end of the pipe nearly a foot lower than the inner end, the strainer was never out of water, but always covered, even at the lowest tide.

I then thought that if I were to dig down to the pipe, and, by bending the inner flexible joint, could succeed in getting the sand from under the box and the two inner lengths of pipe, and lower them, it would answer every purpose; for, although the middle lengths of the pipe would be nearly a foot higher than the ends, it would act as a syphon. I adopted this plan; and by setting seven or eight men at work we succeeded in getting the two lengths and the box down about nine inches lower. We got them down as far as possible, until we came to red clay, and stones as large as my head. I then tried the staff and float, and found that there was plenty of water at low tide; and, believing that it was as low as it could possibly be got, and that it would embrace any range of tides they will ever have here, I filled in again, and engaged an observer to record the tides. It has now been in operation nearly two weeks, and seems to work very well indeed. The tides are very irregular, and there is not over two feet, and sometimes but one, of rise and fall.

Yours, respectfully, &c.,

G. A. FAIRFIELD, *Sub-Assistant.*

Prof. A. D. Bache, *Superintendent Coast Survey.*

APPENDIX No. 14.

Report of Lieut. W. R. Palmer, United States Topographical Engineers, assistant in the Coast Survey, to the Superintendent, upon the reconnaissance of the Rappahannock river, Virginia, from Fredericksburg to Chesapeake bay.

Baltimore, *November* 24, 1852.

Dear Sir: In conformity with your instructions of the 17th instant, I submit a report of the result of my first cursory examination of the Rappahannock river.

The Rappahannock may be divided into three sections: first section, from Fredericksburg to Port Royal, thirty five to forty miles. At Fredericksburg the river is one hundred and twenty yards wide, and one mile below, at Barnard's, about ninety yards; hence, to Port Royal its width varies from one hundred and twenty to four hundred yards. The banks of the river are generally higher in this section than below, from thirty to eighty feet; they are usually sloping, but at several points are perpendicular, and, becoming undermined, portions fall off into the river. They are skirted with wood—oak, chestnut, pine, ash, gum, and sycamore, being the principal varieties, but no heavy timber; between the "Woodyard" and "Hopyard" is from fifteen to twenty-two miles; below Fredericksburg the wood is quite dense, and considerable cutting may be required here; there are also marshes bare of wood in this section.

The meanderings of the river are greater here than below, and the obstructions to navigation are more frequent; the first, less than one mile below Fredericksburg, at "Hazel's Bar." At ordinary high water, (the tide rises about three feet nine inches here,) eight feet can be carried over this bar; it is sandy and lumpy. The second obstruction is a sandy shoal of the same depth, two miles below. Third, "Spott's Bar," about eight miles below Fredericksburg, a shoal of similar character, giving, at ordinary high water, a depth of nine and a half feet. At very low water, the steamboat Mary Washington, drawing seven feet, touches all the way from Fredericksburg to "Spott's Bar." At "Moss' Neck," eight miles below "Spott's Bar," this shoal extends for two miles, but ten feet can be had at ordinary high water; sandy, perhaps some clay, and lumpy. No other obstructions in this section.

The effect of the freshets is of course greater here than below; the spring freshets usually occasion a rise of fifteen feet; in 1846, and again in 1852, the waters rose no less than twenty feet at Fredericksburg; they subside very rapidly, frequently in twenty-four hours; freshets also take place in the fall, but are not so great as those of spring; this year one occurred in July. The water is fresh, or very nearly so, in this portion of the river.

Second section, from Port Royal to Tappahannock, a distance of thirty-five to forty miles, the width of the river varies from three hundred yards to more than one mile; just below Tappahannock, it spreads to near two miles wide. The banks do not average as great an elevation as in section one, although the highest bluff upon the river is at "Smith's woodyard," about twenty-five miles below Port Royal. This bluff is one hundred and twenty feet high, of clay chiefly; both banks are wooded similar to section one: there are also marshy flats in this section. Although the river is crooked, it is not quite so irregular in its course as above.

The obstructions are, first, at Port Tobago bay, eight miles below Port Royal; between ten and eleven feet can be carried over this bar at ordinary high water, but the channel is narrow. Second, "Green bay," three and a half miles further, of the same depth as at Port Tobago bay. Third, about five miles above Tappahannock, near Taylor's Hole, is a shoal giving at ordinary high water between nine and ten feet only, hard sand intermixed with clay, in lumps, probably a deposite from Tappahannock creek. The channel is crooked here; the water is brackish. There are but two islands of any size, "Paine's island," a marshy flat, and "Mulberry island," five to eight feet high; this could be cultivated. Each of these contains perhaps one hundred acres.

Third section, from Tappahannock to the mouth of the river, said to be seventy miles: I estimate it at between fifty and fifty-five. From Tappahannock to Urbanna may be twenty-five to thirty, and from Urbanna to the Chesapeake twenty to twenty-five miles. Throughout this lower portion, the river is from two to upwards of three miles wide. The banks are generally less elevated—that is, adjacent to the shores—as the higher land recedes, and is often from one to two miles back from the river. Although the river changes its direction in this section, it is much less crooked than in sections one and two.

The obstructions are, first, "Bowlee's Rocks," thirteen miles below Tappahannock; these are said to be banks of oysters conglomerated, only three feet below the surface at low water. The light-boat stationed here warns the navigator from approaching too near them. Below this point there seems to be no further obstruction to the navigation of the Rappahannock. The water is salt here. The upper portion of the river is quite muddy; below Tappahannock the water of the Chesapeake predominates. The velocity of the current is about one knot the hour.

The tributaries are Piscatawa river, Toteskey creek, Moratica creek, Curratoma river, and Carter's creek; none can be called very considerable.

There are several small towns or villages on the banks of the Rappahannock: Port Royal, forty miles below Fredericksburg, contains one thousand inhabitants; Tappahannock, six hundred to eight hundred; and Urbanna, one hundred to one hundred and fifty; and others smaller.

No rock formation is to be found between the falls at Falmouth (one mile above Fredericksburg) and its mouth. The distance is said to be, by the pilots and others, one hundred and fifty-five miles from Fredericksburg, by the river, to the Chesapeake. I do not think it exceeds one hundred and thirty miles.

I am, very respectfully, your obedient servant,

W. R. PALMER,

Lieut. Topographical Engineers, and Assistant in U. S. Coast Survey.

Prof. A. D. Bache, *Superintendent U. S. Coast Survey, Wilmington, N. C.*

APPENDIX No. 15.

Report of Lieut. Comg. J. J. Almy, U. S. Navy, assistant in the Coast Survey, to the Superintendent, upon the observations of off-shore tides, with a gauge secured to a tripod, seaward of Sand Shoal inlet, Virginia.

U. S. Coast Survey Steamer "Hetzel,"
Eastville, Northampton County, Va., *July* 12, 1853.

Sir: It gives me pleasure to report to you that I have at last been enabled to carry into effect your instructions in regard to observing off-shore tides by the floating tide-rod, in a box secured to a tripod, after the plan of the model which is in the Coast Survey office. Want of time, disadvantage of locality, and other circumstances, have hitherto prevented me from doing this the two previous seasons in which I have superintended hydrographic operations upon this coast.

Off seaward of Sand Shoal inlet, outside of the bar, partially protected from breakers and high, rolling surf, and from the wind also, when to the southward I found a comparatively smooth place, having two and two and a quarter fathoms of water, and distant exactly *two nautical miles* from the tide-staff in the inlet, and *one and a half nautical miles* from the nearest land. Upon the second trial, and upon the second day after commencing work upon it, we succeeded in getting the tripod, with its fifteen hundred pounds ballast, overboard, and to stand upright and firm. That very night, however, we were visited by some terrific squalls, which canted, and partially demolished it. The next day we went out with the steamer, got hold of the several parts of the tripod, hoisted it on board, secured it all a-fresh again, got it successfully overboard to stand upright, and where it remained firm and secure, to enable me to have tides observed for *seven days* out of nine—that is, *seven high* and seven low tides—and to compare them with tides observed in the inlet. No doubt the experiment would have been much more satisfactory could the tripod have been planted further seaward, so as to stand. But I did the best which could have been done, and had considerable difficulty, as it was, to rig and make it stand securely.

Herewith I send you a sketch of its position, and the position of the tide-staff in the inlet. I also send a copy of the important portions of the records, by which it will be seen that there was but little difference in the times of high and low water, and the rise and fall of tide.

I will remark that the greatest care was observed in noting the tides at the tripod off shore; that they were noted by myself, Lieut. Perry, and Acting Master Law—one or the other of us always.

I am, sir, very respectfully, your obedient servant,

JOHN J. ALMY,

Lieut. Comg. U. S. N., Assistant in Coast Survey.

Prof. A. D. Bache, *Superintendent Coast Survey.*

Records of tides observed at corresponding times at Sand Shoal inlet, and outside of the bar, seacoast of Virginia, July, 1853.

Date.	Locality.	Time of high water.*	Time of low water.*	Duration of flood.	Duration of ebb.	Rise.	Fall.
1853.		h. m.	h. m.	h. m.	h. m.	ft. in.	ft. in.
July 2	Tripod off-shore	4 15 p. m.	10 15 a. m.	6 00	....	3 8	......
2	Tide-staff in inlet	5 20 p. m.	9 40 a. m.	7 40	....	4 1	......
3	Tripod off-shore	6 00 p. m.	11 00 a. m.	7 00	....	4 0	......
3	Tide-staff in inlet	5 30 p. m.	11 10 a. m.	6 20	....	3 8	......
4	Tripod off-shore	6 00 a. m.	12 15 p. m.	....	6 15	......	3 0
4	Tide-staff in inlet	5 30 a. m.	11 50 a. m.	....	6 20	......	3 1
6	Tripod off-shore	7 30 a. m.	1 15 p. m.	....	5 45	......	3 6
6	Tide-staff in inlet	7 50 a. m.	1 10 p. m.	....	5 20	......	3 6
7	Tripod off-shore	8 00 a. m.	1 30 p. m.	....	5 30	......	3 5
7	Tide-staff in inlet	8 00 a. m.	2 00 p. m.	....	6 00	......	3 7
8	Tripod off-shore	8 45 a. m.	2 15 p. m.	....	5 30	......	3 5
8	Tide-staff in inlet	8 40 a. m.	2 30 p. m.	....	5 30	......	3 6
9	Tripod off-shore	9 00 a. m.	3 00 p. m.	....	6 00	......	3 5
9	Tide-staff in inlet	9 30 a. m.	2 30 p. m.	....	5 00	......	3 4

* These times of high and low water require a correction (to be added) of 22½ minutes.

RECAPITULATION.

Date.	Difference of time.		Difference of rise or fall.
	High water.	Low water.	
	h. m.	h. m.	ft. in.
July 2	1 05	—0 35	0 03
3	—0 30	0 10	—0 02
4	—0 30	—0 25	0 01
6	0 20	—0 05	0 00
7	0 00	0 30	0 02
8	—0 05	0 15	—0 01
9	0 30	—0 30	—0 01

NOTE.—The minus sign denotes tide-water, or rise or fall greater off shore than in inlet.

Number of observations in which tide was earlier off shore than at inlet 3. and the reverse 3, for high water; number of low waters in which tide was later off shore 3, and the reverse 4. High waters simultaneous once. The sum of the positive differences is 1h. 55m. for high water, and of the negative 1h. 05m.; total, 50m. For low water the sum of the positive differences is 1h. 55m., and of the negative 1h. 35m.; total, 20m.

These differences, divided by the number of tides, (seven.) gives for high water an average of 8m. nearly, and for low water of 3m. nearly. High water was, on the average, 8m. earlier, and low water 3m. later, off shore than at the inlet. Both these are less than the average uncertainty of the difference. For rise or fall there are three positive and three negative results, and one zero. The sum of the positive results is 6 inches, of the negative 4 inches. Final result 2 inches; which, divided by 7, the number of observations, gives .3 of an inch for one rise or fall, which is less than the uncertainty of the difference.

APPENDIX No. 16.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the report of Lieut. Comg. J. J. Almy, U. S. Navy, assistant in the Coast Survey, upon the determination of two important and dangerous shoals lying at the entrance into Chesapeake bay.

COAST SURVEY STATION, NEAR PHILLIPS, MAINE, *August* 29, 1853.

SIR: I have the honor to transmit a copy of a report from Lieut. Comg. J. J. Almy, U. S. Navy, assistant in the Coast Survey, upon the determination of the positions of two important and dangerous shoals lying off the eastern shore of Virginia, at the entrance into Chesapeake bay, and which are not laid down upon any existing map.

The outer shoal lies E. by S. ¼ S., (true,) distant seven nautical miles from Smith's Island light-house, with 3¼ fathoms upon it at low tide, and 7 fathoms between it and the land. This shoal lies very nearly in the track of vessels bound in and out of Chesapeake bay, from and to the northward and eastward. The inner shoal lies SE. by E., (true) distant four and three-quarter nautical miles from Smith's Island light-house, with 17 feet upon it at low water, and 5 fathoms between it and the land.

I would respectfully request authority to publish this information.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

UNITED STATES COAST SURVEY STEAMER "HETZEL,"
Capeville, Northampton County, Va., August 17, 1853.

SIR: In the course of my soundings lately off Smith's island, seacoast of Virginia, I have come upon and established the positions of two important and dangerous shoals. One of these (the outer shoal) lies E. by S. ¼ S., (true,) distant *seven* nautical miles from Smith's Island light-house, with 3½ fathoms upon it at low water, and 7 fathoms water between it and the land. This is a small shoal, with an extent of about 200 *feet* in a NE. and SW. direction, where 3¼ and 3½ fathoms are to be found, and with four fathoms extending 200 yards, when it deepens off suddenly all around into 5, 6, and 7 fathoms water. The other (inner shoal) lies SE. by E., (true) distant *four and three-quarter* nautical miles from Smith's Island light-house, with 17 feet water upon it at low tide, and 5 fathoms water between it and the land. This is a large shoal in extent, running a quarter of a mile, with not over 3½ fathoms upon it.

As there is but little variation of the compass, only two degrees less than a quarter of a point, I have given the true bearings, which I think will suffice and prevent confusion. Smith's Island light-house is in latitude 37° 07′ 46″ north, and longitude 75° 52′ 53″ west.

Like all the shoals upon this part of the coast, the direction of their formation is nearly parallel with the land—northward and eastward, and southward and westward—with hard, sandy bottom, coarse light, grey, white, yellow, and red sand, with broken shells. I do not claim these as discoveries, as there have been reports—vague and contradictory, to be sure—of shoal-water being in the vicinity of where these have been found. They are not down, however, upon any published chart. Some few sea captains and pilots have reported having been upon these shoals; other captains and pilots have positively denied the existence of them, saying that if there was shoal-water about there, they certainly would have seen it during a course of years which they have been sailing about there. I have crossed these shoals several times, and also anchored upon them, in order to fully verify their existence and exact position.

By a glance at the chart it will be seen that the outer shoal lies very nearly in the track of vessels going out of Chesapeake bay, bound to the northward and eastward, or coming into the bay from the northward and eastward.

I am, sir, very respectfully, your obedient servant,

JOHN J. ALMY,
U. S. N., Lieut. Comg., Assistant in Coast Survey.

Prof. A. D. BACHE, *Superintendent Coast Survey.*

APPENDIX No. 17.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, reporting the discovery by Lieut. Comg. T. A. Craven and Lieut. Comg. J. N. Maffitt, U. S. N., assistants in the Coast Survey, of a bank lying to the east of the Gulf Stream.

SEBATTIS STATION, KENNEBEC CO., MAINE, *July* 23, 1853.

SIR: I have the honor to communicate the interesting discoveries made by Lieut. Comg. T. A. Craven and Lieut. Comg. J. N. Maffitt, U. S. Navy, assistants in the Coast Survey, in their recent cruises for the exploration of the Gulf Stream south of Charleston. In running the section across the Gulf Stream from Charleston, Passed Midshipman Jones, of Lieut. Comg. Maffitt's party, in charge of the Coast Survey schooner "Crawford," discovered that soundings could be kept at depths less than six hundred fathoms entirely across the stream, bottom being brought up. Beyond the Gulf Stream the soundings correspond with those laid down upon the bank struck by Lieut. Comg. Craven further south. The "Crawford" was on this bank on the 7th, 8th, 9th, and 10th. On the 7th bottom was brought up from 300 fathoms, in latitude 31° 37′ and longitude 78° 33½′. On the 10th of June, in running the section of the Gulf Stream from Cape Canaveral, Florida, after crossing the stream Lieut. Comg. Craven obtained soundings in 460 fathoms, and the bottom was brought up in latitude 28° 24½′ north, and longitude 79° 05′ west. The shoal thus independently discovered by Lieuts. Comg. Maffitt and Craven was again struck by the latter in the cross-sections from St. Augustine, Florida, St. Simons, Ga., and Charleston, S. C. A full examination of this ground, which is probably connected with the Bahama Banks, will be made soon. The specimens of bottom brought up are deposited in the Coast Survey office.

I would respectfully request authority to publish this notice.

Yours respectfully,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

APPENDIX No. 18.

Extracts from the report of Lieut. James Totten, U. S. Army, assistant in the Coast Survey, in regard to the climate, soil, and character of the Florida Keys.

NEW LONDON, CONN., *October* 2, 1853.

DEAR SIR: * * * * * * * A few remarks may not be out of place here in regard to the geographical positions, climate, quality of soil, and general character of the Florida Keys, now under consideration, in view of the lands thereof being thrown into market by the government. A very large number of these keys, and those particularly of which I wish to be understood to speak, lie within the meridians and parallels passing through the two points, Cape Florida and Sand Key. The position of Cape Florida is in latitude 25° 39′ 52″ north, and longitude 81° 05′ west, and Sand Key is in latitude 24° 27′ 10″ north, and longitude 81° 52′ 43″ west. Within the limits mentioned there may be anywhere between five hundred and one thousand keys or islands, counting large and small. The number has not yet been ascertained with any degree of accuracy, and cannot be until the survey is completed.

The climate of the keys is perfectly salubrious and pleasant during the winter months; and even in the summer, owing to the almost constant breezes, much may be said commendatory of it in this respect. Owing to the delightful character of their climate, I am of opinion that it will eventually be ascertained and conceded that these keys are particularly well adapted to the residence of those afflicted with pulmonary complaints. Slight changes in temperature, and their regularity, combined with continued mildness, is understood to be what is sought for by invalids of this class, and I believe that such persons will come as near finding this amid the Florida Keys as in any other part of the United States.

The best soil of the Florida Keys cannot be compared in fertility with many parts of that on the main land of Florida, and a large number of them may, without prejudice, be pronounced entirely worthless for any kind of agricultural purposes. The soil on the better class is composed, in a great measure, of the sand resulting from the grinding up, wearing away, or disintegration of the coral rocks and shells, and of decayed vegetable matter accumulated there during past ages. It is usually found to contain within it large collections of undecayed shells and solid coral rock, and often lies upon compact and extensive beds of an apparently *stratified* coral formation. Notwithstanding the peculiarities of the soil, the better class of the keys are found to yield many very desirable and useful tropical fruits in perfection, and also many of the now common and useful vegetables. Vegetables are not, however, produced in very great perfection upon the keys, and yet they can be cultivated to such an extent as to answer all the wants of those who may hereafter settle on them. With care and some practical information as to the best means of proceeding in that climate and soil, much may be accomplished in raising vegetables on these lands. The lemon, lime, orange, papaya, cocoanut, banana, plantain, pineapple, guava, and tamarind, are some of the tropical fruits which have been cultivated upon the keys with success, and there are many others not yet tried, which it is evident will flourish equally as well in that climate as those I have mentioned.

In the cultivation of fruits on these keys, in fishing in the adjacent waters, in making salt, and in other occupations resulting from the settlement of these islands, they would in a few years become the homes of a useful, hardy, and happy population, and it would be worth the experiment for government to encourage the project to any reasonable extent within its power. As far as the government itself is concerned, I do not hesitate to say, emphatically, that these keys can never be of any great utility as long as they are kept out of market, other than what might be derived from them if in private hands. As to the timber upon them, (for which it is said the government has so long held them,) it is not of a quality or quantity to make it worth consideration, when compared with the advantages which would flow to both State and Federal governments from having the keys well populated. The timber growing upon these islands, as a general thing, may be stated to be too small for the purposes of strong naval construction. Its character is better adapted to the building of the smaller classes of coasting vessels, such as sloops and schooners, and it is believed there is very little, if any, large enough for heavy ships of war. But admitting that this timber may be useful in some cases to the government, it may be safely asserted that its value will be very little enhanced, if any, by being in private hands, as it is the labor of preparation for, and transportation to market, which must fix its value, and these expenses the government does not avoid by holding possession of the lands. These being some of the facts relative to the present condition of the Florida Keys, I conceive that the only way in which the government can ever derive any benefit from them is by putting them into market at once, or by giving them away in small portions to actual settlers. If it is possible to induce a number of people to settle upon the lands for the cultivation of those productions to which the soil and climate are adapted, the most satisfactory result will be obtained which can ever be reasonably anticipated. * * * * * * * * *

I am, very respectfully,

JAMES TOTTEN,
Assistant in United States Coast Survey.

Prof. A. D. Bache,
Superintendent United States Coast Survey.

APPENDIX No. 19.

Report of F. H. Gerdes, Esq., assistant in the Coast Survey, to the Superintendent, on the preliminary survey of the entrance into Barataria bay, coast of Louisiana.

U. S. Surveying Schooner "Gerdes," off Caillou Point, *January* 26, 1853.

Sir: The Bay of Barataria, opening from the Gulf of Mexico, about fifty miles west of the Balize, affords the first approach to New Orleans on that side of the Mississippi; and between this bay and the metropolis of the south, small steamboats and luggers of light draught are constantly plying.

The inland communication from the bay is by Bayou St. Denis, or by Grand Bayou, to Little Lake, thence by Bayou Perot to Lake Washa, and thence by a canal entering the Mississippi nearly opposite Carrolton, about ten miles above the city; the whole distance being about one hundred and ten miles.

To defend the harbor, and prevent an approach through this bay to New Orleans, a site for a fortification was selected at the entrance of the bay, and some works have been erected.

A survey of the entrance was made in 1840 by Lieut. (now Major) Beauregard, United States engineers; but the changes since that time, resulting from the strong westerly currents of the Gulf, have been so considerable as to render necessary a resurvey in order to furnish a preliminary harbor-sketch for publication, according to your instructions. The following are some of the most marked changes:

1. On the west side of the main pass into the bay, there was thirteen years ago a small sand island called the Brass bank, while the point of the western island (Grand Isle) was nearly a mile further to the southwest, leaving between that point and the Brass bank a flat, on some parts of which were from seven to nine feet water. All this is now dry land and beach, and the Brass bank forms an actual point of Grand Isle.

2. On the eastern point of the entrance, near the fort, the sea is making heavy inroads. Since the last summer, the beach has lost more than one hundred yards, and the new United States quarters for officers are now distant only twenty-five or thirty yards from high-water mark, and perhaps twice as far from low-water mark. The front fence of the enclo-

sure is washed away, and the place where it stood is below low-water mark. Any continued easterly storms will endanger all the buildings extremely, and must prove ultimately fatal even to the fort itself if the action of the water is not checked.

3. A new channel (which I have named the East channel) has been opened, probably by the combined action of westerly currents and of the easterly storms of last year, close along the beach at the west point of Grand-terre, separating the east Sambo shoal from the shore by seven feet of water. In 1840, there was only three and a half feet; the depth has been therefore doubled in thirteen years. This channel is of easy access.

4. On the bar in the main channel, (Grand Pass,) the depth has generally increased. Eight feet can now be carried at low tide, and ten feet at very full tides. The increase averages about one foot.

The entrance of this bay has been carefully surveyed, and the chart can be used as a harbor chart. The following operations were performed by the aid of such instruments as you had directed me to take out, whose results in general were very satisfactory, as the journals of observations and the documents therewith will show.

1. A base line, 1328.15 metres in length, was measured twice on the island of Grand-terre, commencing on the Gulf shore at the fence of Forstall's sugar plantation, and running across the island in a northwest direction to the old Fort Lafitte.

2. Eight triangulation signals were established by measurement of angles, at four stations, with a 6-inch Gambey theodolite.

3. Seven buildings and prominent objects were determined by the same means.

4. The shore-lines outside and inside were actually surveyed, and all projecting points determined by theodolite and compass.

5. Soundings over the bar and in the channels were taken by staff, angles determined by sextant, and tidal observations made during the time of sounding.

6. Astronomical observations were taken as follows:

1852.	December 4 and 5, at Pascagoula.	Transits 4 sets stars each.
	December 31, Fort Livingston.	Transits 12 sets stars each.
1853.	January 1, Fort Livingston.	Transits 12 sets stars each.
	January 11, Fort Livingston.	Transits 4 sets stars each.
	January 4, Fort Livingston.	Observations for latitude, zenith telescope, 1 pair stars.
	January 5, Fort Livingston.	" " " 5 "
	January 10, Fort Livingston.	Observations for motion of the magnet, with declinometer, for two hours, at every five seconds.
	January 12, Fort Livingston.	For variation of the needle, 3 sets of observations.

7. A preliminary plotting was made, the soundings laid down, and the topography inserted.

The latitude of the station at Fort Livingston (southwest angle of the main work) is 29° 16′ 43″.85 north; the azimuth thence reckoned from S. by W. to trigonometrical station at Fort Lafitte, 184° 15′ 52″.39; approximate longitude 89° 54′ 30″; mag. var. 7° 39′ 22″.

This is quite classical ground in the history of the United States. Remains of old Fort Lafitte, and of many buildings, are to be seen still. It was here that the late Commodore Patterson broke up the freebooters and pirates sailing under the Carthagenian flag; he destroyed the fort, which was mounted with twenty pieces of cannon, dispersed a force of from eight hundred to one thousand men, of all nations and complexions, and captured seven schooners (one armed, under Carthagenian colors) and one felucca.

The whole gang had been harboring on the Chenaie islands, Grand Isle, and Grand-terre.

* * * * * * * *

The sites and localities for light-houses at the entrance of the bays of Barataria and Timballier, on the Gulf of Mexico, as proposed in my reports of February and October, 1853, possess both great advantages, and, as far as I would like to judge from my present opinion, and from information received from others, they are of nearly equal importance, but both would serve different purposes. A light at the west end of Isle au Grande-terre, (Barataria,) would principally be useful for the navigation of the bay and adjacent waters, such as the Bay of Camisada, which contains same settlements of considerable size. For the benefit of communication with New Orleans, this site affords the greatest advantage, and would also give a direct bearing for crossing the bar from the Gulf. As stated in my first report, there are more than one hundred luggers constantly plying between New Orleans and these waters, and most of them have to pass through the Barataria into the Camisada by the bayous of St. John, Fifi, and Rigaud. Coming from New Orleans, either through the Barataria or by the Gulf, it is very difficult to distinguish the inlets of these streams from any part of the low marshy and monotonous coast, and at night it is entirely impossible. A light-house, however, judiciously placed on the opposite beach, would furnish a direct bearing to each of them at any time. The erection of a light-house at the east side of Grand Pass into the bay of Timballier will be of great advantage to the Gulf navigation between New Orleans and Mobile, with the Attakapas sugar region and Texas. The enclosed sketch, a reduction of my map of general reconnaissance of the Gulf coast west of the Mississippi, will at once sustain this opinion, and also show the eastern extension of the Ship shoal, which, according to information, terminates abreast of the Timballier. This bay forms a most excellent harbor of refuge—a fact of which nothing was known, according to the existing charts; and the proposed locality for the site commands also the entrance to the inside Ship-shoal channel, so that a vessel might lay her course from the Southwest Pass directly for this light. This line will cut the large curve of the Gulf, in which Barataria is situated. It is true that the currents near the Louisiana coast have a northerly tendency, and vessels find themselves not unfrequently in sight of Fort Livingston, Barataria, or at least at a higher latitude than they supposed themselves to be; but whenever the proper investigations have been made, and the currents determined, this will form a difficulty no longer. Having made the light-house at Timballier, and verified her position, any vessel may follow the coast by soundings, or even anchor inside the shoal in perfect safety. I have seen the New Orleans revenue cutter, in company with two large schooners, ride out here a very severe gale of wind of two days' duration, perfectly easy, and without any dragging. Timballier light would also give a direct bearing for the bar of the bay, on which are eleven or twelve feet at low tide.

Both light-houses, therefore, will be very useful—the one at Timballier chiefly for Gulf navigation, and for avoiding danger; the other principally for inland navigation, and facilitating commercial intercourse, sustained by the wishes of a large and thriving community. The coasting trade with the Attakapas and Texas, and also the inland navigation through Barataria, has become, in the last four years, quite important, the number of vessels employed in them having been more than doubled. Their trade, therefore, justly claims and deserves attention.

Very respectfully, yours, &c.,

F. H. GERDES, *Assistant.*

Prof. A. D. Bache, *Superintendent U. S. Coast Survey.*

APPENDIX No. 20.

Report of F. H. Gerdes, Esq., assistant in the Coast Survey, to the Superintendent, on a reconnaissance of the entrance into Timballier bay, coast of Louisiana.

U. S. SURVEYING SCHOONER "GERDES," OFF ISLE DERNIERE, *February* 5, 1853.

SIR: The vast quantity of water coming through various large channels, such as Bayou Lafourche, Bayou Chenaie, and Bayou Bonne-terre, indicated, as I thought, another outlet to the Gulf than only the West Pass into Timballier bay, which, according to the charts, has nine feet of water, but actually carries, I suppose, not near so much. At the Grand Pass into Timballier bay, Blunt's chart shows no water at all, but a flat stretches from isle to isle. I received, however, some information to the contrary, which induced me to enter this bay under charge of a pilot. At our first run, with a very low tide, I had ten feet water, and found very good anchorage three and three-quarter miles northwest from the east point of Timballier isle, in fifteen to eighteen feet water, with sticky and soft bottom.

While reconnoitring the bay, I found sufficient water for inside navigation to Bayou Chenaie and to West Pass for luggers, such as are generally used on this coast. The anchorage appears to me exceedingly useful for a harbor of refuge.

I enclose a tracing of a plotting, yet imperfect, the data for which were derived from chainings and bearings. I had no opportunity for observations for latitudes, which I therefore take from Blunt's chart. On the only clear morning I had, time was ascertained with artificial horizon on East Point, and five chronometers gave it 22m. west of the Barataria astronomical station.

According to the charts, this harbor must have been unknown, and I have therefore forwarded this sketch and report at the earliest date.

Very respectfully, your obedient servant,

F. H. GERDES.

Prof. A. D. BACHE, *Superintendent United States Coast Survey.*

APPENDIX No. 21.

Extracts from the report of F. H. Gerdes, Esq., assistant in the Coast Survey, to the Superintendent, upon the survey of Isle Dernière and Ship shoal, coast of Louisiana.

NEW ORLEANS, LA., *March*, 1853.

SIR: * * * * * * * * *

The Ship shoal runs east and west, and lies about twelve miles to the south of Isle Dernière, the west end of the shoal being nearly abreast of Racoon Point, and the east end extending to about opposite the middle of the island. From the inhabitants of the key, my pilot, and others, I was informed that nine feet of water was the least that could be found on the shoal. The keeper of the light-boat, Capt. Luike, who has been in charge two years, told me there was no less than fourteen or fifteen feet to be found, and states that he had personally made investigations and soundings. The first statement seems, however, to be the more correct one. Breakers on the shoal can only be perceived in southerly winds. West of the shoal there seems to be an opening into the Gulf, and it is reported that six or seven fathoms can be brought on it. Another shoal connected with the main reef makes out to the southwest, and commences from four or five miles from Racoon Point, extending much further into the Gulf than the Ship shoal, and is by far the more dangerous of the two. Here the steamer Galveston was wrecked several years ago, and some parts of the wreck are still visible. The light-ship is anchored within half a mile of this wreck, and forms in her present position only a guide for keeping off. Where the Galveston lies there seems to be only four feet of water.

On Isle Dernière the following operations were performed by the party under my charge:

A.—Astronomical observations.

A station was selected on the sand ridge running lengthwise over the island, about three and three-fourths miles east of Racoon Point, nearly opposite the large and conspicuous dwelling of Mr. Maskel, and a suitable wooden house was erected for an observatory, in which the transit and zenith telescope were firmly mounted, and the following number of observations made:

I. With the transit:

1853. February 7th	22 sets of stars.
Do.... 9th	4 .....do.
Do.... 10th	8 .....do.
Do.... 11th	16 .....do.
Do.... 19th	12 .....do.
Total	62

II. With the zenith telescope:

February 9th	7 pairs of stars.
Do... 11th	2 ....do.
Do... 23d	6 ....do.
Do... 24th	5 ....do.
Total	20

III. Readings for azimuth were made on each night of transit observations.

IV. Declinometer observations, February 20, during four hours, every ten minutes, for the motion of the magnetic needle.

B.—*Trigonometrical operations.*

Stations of secondary and tertiary triangulations were selected, and signals erected on Racoon Point, on different parts of the beach, on the village creek, and on the Cayambo; but the land being very low, and thickly covered with chaparral, it was very difficult to get well-shaped triangles properly connected. The angles were observed with a six-inch Gambey theodolite, and provisionally calculated from the azimuth by rectangular coördinates on the true east and west line of the astronomical stations. Annexed is a list of the same.

* * * * * * * *

C.—*Topography.*

An accident having happened to the plane-table alidade, the instrument could not be depended upon for running the important south-side shore-line; and as the whole could not be well included in the triangulation, sixteen lines, of nearly one mile each, were very carefully chained along the coast, and the intermediate angles measured with a six-inch Gambey theodolite, and afterwards calculated by coördinates from the trigonometrical data, and verified by several triangulation points. The survey of the island was extended eastward as far as it has any bearing to the survey of the shoals, viz: eleven miles on the south side, and north for eight miles, from Racoon Point, which makes an average of thirty-three and a quarter miles of shore-line, small streams and numerous ponds not counted. The annexed tracing is an incomplete copy of the topographical sheet.

D.—*Tidal observations.*

As Lieutenant Commanding Sands is probably going to observe a regular set of tidal changes, only a few observations were taken, and those on the inland side of the island, although a great difference exists there and on the Gulf coast. The changes observed within half a moon give a rise of twenty-three inches in average, requiring a time of twenty-five hours from full to full tide.

In regard to the proper name of this island, and also of a great many other keys, points, bays, bayous, there seems to be a great discrepancy in the various existing maps. Isle Dernière is sometimes called "Isle au Vin," (Spanish chart and Com. Moore;) "Ship Island," (Blunt;) "Isle aux Vins," (Blunt;) or "Last Island," (Topographical Engineers;) but it can be maintained that the name "Isle Dernière," as used in this report, is the proper appellation. In 1805, M. C. Baptiste, a French emigrant, landed on this island, which was then entirely uninhabited, and described it to his friends as the last of a string of islands running from the east to the west; and since then it always went by the name of "Isle Dernière." A passage between the shoal, deep enough for ships, gave rise to the name of "Ship Shoals," and no doubt from this name the island was marked as "Ship Island." The name "Isle au Vin" is undoubtedly incorrect, and probably misspelt from "Isle aux Vins," which is the next one to the last, and called so after a species of creepers peculiar to this coast, and more particularly to that key, a large part of which is covered with them. This is, however, not the one which is represented by Blunt as such, but is situated to the west of Caillou, and separated from Dernière by a pass of three miles wide. This same disagreement exists along the coast; the original names are chiefly Spanish or French. I have taken great care to find the proper appellations, and will introduce them in the general map of reconnaissance.

Isle Dernière is an island of some twenty-two miles in longitudinal extent; on some places more, and on others less, than one mile wide. It is entirely level and low, with the small exception of a sand ridge, five or six feet high, running along the beach. For eight miles it has been covered with thick chaparral; but during the last three or four years the western part has become cleared and thickly settled, and now becoming, during the summer season, a very suitable and fashionable watering place for the large population at the Attakapas and Plaquemines. There are at present, perhaps, sixty houses in the village of Isle Dernière, nearly all owned by planters.

At the trigonometrical stations stone cones were buried; and at the astronomical point a large square stone, with copper bolts, was secured four feet under ground, fastened in a strong cedar frame work. I may as well mention here that at Fort Livingston, in Barataria, the astronomical station was similarly secured, and the proper descriptions of the stations made.

* * * * * * * *

Very respectfully, your obedient servant,

F. H. GERDES.

Prof. A. D. Bache, *Superintendent U. S. Coast Survey.*

APPENDIX No. 22.

Extracts from the report of F. H. Gerdes, Esq., assistant in the Coast Survey, to the Superintendent, in relation to the channels of trade of the Attakapas plantations, Louisiana.

Tarrytown, N. Y., *October*, 1853.

Sir: * * * * * * * * The trade from these plantations (Attakapas) is very great, and the towns of Franklin, Portersville, and others, are fair specimens of growth and improvement in the South. In former times the commercial intercourse was chiefly carried on by the junction of the rivers in the vicinity with the Mississippi, which was certainly a very circuitous and slow route. In later years, however, and chiefly since the trade has become more lively in the western part of the Gulf, this commercial intercourse has taken another turn, and is carried on mostly by the Atchafalaya and the Gulf, *via* the Southwest Pass, to New Orleans. More than a hundred vessels arrive annually at the mouth of the Atchafalaya, and receive their cargoes either by lighters or steamboats. Little is known of the entrance of the bays and rivers, except by the branch pilots at Point au Fur, or by some old traders; and for this reason I have recommended to you a preliminary survey, grounded upon tertiary triangulation, and embracing the soundings of the principal inlets, channels, and bars. It is said that twelve or thirteen feet can be brought into the Atchafalaya. * * * * * *

Very respectfully, your obedient servant,

F. H. GERDES.

Prof. A. D. Bache, *Superintendent U. S. Coast Survey, Washington.*

APPENDIX No. 23.

Letter from the Superintendent of the Coast Survey to the Secretary of the Treasury, communicating extracts from a letter of Lieut. Comg. James Alden, U. S. Navy, assistant in the Coast Survey, upon the results of an examination of the coast and several harbors and anchorages between San Francisco and the Columbia river.

Coast Survey Station, near Phillips, Franklin Co., Maine,
October 11, 1853.

Sir: I have the honor to communicate herewith extracts from a letter of Lieut. Comg. James Alden, U. S. Navy, assistant in the Coast Survey, upon the results of an examination of the coast and several harbors and anchorages between San Francisco and the Columbia river, in his recent trip of reconnaissance northward, in the Coast Survey steamer "Active."

I would respectfully request authority to publish this information.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. James Guthrie, *Secretary of the Treasury.*

U. S. Surveying Steamer "Active,"
Columbia River, August 18, 1853.

Dear Sir: We arrived here last Monday evening, after finishing the reconnaissance up to within sixty miles of this place: the weather was so bad just then, that I concluded to let that part stand until our return from the north. Mr. Davidson has occupied twelve stations on this part of the coast, including San Francisco and this. We found, much to my surprise, good anchorages every night, except the one before we got in here. At every stopping place the observatory was put up, and sights obtained. A survey of the anchorage at Mendocino City, which is some seventy miles to the southward of that cape, and of a snug cove, forty miles further on, was made. Humboldt bar has been examined, the bay at Crescent City, under Pt. St. George, surveyed, the hydrography of Port Orford, or Ewing harbor, done, and a survey made of the entrance of the Umquah, including six miles of the river. We found a good wide passage through the reef off Rogue's river, and examined those through the reefs off Pt. St. George and Cape Blanco. They are all entirely safe and perfectly practicable. For steamers bound north, particularly in the summer time, when it is necessary to keep close to land for shelter from the wind, which blows almost a gale down the coast, such "cut-offs" will prove invaluable. We have brought a line of soundings up the coast, getting casts at intervals of every two miles, and seldom at a greater distance than one mile from the shore, often within a quarter of a mile, and frequently within two or three hundred metres of the rocks; so you will perceive that our opportunities for giving the coast a thorough examination have been complete. We were delayed in Humboldt seventeen days—two weeks by fogs—before we could get any sights, and then three days on account of the roughness of the bar, the sea breaking the whole time entirely across. We found the bar pretty nearly as it was when we surveyed it two years ago; but I am satisfied, from all the information I could get, that it has undergone very important changes in the mean time.

The entrance to this river, (Columbia) the south channel, or rather what they call the Point of Sands, or North Spit, has crept down a little towards the beach, but the change is not half so great as I had been led to imagine from the reports of pilots and others. When we came in, or rather when we made the breakers, the fog was very thick; it soon, however, lifted a little, so that one of our marks could be discerned through the mist, and, giving the north breaker or Point of Sands a wide berth, we crossed the bar in *a quarter less five fathoms*—more water than I have ever known there before; the tide, too, had been flowing only about one hour. There is a new channel opened into the old north channel, through the middle sands, about half way, which the pilots use now to bring vessels in, drawing twelve or thirteen feet of water. The wind being more favorable in that quarter at this season of the year, it is found very convenient.

* * * * * * * * *

I was exceedingly desirous of completing the reconnaissance and survey of the Umquah during this season, and was very fortunate in being able to accomplish it. The entrance is narrower than that of Humboldt, and there is less than two and a half fathoms of water on the bar. We went in and came out without difficulty, but drawing only eight feet of water.

* * * * * * * * *

With great respect, I am your obedient servant,

JAMES ALDEN,
Lieut. Comg. U. S. Navy, Assistant in U. S. Coast Survey.

Prof. A. D. Bache,
Superintendent U. S. Coast Survey, Washington, D. C.

APPENDIX No. 24.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting extracts from the report of Lieut. Comg. James Alden, U. S. Navy, assistant in the Coast Survey, upon the determination of the position of a bank in the Pacific, lying in the track of the Panama steamers.

Near Leeds' Station, Maine, *July* 15, 1853.

Sir: I have the honor to transmit herewith extracts from a report of Lieut. Comg. James Alden, U. S. Navy, assistant in the Coast Survey, upon the determination of the position of a bank in the Pacific, lying in the track of the Panama steamers, and which has been called the Cortez Shoal.

This shoal was first seen by Captain Cropper, of the "Cortez," and its position afterwards determined by the commander of the steamer Pacific, which varies very slightly from that given by the Coast Survey officers.

I am indebted to G. W. Blunt, Esq., of New York, for having early called my attention to the discovery of this shoal. The information, however, had previously reached Lieut. Comg. Alden, who despatched a party to determine its position.

The shoal will be immediately indicated upon the charts now on hand and ready for distribution, as well as on all future editions.

I would respectfully request authority to publish the above.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. James Guthrie, *Secretary of the Treasury, Washington.*

U. S. Surveying Schooner "Ewing," off San Pedro, *June* 1, 1853.

Sir: I have the pleasure of reporting my return to this place from the shoal to the southward of San Clemente and San Nicolas, of which I have made a thorough examination, having been five days anchored upon it.

The shoal, or bank, is in latitude 32° 30′ north, longitude 119° 10′ 50″ west. The island of San Nicolas bears NW. by N. (by compass) distant 46 miles; island of San Clemente bears NE. ½ N. (compass) distant 43½ miles. The nature of the bottom is hard, composed of white sand, broken shells, and coral. The least water found—ten fathoms—would be about nine reduced to low water; and the character of the soundings, as you will find upon reference to the chart which I send herewith, irregular and abrupt.

The weather, while at anchor upon the shoal, we found different from that which ordinarily prevails upon the coast in the vicinity, bearing a strong resemblance to that upon the banks of Newfoundland.

The current is irregular, frequently setting against the wind, and running with a velocity of nearly two knots per hour, producing a heavy sea, and causing the water probably to break in heavy weather, as has been reported.

Very respectfully, your obedient servant,

T. H. STEVENS, *Lieut. Comg. U. S. N.*

Lieut. Comg. James Alden,
U. S. N., Chief of Hydrographic party on Western Coast.

APPENDIX No. 25.

Extracts from the reports of the Chiefs of the different divisions to Capt. H. W. Benham, Corps of Engineers, assistant in charge of the office, showing the details of the work executed in each division.

A.—Computing Division; J. E. Hilgard, assistant, in charge. List of computations made during the past year to November 1, showing the persons of the division by whom they were made.

Computing Division, *November* 12, 1853.

Dear Sir: The annual report of the computing division of the office is herewith respectfully submitted. The current duties of the computing division consist in computing the results of the work of field parties, in verifying the same by comparing them with those computed by the observers, and in furnishing them for the use of the office, or of field parties, when required. In the performance of these duties, the organization of the division has been very efficient during the past year. All the field-work of 1852, and all that of 1853, which has been received, has been computed, and the revisions have been made as far as the computations of observers have been received.

The project of this class of work is necessarily general in its terms, and no inconvenience arises from the circumstance, as everything is provided for as soon as received. The records of results have been kept up with care, and the system has been extended and improved, chiefly by Mr. Schott. Calls for results or information can be promptly complied with.

As the work in different sections accumulates, as series of triangulations are completed or join with others, as additional astronomical determinations are obtained, further revisions and adjustments of the work become necessary. These are undertaken at times when the current work does not require the employment of the whole force of computers. The discussion of the primary triangulation in Sections I and III has been advanced, that of the zenith-sector latitudes has been made, the adjustment of the secondary triangulation in Section I has been brought up to date, that of Section III has been commenced, and that of the seaboard triangulation in Section IV has been made as far as existing data required.

The industry, zeal and fidelity of all the gentlemen engaged in the computing division, is deserving of great commendation. The attendance at the office has been very good, and all appear to take that interest in the success of the work which stimulates to a prompt and faithful performance of duty.

The manner in which the different classes of work are distributed among the computers is, in general, as follows: The computations of latitude and azimuth are made by *Mr. E. Nulty;* their revision and the reduction of transit observations are made by *Mr. Main.* The work of triangulation is computed by *Mr. Werner*, and revised by *Mr. Rumpf*, who also has in charge the registers of geographical positions. *Mr. J. E. Nulty* and *Mr. Wiessner* are engaged on different classes of work, as demanded by its occurrence. The clerical work is performed by *Mr. Hoover*, who also makes miscellaneous computations.

Mr. Schott, when not in charge of the computing division, or engaged on special duty, makes computations of astronomical work, and discussions of results generally.

The occupation of the several computers during the past year is stated below.

Mr. Charles A. Schott was in charge of the computing division during five months, during which I was engaged in field work. He has computed the longitude of Cedar Keys and St. Marks from a chronometer expedition in 1852, and the telegraphic longitude of Cambridge, Bangor, and Halifax; has been engaged in the discussion of the primary triangulation in Section I, the revision and discussion of the zenith sector latitudes, and the reduction of some magnetic observations. He has also frequently been engaged on hydrographic duty, in connexion with which he has made reports on tides and currents in Long Island sound and approaches; on currents near the coast of Maryland and Virginia; on currents in Charleston harbor; on currents and tides in Savannah river, and on other matters relating to hydrography.

Eugene Nulty, Esq., has computed the observations of time and azimuth at stations Mount Pleasant and Cape Small, (Section I,) Roslyn, (Section III,) New Cut, (Section V,) Depot Key, (Section VII,) and Tongue Point Neck, (Section XI,) and the observations of latitude at stations Agamenticus, Mount Pleasant, (Section I,) Mount Rose, (Section II,) Roslyn, (Section III,) and Depot Key, (Section VI.)

Assistant Theodore W. Werner has computed the secondary triangulation of Casco bay, 1852, in Section I; in Section II, the triangulation of Hudson river, 1852–'53; in Section III, the triangulation of Chesapeake bay, of the Appomattox and James rivers, 1852, and magnetic observations at five stations; in Section IV, the triangulation of Currituck sound, 1850–'51, and of Core sound, 1852–'53; in Section V, the triangulation of Savannah river and of St. Helena sound, 1851–'52; in Section VI, the triangulation of Card's sound, 1852, of the Florida reef, 1852–'53, and of the St. John's river, 1853; in Section VIII, the triangulation of Lake Borgne, 1852; in Section IX, the triangulation of 1852–'53. He has also made a check computation of the triangulation of Narragansett bay, and various miscellaneous computations.

Mr. G. Rumpf has kept the registers of geographical positions, and has been engaged in preparing the list for the annual report. He has revised all computations of triangulation of the year, and has made the necessary check computations. He has computed the primary triangulation in Section I, 1851, the secondary triangulation on the seacoast of Virginia, 1852, and that of Georgetown harbor, (S. C.) 1853; the latitude of False Dungeness and Point Hudson, Section XI, and magnetic observations in Section I; has revised the computation of azimuth at Mount Pleasant, and the secondary triangulation south of Cape Henlopen, 1844, and has made some progress with the revision of the secondary triangulation of the upper part of Chesapeake bay, besides making many miscellaneous computations required for the use of the office. He has also made considerable progress in arranging and indexing the books of observations and computations previous to 1844.

Mr. James Main has computed the chronometric difference of longitude of San Diego, San Francisco, Punta de los Reyes, (Point Reyes,) Section X, and Scarboro' harbor, False Dungeness, Port Hudson, Section XI; the latitude of Presidio hill, Section X, and of Agamenticus by zenith sector, Section I; the transits for longitude at Scarboro' harbor, Section XI, and at Telegraph hill, Section X, and the observations of azimuth at Savannah. He has revised the computations of latitude of stations Mount Independence, Mount Pleasant, Cape Small, Causten, and Roslyn, and those of azimuth at stations Cape Small and Depot Key. He has also in part computed the longitude of Scarboro' harbor from moon culminations, and has computed the projection for the Congress map.

Mr. J. T. Hoover has performed the clerical duty of the computing division, and has made many miscellaneous computations, among which are the reduction of horizontal angles at Mount Pleasant and Cape Small by least squares. computation of places of stars, of micrometer values, of probable errors of the primary triangulation in Section I, and reduction of currents. He has also assisted in preparing the list of geographical positions.

Mr. J. E. Nulty joined the computing force in November, 1852. He has assisted other computers, and has computed the triangulation of Columbia river, Section XI, the latitude of Scarboro' harbor, that of a station in Washington city, and has revised the zenith sector latitude of Hill's hill.

Mr. J. Wiessner joined the office in January, 1853. He has been principally engaged in assisting Messrs. Schott and Main, and has made many minor geodetic and astronomical computations.

Mr. E. F. Mason was attached to the computing division until May, when he left for field-duty. During two months he was prevented from working by sickness. He computed the L. M. Z. of the revised secondary triangulation in Section I, and occasionally assisted Mr. Rumpf.

Computations of probable errors and discussions of various kinds were made by A. S. Clements, under the immediate direction of Mr. Hilgard.

Work of duplicating and miscellaneous copying was done by R. Freeman.

B.—Drawing Division. Capt. A. A. Gibson, U. S. Army, to Capt. H. W. Benham, assistant in charge of Coast Survey office. List of maps and sketches completed or in progress during the year, to November, and by whom they have been drawn.

Drawing Division, *November* 15, 1853.

Sir: I have the honor to submit the following report of the operations in the drawing division of the Coast Survey office during the year ending November 30, 1853.

The drawing division was under the charge of Captain J. G. Foster, corps of engineers, assistant, until the latter part of December, when he was relieved by Mr. J. J. Lee, who discharged this duty until the middle of May following. Mr. Lee left the office at that time, and Messrs. Williams and Hergesheimer were necessarily placed in this position until the duty was assigned to me in August.

The following is a statement of work accomplished by the draughtsmen:

Assistant W. M. C. Fairfax has been engaged upon the reductions of the hydrography of Boston harbor, $\frac{1}{20{,}000}$; the topography and hydrography of Long Island sound, No. 1, $\frac{1}{80{,}000}$; the topography of Chesapeake bay, No. 1, $\frac{1}{80{,}000}$; the lettering and revision of Mobile bay, Nos. 1 and 2, $\frac{1}{80{,}000}$; and the map of the Gulf of Mexico, $\frac{1}{3{,}000{,}000}$, for Mr. Andrews' report on the commerce of the Gulf. In addition to work on the progress sketches he has expended much time in the examination and verification of charts, in the revision of sailing directions, preparing estimates of work, and in many other subjects of a miscellaneous character, wherein his long experience rendered him eminently useful, and for which there has been an unusual demand for his services. By ill health he was prevented from attending to his duties in the office from the first of September to the middle of October.

Assistant M. J. McClery has devoted a large portion of his time to the reduction of the topography of Chesapeake bay, No. 2, $\frac{1}{80{,}000}$, now nearly completed. He has made some additions to the reduction of Chesapeake bay, No. 3, $\frac{1}{80{,}000}$, and assisted in preparing the map of Savannah river, $\frac{1}{5{,}000}$, for the Board of Engineers; the seacoast chart of Delaware, Maryland, and part of Virginia, No. 1, $\frac{1}{400{,}000}$; and the assemblage map for Congress, $\frac{1}{7{,}500{,}000}$, the coloring of which is his own, and also the study of the tints for their characteristic meaning. In verifying, &c., he has rendered some assistance.

Mr. Joseph Welsh was engaged on the reduction of the topography of the eastern series, No. 2, $\frac{1}{80{,}000}$, until July, when he took in hand the reduction of No. 3 of the same series, of which nearly one-half of the topography had been previously made by Mr. Fairfax. He made the reduction of the preliminary sketch of Pungoteague creek, $\frac{1}{40{,}000}$, assisted to finish the map of Savannah river, $\frac{1}{5{,}000}$, and expended upwards of one month on the title and other lettering of the Congress map, $\frac{1}{7{,}500{,}000}$, and projections and verifications.

Mr. J. J. Ricketts has made the original chart of the hydrographic survey of Key West harbor, $\frac{1}{5{,}000}$, by Lieut. J. Rodgers, and completed about one-half of a similar chart of Key Biscayne, $\frac{1}{20{,}000}$, by that officer. He reduced the hydrography of Key West harbor to a scale of $\frac{1}{30{,}000}$, assisted to complete the map of Savannah river, $\frac{1}{5{,}000}$, and the comparative map of Flynn's shoals, reduced the shore-line of Sandy Hook, $\frac{1}{40000}$, to show its changes, and revised the hydrography of several preliminary sketches.

Mr. Charles Mahon, on contract, reduced the topography of Mississippi sound, No. 2, $\frac{1}{80000}$, and finished the topography of the eastern sheet of Albemarle sound, $\frac{1}{80000}$.

Mr. John Lambert, on contract, reduced the topography and hydrography of Santa Barbara, $\frac{1}{20000}$, and Cape Flattery and Nee-ah harbor, $\frac{1}{40000}$. He added some lettering to the reconnaissance of the Western coast. In March he joined the party under Governor Stevens, in the expedition by land to the Territory of Washington, and thereby the Coast Survey lost the services of this valuable draughtsman.

Mr. A. Boschke, on contract, made the reduction of Shoalwater bay, $\frac{1}{80000}$, assisted to complete the map of Savannah river, $\frac{1}{5000}$, and for a short period was employed on miscellaneous work.

Mr. J. R. P. Mechlin has been employed in the office since March, principally on reductions of the hydrography of Chesapeake bay, No. 1, $\frac{1}{80000}$, and No. 3 of the same series. He made the projections for the Congress map, $\frac{1}{1500000}$, and other sheets. Commencing the hydrography of Chesapeake bay, $\frac{1}{400000}$, the work was discontinued before he had made sensible progress on it.

Mr. E. Hergesheimer made the reductions of the reconnaissance of the Western coast from Gray's harbor to Admiralty inlet, $\frac{1}{600000}$, the commercial map of the Gulf of Mexico, $\frac{1}{3000000}$, and the map of Appomattox river, $\frac{1}{5000}$, for the commission on its improvement. He has assisted in preparing a similar map of that river for the Chamber of Commerce of the city of Petersburg, Va., and made additions to the seacoast chart of Delaware, Maryland, and part of Virginia, $\frac{1}{200000}$, to the history maps and to the progress sketches. He has executed much miscellaneous work.

Mr. E. Freyholdt has made the reductions of the preliminary sketches of San Luis Pass, $\frac{1}{10000}$, east and west entrances to St George's sound, $\frac{1}{80000}$, and Sow and Pigs reef, $\frac{1}{2400}$ and $\frac{1}{20000}$; also, comparative maps of Barataria bay, Cape Fear river, and the mouth of the Columbia river. He has been employed on the Congress map, $\frac{1}{1500000}$, and in making projections, tracings, and other miscellaneous work.

Mr. L. D. Williams joined the office at the close of the month of March. He has made the reductions of the preliminary sketches of Barataria bay, $\frac{1}{30000}$, Cape Charles and vicinity, $\frac{1}{80000}$, and Romer and Flynn's shoals, $\frac{1}{40000}$, and additions to the progress sketches. He was first employed as a clerk in the division upwards of one month, and in portions of May and June acted in its charge. With the assistance he has rendered on the Congress map, the making of projects and tracings comprise the greater portion of his miscellaneous duties.

Mr. John R. Key made the reduction of False Dungeness, $\frac{1}{30000}$, and portions of the reductions of Albemarle sound, $\frac{1}{200000}$, and Cape Charles and vicinity, $\frac{1}{80000}$; the reductions of the hydrography of San Diego bay, $\frac{1}{25000}$, and reconnaissance of the coast of Florida, from St. Mark's to St. Andrew's sounds, $\frac{1}{600000}$; and rendered much assistance in preparing the Congress map, $\frac{1}{1500000}$. The remainder of his time has been spent in making tracings, &c.

Mr. Arthur Balbach, on contract, has made the reductions of the entrance to St. John's river, $\frac{1}{25000}$; Cherrystone inlet, $\frac{1}{40000}$; and the portion surveyed of the seacoast of Virginia, No. 2, $\frac{1}{200000}$.

Mr. W. P. Schultz has had in charge the arrangement, registering, and care of the miscellaneous maps. He has also been employed on progress sketches, tracings, projects, the measurement of shore-lines, &c., of topographic sheets, and other work of this description.

Mr. Bernard Hooe, jr., has made the reductions of the hydrographic survey of Cortez Bank, $\frac{1}{10000}$, and the sketch for light-house purposes of the mouth of Sabine river, $\frac{1}{20000}$. His chief employment has been on tracings, and, when not otherwise engaged, he has practised drawing topography.

Mr. W. B. McMurtrie was temporarily assigned to duty in the office from the 6th of September to the 28th of October, when he left to join Lieut. Alden's party on the Western coast. He worked thirty-one days on the statistics for the annual report of this year, and copying views of the Western coast.

Mr. J. C. Tennent was employed on the commissioners' map of Appomattox river, $\frac{1}{5000}$, and on miscellaneous duties during the month of November, 1852, when he was transferred to the tidal party on the Appomattox river, and subsequently to the engraving division.

Mr. Thomas Adams was employed in this division as a clerk the first five months of the year. In April he left the office to join the party under Governor Stevens, in its expedition to Washington Territory. Since the first of May, Mr. W. B. Stuart has been employed as the clerk.

J. N. Campbell and *Thomas McEnery*, artificers detached from the company of sappers and miners, have been employed in tracing and copying during the entire year.

The amount of miscellaneous work has been unusually large.

In the discharge of their duty, the draughtsmen merit, in general terms, a favorable notice.

List of maps and sketches completed, or in progress, during the year ending November, 1853, arranged im the order of sections.

Section I.

1. Progress sketch, $\frac{1}{600000}$	Completed.
2. Alden's Rock (Portland harbor) light-house sketch	Do.
3. Hydrography of Boston harbor, $\frac{1}{40000}$	Do.
4. Minot's Ledge (Boston harbor) light-house sketch	Do.
5. Sow and Pigs reef ($\frac{1}{20000}$ and $\frac{1}{2400}$) do	Do.
6. Topography of east series, No. 2, $\frac{1}{80000}$	In progress.
Do. do. No. 3, do	Do.

Section II.

1. Progress sketch, $\frac{1}{600000}$	Completed.
2. Topography of Long Island sound, No. 1, $\frac{1}{80000}$	In progress.
3. Hydrography do. do. do	Do.
4. Topography south side Long Island, No. 2, do	Completed.

5. Comparative map of Romer and Flynn's shoals, $\frac{1}{10{\cdot}000}$ .... In progress.
6. Hydrography of Romer shoals, $\frac{1}{40{\cdot}000}$ .... Completed.
7. Shore-line of Sandy Hook, $\frac{1}{10{\cdot}000}$, $\frac{1}{40{\cdot}000}$ .... Do.

Section III.

1. Progress sketch, $\frac{1}{400{\cdot}000}$ .... Completed.
2. Topography of Chesapeake bay, No. 1, $\frac{1}{80{\cdot}000}$ .... In progress.
3. Topography of do. No. 2, do .... Do.
4. Topography of do. No. 3, do .... Do.
5. Hydrography of do. No. 1, do .... Do.
6. Hydrography of do. No. 3, do .... Do.
7. Chart of do. $\frac{1}{400{\cdot}000}$ .... Do.
8. Seacoast of Delaware, Maryland, and Virginia, No. 1, $\frac{1}{200{\cdot}000}$ .... Completed.
9. Preliminary sketch of seacoast of part of Virginia, No. 2, $\frac{1}{200{\cdot}000}$ .... Do.
10. Preliminary sketch of Hog Island harbor and Metomkin and Wachapreague inlet, $\frac{1}{40{\cdot}000}$ .... Do.
11. Preliminary sketch of Cape Charles and vicinity, $\frac{1}{80{\cdot}000}$ .... Do.
12. Preliminary sketch of Cherrystone inlet, $\frac{1}{40{\cdot}000}$ .... Do.
13. Preliminary sketch of Pungoteague inlet, $\frac{1}{40{\cdot}000}$ .... Do.
14. Hydrography and topography of Appomattox river, $\frac{1}{5{\cdot}000}$, for Chamber of Commerce .... In progress.
15. Hydrography of Appomattox river, $\frac{1}{5{\cdot}000}$, for commissioners .... Completed.

Gulf Stream.

1. Progress of Gulf Stream exploration.
2. Diagrams of the Charleston, St. Simon's, and Cape Canaveral sections

Section IV.

1. Progress sketch, $\frac{1}{600{\cdot}000}$ .... Completed.
2. Progress sketch, No. 2, $\frac{1}{400{\cdot}000}$ .... Do.
3. Topography of E. sheet of Albemarle sound, $\frac{1}{80{\cdot}000}$ .... Do.
4. Topography of Albemarle sound, $\frac{1}{200{\cdot}000}$ .... Do.

Section V.

1. Progress sketch, $\frac{1}{400{\cdot}000}$ .... Completed.
2. Preliminary sketch of Cape Roman shoals, $\frac{1}{100{\cdot}000}$ .... Do.
3. Progress sketch No. 2, Savannah river, $\frac{1}{200{\cdot}000}$ .... Do.
4. Map of Savannah river, $\frac{1}{5{\cdot}000}$, for Board of Engineers .... Do.

Section VI.

1. Progress sketch, $\frac{1}{1{\cdot}200{\cdot}000}$ .... Completed.
2. St. John's river, $\frac{1}{25{\cdot}000}$ .... Do.
3. Progress sketch No. 2, Florida reefs, $\frac{1}{400{\cdot}000}$ .... Do.
4. Key Biscayne chart, $\frac{1}{20{\cdot}000}$ (plotting of original work) .... In progress.
5. Key West chart, $\frac{1}{50{\cdot}000}$ .... Completed.

Section VII.

1. Progress sketch, $\frac{1}{600{\cdot}000}$ .... Completed.
2. Preliminary sketch of E. and W. entrances to St. George's sound, $\frac{1}{80{\cdot}000}$ .... Do.

Section VIII.

1. Progress sketch, $\frac{1}{600{\cdot}000}$ .... Completed.
2. Topography of Mississippi sound, No. 2, $\frac{1}{80{\cdot}000}$ .... Do.
3. Preliminary survey (a re-survey) of Horn Island Pass, $\frac{1}{40{\cdot}000}$ .... Do.
4. Preliminary survey of E. Pascagoula, $\frac{1}{20{\cdot}000}$ (light-house sketch) .... Do.
5. Preliminary sketch of Barataria bay, $\frac{1}{30{\cdot}000}$ .... Do.
6. Comparative map of do .... Do.
7. Preliminary chart of Ship shoal, off Isle Dernière, $\frac{1}{80{\cdot}000}$ .... Do.

Section IX.

1. Progress sketch, $\frac{1}{600{\cdot}000}$ .... Completed.
2. Entrance to Sabine river, $\frac{1}{40{\cdot}000}$ (light-house sketch) .... Do.
3. Galveston entrance, $\frac{1}{40{\cdot}000}$ .... Do.
4. San Luis Pass, $\frac{1}{40{\cdot}000}$ (topography complete) .... Do.
5. Aransas Pass, $\frac{1}{20{\cdot}000}$ (light-house sketch) .... Do.

Section X.

1. Progress sketch, $\frac{1}{400{\cdot}000}$ .... Completed.
2. Survey of Cortez Bank, $\frac{1}{10{\cdot}000}$ .... Do.
3. Preliminary sketch of San Diego bay, $\frac{1}{25{\cdot}000}$ (reduction of hydrography) .... Do.
4. Preliminary sketch of Santa Barbara, $\frac{1}{20{\cdot}000}$ .... Do

SECTION XI.

1. Progress sketch, $\frac{1}{40,000}$ .... Completed.
2. Comparative map of mouth of Columbia river .... Do.
3. Preliminary survey of Shoal-water bay, $\frac{1}{80,000}$ .... Do.
4. Reconnaissance from Gray's harbor to Admiralty inlet, $\frac{1}{600,000}$ .... Do.
5. Preliminary survey of Cape Flattery and Nee-ah harbor, $\frac{1}{40,000}$ .... Do.
6. Preliminary survey of False Dungeness, $\frac{1}{80,000}$ .... Do.

C.—ENGRAVING DIVISION. Lieutenant E. B. Hunt, United States corps of engineers, to Capt. H. W. Benham, assistant in charge of Coast Survey office. List of maps and sketches engraved and engraving, during the year, to November, with names of the persons by whom they have been done.

NOVEMBER 15, 1853.

This division was continued under the charge of A. W. Tinkham, assistant, from the date of the last report till his resignation from the Coast Survey in April. In August, the two divisions of drawing and engraving were placed under the charge of A. A. Gibson, Captain United States army, but in October the engraving was transferred to E. B. Hunt, Lieutenant of engineers, United States army, who has continued to the present time. From April to August, Mr. John C. Tennent acted in charge, and subsequently assisted in attending to the details of management.

The additions to the list of finished maps during the year have been four in number, viz: Wellfleet harbor, mouth of Connecticut, seacoast of Delaware, Maryland, and part of Virginia, and Galveston entrance.

New editions consequent upon extensive alterations or additions on the plates, have been issued of eight charts, viz: Mobile bay, $\frac{1}{200,000}$, (2d edition;) Davis' South shoals, (6th edition;) Hatteras inlet, (4th edition;) North Edisto river, (2d edition;) Key West, $\frac{1}{100,000}$, (2d edition;) San Diego entrance, (2d edition;) and San Francisco city, (3d edition.)

Besides these there have been twenty-one preliminary sketches, reconnaissances, &c., engraved, some of them, especially of the Western coast, approaching in character to the style of our finished harbor maps.

Sixteen finished maps have been in progress during the year, of which number three have been commenced since the date of last report. These are Newburyport harbor, Albemarle sound, No. 2, $\frac{1}{80,000}$, and Key West, $\frac{1}{50,000}$. For the detailed list of maps finished, engraving, or newly taken in hand since last report, I respectfully refer to accompanying papers, as also a complete list of all maps engraved or maps in progress by the Coast Survey up to the present time.

There have been eight engravers, on very nearly constant work, engaged during the year, in addition to seven apprentices, (four of whom have come into the office during the year.) Besides, there has been a force of six contractors available, in Philadelphia, New York, and Washington, to do topography or lettering as occasion required. Total number of engravers and apprentices at present working for the office, six engravers, on salary or per diem in the office, three contractors, and seven apprentices, making sixteen in all.

The copper-plates received into the office since the date of Mr. Tinkham's resignation have all been inspected in the engraving division. These plates have been furnished by Mr. A. Burdett of Baltimore, purchased by him in the rolled sheets, generally in New York city, and afterwards hammered thoroughly and planished on the surface in his establishment in Baltimore.

I herewith give a general summary of the work done upon several of the most important plates during the year, with notes upon their present condition.

Boston Harbor.—The marsh, grass, woods ruling of the city of Boston, some outlines, and a portion of the sand dry at low water, have all been worked upon during the year, thus completing the engraving of the topography, (excepting corrections of a minor character,) by Mr. A. Rollé, assisted in the marsh ruling by Mr. J. Young. The general lettering has been partly completed by Mr. John Knight. There remain, to complete the plate, the remaining sanding, engraving of views, and lettering.

Salem Harbor.—The soundings, bottoms, and general lettering, have been engraved by Mr. S. E. Stull, on contract. The sanding of six, twelve, and eighteen feet curves, has been about half completed by Mr. H. M. Knight. The hills are near completion, by Mr. F. Dankworth. None of the lettering has yet been taken in hand.

Newburyport Harbor was commenced during the year. Mr. J. Young engraved the outlines and woods; Mr. A. Rollé the hills; apprentice H. C. Evens the sanding; and Mr. S. Siebert the marsh and mud, on contract. Some lettering was done by Mr. W. Smith on contract.

Wellfleet Harbor.—Finished during the year. Topography by Mr. S. Siebert; sanding by Mr. E. F. Woodward; and lettering generally by Mr. S. E. Stull.

Muskeget Channel.—This plate, after the topography and hydrography were completed, was enlarged, by electrotyping, to its present dimensions, in order to take in additional work; it is still in hands.

Mouth of Connecticut river.—Completed during the year and published.

Long Island Sound, No. 1.—The remaining work on this to be done is the completion of topography about western part, the lettering of sailing directions, and sanding of upper shore. Nos. 2 and 3 are essentially finished. New sailing directions on each of these, conforming to No. 1, and the abbreviations for the "bottoms," have been changed in order to maintain uniformity throughout the three sheets.

Chesapeake Bay, No. 1.—About two months' work has been done in topography, by Mr. S. Siebert, in the office.

Albemarle Sound, No. 1, $\frac{1}{80,000}$, has been completed as far as the outlines, and is about being progressed with in the topography, lettering, &c.

Mobile Bay, Nos. 1 and 2.—Completed as far as the topography and soundings, and bottom, are concerned. The two plates are about being electrotyped from, to form by junction a single plate of the size of general coast chart, taking in the entire bay.

1. The engraving of the following finished maps has been completed during the year: 1. *Wellfleet harbor,* by S. Siebert, E. F. Woodward, J. Knight, J. S. Pettit, and R. F. Bartle. 2. *Mouth of Connecticut river,* by O. A. Lawson, G. McCoy, W. Smith, and J. Knight. 3. *Seacoast of Delaware, Maryland, and part of Virginia,* (2d edition,) by H. C. Evens, L. E. Stull, W. Smith, and J. and H. M. Knight. 4. *Galveston entrance,* by H. C. Evens and J. Young.

2. The engraving of the following sketches and preliminary charts has been completed during the year: 1. *Davis' South shoal,* (6th edition,) by S. E. Stull, J. Knight, and W. Smith. 2. *Sow and Pigs reef,* by J. V. N. Throop, W. Smith, and H. C. Evens. 3. *Romer and Flynn's shoals,* by W. Smith and T. H. Oehlschlager. 4. *Chincoteague inlet,* by J. E. Stull, H. M. Knight, H. C. Evens, and J. J. Knight. 5. *Watchaprigue and Metomkin inlets, and Hog Island harbor,* by J. J.

Knight and W. Smith. 6. *Cape Charles and vicinity*, by E. Yeager and C. Smith. 7. *Hatteras inlet*, (4th edition,) by E. F. Woodward, J. J. Knight, T. H. Oehlschlager, W. Smith, and J. Knight. 8. *Ocracoke inlet*, by J. H. Goldthwaite, T. H. Oehlschlager, E. F. Woodward, and H. M. and J. J. Knight. 9. *Cape Fear river and New inlet*, by H. C. Evens and W. Smith. 10. *North Edisto river*, (2d edition,) by T. H. Oehlschlager and W. Smith. 11. *Key West*, $\frac{1}{100\,000}$. (2d edition,) by E. Yeager and W. Smith. 12. *Channel No.* 4, *Cedar Keys*, by T. H. Oehlschlager, H. C. Evens, and W. Smith. 13. *East and West entrances St. George's sound*, by S. W. Bradley and W. Smith. 14. *Mobile bay*, $\frac{1}{200\,000}$, (2d edition,) by W. Smith and H. M. Knight. 15. *Horn Island Pass*, by J. S. Pettit, T. H. Oehlschlager, J. H. Goldthwaite, W. Smith, M. F. O. Stroble, and H. M. Knight. 16 to 19. *Cat Island tidal diagrams*, by H. C. Evens, W. Smith, and H. M. Knight. 20. *Barataria bay*, by S. W. Bradley, W. Smith, and T. H. Oehlschlager. 21. *Timballier bay entrance*, by J. S. Pettit and W. Smith. 22. *Galveston entrance*, (preliminary sketch,) by H. C. Evens and S. E. Stull. 23. *Galveston bay*, (2d edition,) by J. Knight, H. M. Knight, H. C. Evens, and M. F. O. Stroble. 24. *San Luis Pass*, by J. J. Knight, E. Yeager, and H. M. Knight. 25. *Alden's reconnaissance from San Francisco to San Diego*, by G. McCoy, W. Smith, and T. H. Oehlschlager. 26. *Cortez Bank*, by W. and C. Smith. 27. *Santa Barbara*, by M. F. O. Stroble, J. Young, and W. Smith. 28. *San Francisco city*, (3d edition,) by M. F. O. Stroble, W. Smith, J. Young, and J. and H. M. Knight. 29. *Shoal-water bay*, by J. Young, S. E. Stull, and J. Knight. 30. *Reconnaissance of Western coast, from Gray's harbor to Admiralty inlet*, by G. McCoy, E. F. Woodward, W. Smith, and J. Knight. 31. *Cape Flattery and Nee-ah harbor*, by S. Siebert, S. E. Stull, E. F. Woodward, and W. Smith. 32. *False Dungeness*, by J. S. Pettit and W. Smith. 33 *Self-registering tide-gauge*, by H. C. Evens, H. M. Knight, and T. H. Oehlschlager. 34 to 52. Progress and miscellaneous sketches, by sundry engravers.

3. The engraving of the following maps has been continued during the year: 1. *Salem harbor*, by H. M. Knight, S. E. Stull, G. McCoy, and F. Dankworth. 2. *Boston harbor*, by A. Rollé and J. Young. 3. *Muskeget channel*, by W. Smith and J. Young 4. *Long Island sound*, No. 1, by J. Knight, S. Siebert, (on contract,) and A. Rollé. 5. *Long Island sound*, No. 2, by W. Smith and J. Knight. 6. *Long Island sound*, No. 3, by W. Smith and J. Knight. 7. *Chesapeake bay*, No. 1, $\frac{1}{80\,000}$, by S. Siebert. 8. *Charleston harbor*, by F. Dankworth, G. McCoy, and E. Yeager. 9. *Mobile bay*, No. 1, $\frac{1}{80\,000}$, by S. Siebert, W. Smith, and J. H. Goldthwaite. 10. *Mobile bay*, No. 2, $\frac{1}{80\,000}$, by S. Siebert and W. Smith.

4. The engraving of the following finished maps has been commenced during the year: 1. *Newburyport harbor*, by H. M. Knight, J. Young, A. Rollé, W. Smith, and H. C. Evens. 2. *Albemarle sound*, No. 1, $\frac{1}{80\,000}$, by J. Young. 3. *Albemarle sound*, No. 2, $\frac{1}{80\,000}$, by J. Young and S. Siebert. 4. *Key West*, $\frac{1}{50\,000}$, by E. F. Woodward.

5. The following preliminary charts are also in progress: 1. Cherrystone inlet; 2 Pungoteague creek; 3. Cape Roman shoals; 4. St. John's river, entrance; 5. Isle Dernière; 6. Aransas Pass, 2d edition, enlarged; 7 to 23. Sketches showing the progress of the survey.

D.—ELECTROTYPE DIVISION. Mr. George Mathiot to Capt. H. W. Benham, assistant in charge of Coast Survey office. List of electrotype plates made in alto and basso during the year ending November 1.

There have been forty-seven electrotype plates made, of which twenty-three were alto, or mould plates, and twenty-four were basso, or printing plates, as exhibited by the following list:

Name of plate.	Number of altos.	Number of bassos.
1. Muskeget channel	1	1
2. Mouth of Connecticut River	2	1
3. New Haven harbor	1	1
4. Captains' island, E. and W.	1	1
5. No. 1, Long Island sound		1
6. General coast chart	1	2
7. New York, $\frac{1}{30\,000}$, (six sheets)	3	
8. Edisto	2	2
9. Sketch H, in Section VIII	1	1
10. Mouths of the Mississippi	1	1
11. Delta of the Mississippi	1	1
12. Alden's chart of Western coast	3	5
13. San Diego entrance	1	1
14. San Pedro	1	1
15. Santa Barbara	1	1
16. Monterey harbor	1	1
17. Point Pinos views		1
18. San Francisco city	1	1
19. Humboldt bay	1	1
Total	23	24

The plates of Muskeget channel, Edisto, Sketch H, in Section VIII, Delta of the Mississippi, and Alden's chart of the Western coast, have been enlarged or formed by the electrotype, as follows:

Muskeget channel was enlarged in three directions by joining and incorporating.

Edisto was extended in one direction by one piece added to the original, and incorporated by the electrotype process.

Sketch H was extended in a similar manner.

Delta of the Mississippi was formed by incorporating five pieces.

Alden's chart was also formed of five pieces.

San Pedro had the view set in it by electrotyping.

During the past year I have also, by the electrotype process, gold-plated nineteen deep-sea thermometers, and the working parts of the refracting pyrometer, used for testing the base apparatus.

The engraving division has been furnished with sixty blank plates for engraving of charts, sketches, &c.

I have furnished the engineer corps with six quarter-metre scales, graded on both sides.

E.—Printing Division. Mr. S. D. O'Brien to Capt. H. W. Benham, assistant in charge Coast Survey office. List and number of maps printed during the year ending November 1.

Plate.	Number of impressions.
Since November 1, 1852, there have been printed as follows:	
Section I.	
1. New Bedford harbor	200
2. Holmes' Hole and Tarpaulin cove	100
3. Edgartown harbor	112
4. Nantucket harbor	490
5. Davis' South shoal	50
Section II.	
6. General coast chart, from Gay Head to Cape Henlopen	1,902
7. New London harbor	170
8. New Haven harbor	466
9 Cawkins' and Sheffield's islands	413
10. Hart and City island and Sachem's Head harbor	333
11. New York bay and harbor, $\frac{1}{30.000}$, in six sheets	190
12. Sandy Hook changes	50
13. Little Egg harbor	171
14. Delaware bay and river, three sheets	428
Section III.	
15. Seacoast of Delaware, Maryland, and part of Virginia	520
16. Entrance to Chesapeake bay	100
17. Chincoteague inlet	520
18. Annapolis harbor	384
19. Mouth of Chester river	531
20. Fishing and Donoho's Battery	100
Section IV.	
21. Pasquotank river	190
22. Hatteras shoals	162
23. Ocracoke inlet	200
24. Beaufort harbor	100
25. New river and bar	500
Section V.	
26. Bull's bay	262
Section VI.	
27. Mosquito inlet	262
28. Cape Canaveral shoals	162
29. Key West	340
30. Rebecca shoals	37
Section VII.	
31. St. Andrew's shoals	162
32. Reconnaissance vicinity of Cedar Keys	100
33. Channel No. 4, Cedar Keys	300
34. St. Mark's bar and channel	300
Section VIII.	
35. Mobile bay, $\frac{1}{200.000}$	300
36. Horn Island Pass	10
37. Cat and Ship Island harbors	538
38. Pass Christian	262
39. Delta of the Mississippi	50
Section IX.	
40. Entrance to Galveston bay	400
41. Aransas Pass	62

E—Continued.

Plate.	Number of impressions.
SECTIONS X and XI.	
42. Alden's reconnaissance Western coast, in three sheets	1,605
43. San Diego bay	1,107
44. Catalina harbor	162
45. San Pedro	400
46. Prisoners' harbor, Cuyler's harbor, &c.	500
47. San Simeon, Santa Cruz, &c.	750
48. Santa Barbara	650
49. Point Conception	112
50. Point Pinos	112
51. Monterey harbor	1,367
52. McArthur's reconnaissance Western coast, in three sheets	450
53. San Francisco city	428
54. Mare Island straits	287
55. Trinidad bay	162
56. Humboldt bay	367
57. Cape Hancock, or Disappointment	250
Annual sketches	524
Finished and unfinished plates, and quarterly proofs	2,434
Total	24,076

F.—DIVISION FOR PUBLISHING, DISTRIBUTING, AND SALE OF MAPS. Mr. V. E. King to Capt. H. W. Benham, assistant in charge of Coast Survey office.

At the date of the last report, November 1, 1852, forty-two sheets of Coast Survey maps had been published: since then five sheets have been added, viz: Wellfleet harbor; Mouth of Connecticut river; Seacoast of Delaware, Maryland, and part of Virginia; Galveston entrance; Alden's reconnaissance from San Francisco to San Diego—making the number now published forty-seven sheets.

There have also been published the following preliminary charts and sketches:

1. Davis' South shoals, 6th edition.
2. Sow-and-Pigs reef.
3. Romer & Flynn's shoals.
4. { Wachapreague and Metomkin inlets. / Hog Island harbor. / Cape Charles and vicinity. }
5. Chincoteague inlet.
6. Hatteras inlet, 4th edition.
7. Ocracoke inlet.
8. Cape Fear river and New inlet.
9. North Edisto river, 2d edition.
10. Key West harbor and approaches, $\frac{1}{100.000}$, 2d edition.
11. Channel No. 4, Cedar Keys.
12. East and West entrances to St. George's sound.
13. Mobile bay, $\frac{1}{100.000}$, 2d edition.
14. Horn Island Pass.
15. Cat island, tidal diagrams.
16. Barataria bay.
17. Timballier bay.
18. Galveston entrance.
19. Galveston bay.
20. San Luis Pass.
21. Cortez Bank.
22. Santa Barbara.
23. San Francisco city.
24. Shoalwater bay.
25. Reconnaissance of the West coast, from Gray's harbor to Admiralty inlet.
26. Cape Flattery and Nee-ah harbor.
27. False Dungeness.
28. Self-registering tide-gauge.

The fact of a large number of the above-named preliminary charts and sketches not appearing embodied in the accompanying tabular statement of the distribution for the past year, is attributable to their very recent completion.

List of Charts and Sketches distributed.

Names of charts and sketches.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
Charts.				
1. Richmond island	65	10	126	201
2. Nantucket harbor	15	7	126	148
3. Hyannis harbor	27	7	125	159
4. Edgartown harbor	20	12	123	155
5. Holmes' Hole and Tarpaulin cove	22	8	124	154
6. Harbor of New Bedford	50	14	127	191
7. General chart of the coast	442	31	138	611
8. Fisher's Island sound	16	13	131	160
9. New London harbor	31	26	134	191
10. New Haven harbor	10	16	125	151
11. Harbors of Black Rock and Bridgeport	31	14	123	168
12. Harbors of Sheffield and Cawkins' islands	20	8	124	152
13. Huntington bay	45	10	123	178
14. Oyster or Syosset bay	10	10	123	143
15. Harbors of Captain's island, east and west	20	17	124	161
16. Hart and City islands, and Sachem's Head harbor	38	7	124	169
17. Hell Gate	38	13	130	181
18. New York bay and harbor, six sheets	....	6	23	29
19. New York bay and harbor, $\frac{1}{80000}$	143	23	130	296
20. Western part of south coast of Long Island	29	5	125	159
21. Little Egg harbor	23	12	126	161
22. Delaware bay and river, three sheets	281	17	138	436
23. Seacoast of Delaware, Maryland, and part of Virginia	26	11	18	55
24. Harbor of Annapolis and Severn river	21	11	126	158
25. Mouth of Chester river	16	9	123	148
26. Pasquotank river	21	6	121	148
27. Mobile Bay entrance	39	8	129	176
28. Cat and Ship Island harbors	10	4	83	97
29. Western Coast reconnaissance, (Alden's)	62	18	95	175
30. San Diego bay	40	20	145	205
31. Monterey harbor	385	24	163	572
32. Western Coast reconnaissance, 3 sheets	46	27	141	214
33. Humboldt bay	38	14	136	188
34. Trinidad bay	48	16	140	204
35. Mouth of Columbia river	73	12	149	234
Sketches.				
1. Current chart of Boston harbor	10	....	40	50
2. Nantucket South shoals	76	19	36	131
3. Sandy Hook changes	23	1	38	62
4. Entrance Chesapeake bay	36	1	37	74
5. Chincoteague inlet	14	3	37	54
6. Fishing or Donoho's battery	14	1	36	51
7. Hatteras shoals	26	3	35	64
8. Hatteras inlet	....	....	....	....
9. Ocracoke inlet	14	4	102	120
10. Beaufort harbor	33	19	145	197
11. Frying-pan shoals	31	16	138	185
12. New river and bar	11	8	138	157
13. Bull's bay	26	....	35	61
14. North Edisto	28	17	142	187
15. Entrance Savannah river	28	9	143	180
16. Savannah city	28	3	143	174
17. St. Andrew's shoals	20	....	37	57
18. Mosquito inlet	13	....	37	50
19. Cape Canaveral	15	....	37	52
20. Key West	122	26	64	212
21. Rebecca shoals	3	....	37	40
22. West coast of Florida	50	17	107	174
23. Reconnaissance vicinity of Cedar Keys	13	....	37	50
24. Channel No. 4, Cedar Keys	13	6	37	56
25. St. Marks	8	12	142	162
26. Mobile bay	32	18	....	....
27. Horn Island Pass	13	3	35	51
28. Pass Christian	3	....	36	39
29. Delta of Mississippi	27	6	38	71

List of Charts and Sketches distributed—Continued.

Names of charts and sketches.	Turned over for sale.	For use of office.	Gratuitously distributed.	Total.
30. Galveston bay	82	27	121	230
31. Aransas Pass	3	1	35	39
32. Catalina harbor	259	21	136	416
33. San Pedro	159	13	129	301
34. Prisoners' harbor, &c	159	22	131	312
35. Santa Barbara	100	....	....	100
36. Point Concepcion	20	1	43	64
37. San Simeon, &c	159	16	123	298
38. Point Pinos	114	....	36	150
39. San Francisco city	161	21	197	379
40. Mare Island straits	114	1	51	166
41. Cape Hancock	114	1	41	156
Total	4,375	782	7,260	12,417

Distribution of Coast Survey Reports and Sketch-maps of 1851.

States.	Individuals.	Institutions.	Total.
Maine	103	24	127
New Hampshire	20	18	38
Vermont	9	7	16
Massachusetts	174	45	219
Rhode Island	39	22	61
Connecticut	31	15	46
New York	95	50	145
New Jersey	13	8	21
Pennsylvania	101	28	129
Delaware	....	3	3
Maryland	29	17	46
Virginia	61	17	78
North Carolina	47	7	54
South Carolina	33	6	39
Georgia	22	10	32
Alabama	16	12	28
Mississippi	7	3	10
Louisiana	31	7	[illegible]
Ohio	27	27	54
Kentucky	13	15	28
Tennessee	1	13	14
Indiana	17	21	38
Illinois	24	12	36
Missouri	6	6	12
Arkansas	16	....	16
Michigan	10	8	18
Florida	12	2	14
Texas	7	2	9
Iowa	12	5	17
Wisconsin	2	12	14
California	1	....	1
Minnesota Territory	1	2	3
Forwarded (through the Smithsonian Institution and by other means) to the continent of Europe and Great Britain	....	....	130
To officers of the army	....	....	261
To officers of the navy and naval libraries	....	....	175
To newspaper offices	....	....	272
Incidental distribution, apart from the general list to individuals generally	....	....	982
Total	980	424	3,224

G.—Archives and Library. Mr. C. B. Snow to Capt. H. W. Benham, assistant in charge of the Coast Survey office.

U. S. Coast Survey Library and Archives, *October* 18, 1853.

During the last two years the internal organization of the archives has been undergoing a change, which is now complete.

The sounding, angle, and tidal observations of the past year's operations have been rebound, and all the original hydrographic and topographic maps placed in single tin tubes.

In compliance with your orders, I have removed the duplicate records to a room in the new buildings just below the fire-proof, which adds greatly to the accommodation of the original manuscripts; but it is to be regretted the originals are not in a building fire-proof inside as well as outside.

The arrangements of the archives for the convenience of the survey are in all respects equal to its wants.

Library.

In the same time, the library has been greatly augmented by the addition of many valuable books relating directly or indirectly to the operations of geodetic and hydrographic surveys.

There are now two thousand two hundred and thirty-three volumes belonging to the library; five hundred and twenty-six of which have been purchased, and thirty-four presented, within the past two years. Three hundred of the books belonging to the library are now in the hands of persons attached to the survey.

The acquisition of the Philosophical Transactions of the Royal Society of London, in sixty-seven volumes, from 1665 to 1849, purchased at one-fourth of the cost to subscribers, has proved of great service to the tidal computing department, containing, as they do, many valuable papers on subjects of tides which are not to be found elsewhere, or are out of print. They have also been consulted by other branches of the survey.

There are some deficiencies in the series of Greenwich, Edingburgh, and Cambridge astronomical observations, the English nautical and American almanacs, and some of the scientific periodicals, of which I have heretofore given you a list, and the purchase been approved by the Superintendent, but now awaiting the approval of the estimates by him for the library for the ensuing fiscal year, which, when purchased, will add greatly to the completeness of the library.

I would strongly recommend that a system of exchange be entered into with foreign societies for their publications, by sending them in return the Superintendent's reports and published maps of the survey. They would be of great utility, giving us the latest data upon subjects which would facilitate the operations of the office and field.

H.—Extracts from the report of assistant L. F. Pourtales to Captain H. W. Benham, in charge of the Coast Survey office, on the computations made in the tidal party.

The following list will show in their order the names of the stations reduced, with the name of the person by whom reduced, and the class to which it belongs:

Station.	By whom reduced.	Back work or current work.
Portland, Me.	Messrs. Offley & Heaton	B.
Do	Messrs. Nes & Fendall	C.
Portsmouth, N. H.	Mr. Taylor	B.
Do	Mr. Nes	C.
Newburyport, Mass	Mr. Hawley	B.
Salem, Mass	Messrs. Heaton & Nes	B.
Boston Dry-dock	Lieut. Evans	B.
Boston Light	Mr. Taylor	B.
Nantucket, Mass	Mr. Heaton	B.
Hyannis, Mass	Mr. Taylor	B.
Edgartown, Mass	Mr. Wise	B.
Holmes' Hole, Mass	Messrs. Fendall & Hawley	B.
Tarpaulin Cove	Mr. Fendall	B.
Nobsque Light	do	B.
Wood's Hole, (three stations)	do	B.
Dumpling Rock	Mr. Jones	B.
Bird-Island Light	do	B.
Fort Adams, R. I.	do	B.
Point Judith, R. I.	Messrs. Wise & Heaton	B.
Watch Hill	Mr. Taylor	B.
Montauk Point	Mr. Jones	B.
Stonington	Mr. Nes	B.
New London	Messrs. Mitchell & Heaton	B.
Sheffield Island	Mr. Heaton	B.
Bridgeport, Conn.	Mr. Hawley	B.
Oyster Bay	Mr. Wise	B.
Huntingdon Bay	do	B.
Sands' Point	Mr. Heaton	B.
Throg's Neck	do	B.
New Rochelle	Messrs. Heaton & Offley	B.
Hell Gate, N. Y.	Mr. Jones	B.
Governor's Island, N. Y.	Messrs. Jones & Hawley	B.
Do	Messrs. Offley, Looker & Hawley	B.

Station.	By whom reduced.	Back work or current work.
Sandy Hook, N. J.	Messrs. Fendall & Hawley	B.
Cold Spring Inlet	Mr. Hawley	B.
Higbies	do	B.
Egg Island Light	Mr. Nes	B.
Mahon's Ditch	do	B.
Cohansey Light	do	B.
Bombay Hook	do	B.
Philadelphia Navy-yard	do	B.
Philadelphia, Walnut-st. wharf	do	B.
Old Point Comfort	Messrs. Offley, Looker & Hawley	C.
Point Lookout	Mr. Wise	B.
Bodkin Light	Messrs. Heaton & Offley	B.
Annapolis, Md	Messrs. Heaton, Hawley & Taylor	B.
Do	Mr. Offley	C.
James River (five stations)	Mr. Heaton	C.
Curles Neck	Mr. Nes	C.
City Point	do	C.
Petersburg	Mr. Offley	C.
Smithville	Messrs. Nes & Heaton	B.
Cape Fear River	Mr. Heaton	C.
Orton Light	Mr. Montgomery	C.
Georgetown (2 stations)	Messrs. Montgomery & Fendall	C.
Castle Pinckney	Mr. Nes	C.
Fort Pulaski	Messrs. Offley & Jones	B.
Savannah	Messrs. Wise & Evans	B.
S. W. Pass, La.	Mr. Heaton	C.
Dernière Island	do	C.
Galveston, Texas	do	C.
Rincon Point, Cal.		C.

Comparisons of observations with theory were made by Mr. Mitchell for Old Point Comfort, and by Mr. Heaton for Galveston.

The readings of the times and tides from the sheets of the self-registering tide-gauges were made by Messrs. Offley, Looker, and Hawley.

APPENDIX No. 26.

Tide Tables for the United States.

The following tables give the principal elements of the tides for a number of points on the coast of the United States. They are selected from a large number of observations made by the Coast Survey. In making this selection, none have been used, as a general rule, for which the observations did not extend through at least two lunations.

Explanation of the tables.

Table I gives a list of the stations, beginning at the north and east, and following the coast south and west.

The first three columns of this table need no explanation.

The fourth gives the mean interval between the time of the moon's transit and the time of high water. This is also called the "Corrected Establishment" of a place. Navigators are in the habit of using the term, "time of high water at full and change of the moon," but this is not equivalent to the mean interval on our coast, where the tide follows the transit of the moon, by which it has been produced, by two days. On the Western coast, however, the mean interval appears to coincide with the interval at full and change.

The fifth column gives the difference between the greatest and least intervals. Table III will show at what age of the moon these occur.

The sixth column gives the mean rise and fall or range of the tide. The seventh gives the same for spring tides, and the eighth for neap tides.

The ninth column gives the mean duration of the flood or rise of the tide, and the tenth the mean duration of the ebb or fall of the tide. Both are reckoned from the middle of one stand to the middle of the next.

The eleventh column gives the mean duration of the stand, also sometimes called slack-water, although the latter term is more usually applied to the cessation of the tidal current than to the cessation of the vertical rise or fall of the surface of the water.

Table II. This table gives the rise or fall of the tide at several stations in the Gulf of Mexico. On this part of the coast the tides present the following peculiarities: When the moon's declination is zero, or nearly so, there are two small, irregular tides in twenty-four hours; when the moon's declination is greatest, there is generally but one tide in twenty-four hours. Between these two periods, there are sometimes two very small tides of unequal height. This inequality often amounts to one foot in the height of low water. In the height of high water, however, the inequality rarely exceeds four or five inches, and more generally manifests itself by the tide standing at about the same height for several hours.

When the time of greatest declination of the moon occurs at full or change, the rise and fall are greatest. When the moon's declination is zero in the first or last quarter, the rise and fall are least.

Table III gives the corrections caused by the half-monthly inequality to be applied to the mean interval given in Table I, so as to obtain the intervals at the different ages of the moon.

The first column contains the time of the moon's transit or southing, reckoned from noon or midnight. This quantity is given for every day in the year in the almanacs. The other columns contain the corrections mentioned above. By means of this table, and of Table I, the approximate time of high water can be obtained for every day for the stations enumerated in Table III. It will only be necessary for this purpose to take from an almanac the time of moon's southing on the day for which the time of high water is wanted, then take out from Table III the correction corresponding, apply it with its proper sign to the mean interval of Table I, and add this corrected mean interval to the time of moon's southing before obtained. The time of the preceding low water can be obtained by subtracting from the time of high water the mean duration of flood given in Table I. By adding to the time of high water the mean duration of ebb, the following low water can be obtained. The quantities given in this table can be used for other places in the neighborhood of those named.

Table IV gives the daily inequality, or the quantity by which the a. m. and p. m. tides of a day differ in time and height from the mean interval and mean height of that day. This inequality is not very important on the Atlantic coast. It is more strongly marked at Key West, where, however, the total rise and fall is small. But on the Western coast, the knowledge of this inequality is of the greatest importance, as it is very large. A rock in San Francisco bay may have 3½ feet of water on it at the morning high water, and be awash at high water in the afternoon.

At Key West, the high water next following the southing of the moon is higher than the preceding and following one when the moon's declination is south, and the reverse when north.

At San Francisco the difference of height of two successive tides (either high or low waters) varies with the moon's declination. When the declination is nothing, the difference is nothing, or very small. When the declination is greatest, whether north or south, the difference is greatest.

When the moon's declination is nearly nothing, the interval in time between two successive high waters, or two successive low waters, is nearly twelve hours, and differs most from this when the moon's declination is greatest.

When the moon's declination is north, the highest of the two high tides of the twenty-four hours occurs about one hour and a half after the moon's crossing the meridian, (southing;) and when the moon's declination is south, occurs about one hour and a half after the moon's meridian passage, (southing.)

The lowest of the two successive low waters of the twenty-four hours occurs about seven hours after the highest of the two high waters.

Table V gives the height of the bench-marks established at some of the stations above mean low water. These quantities will be useful to compare future series of tidal observations with the present ones, and also to give permanent points of reference for engineers in charge of marine constructions, deepening of harbors, &c.

I.

Station.	Locality.	State.	Interval between time of moon's transit (southing) and time of high water. Mean.	Difference between greatest and least.	Rise and fall. Mean.	Spring.	Neap.	Mean duration of— Flood.	Ebb.	Stand.
Coast from Portland to New York.			H. M.	H. M.	Feet.	Feet.	Feet.	H. M.	H. M.	H. M.
Portland	Atlantic wharf	Me	11 25	0 44	8.8	10.0	7.6	6 14	6 12	0 20
Portsmouth	Fort Constitution	N. H.	11 23	0 53	8.6	9.8	7.2	6 22	6 07	0 21
Newburyport	Custom-house wharf	Mass.	11 22	0 50	7.8	9.1	6.6	5 16	7 09	0 24
Salem		Mass.	11 13	0 50	9.2	10.6	7.6	6 19	6 06	0 06
Boston Light		Mass.	11 12	0 35	9.3	10.9	8.1	6 20	6 06	0 15
Boston	Charlestown dry-dock	Mass.	11 22	0 44	10.1	13.1	7.4	6 16	6 18	0 09
Siasconsett	Nantucket	Mass.	11 53	0 27	1.0			5 30	6 54	1 13
Nantucket	Commercial wharf	Mass.	12 24	0 37	3.1	3.6	2.6	6 23	5 44	0 09
Edgartown	Light-house pier	Mass.	12 16		2.0	2.5	1.6	6 51	5 29	0 24
Holmes' Hole		Mass.	11 43	0 31	1.7	1.8	1.3	6 41	5 21	0 12
Tarpaulin Cove		Mass.	8 04	0 49	2.4	2.6	2.0	6 09	6 17	0 34
Wood's Hole	North side	Mass.	8 06		3.9			6 31	5 51	
Wood's Hole	South side	Mass.	8 56		1.5			6 03	6 22	
Birds Island Light	Buzzard's bay	Mass.	7 59	0 45	4.4	5.3	3.5	6 51	5 58	
Dumpling Rock	Light-house	Mass.	7 57	0 41	3.8	4.6	2.8	6 50	5 33	0 42
Newport	Fort Adams	R. I.	7 45	0 24	3.9	4.6	3.1	6 21	6 03	0 23
Point Judith		N. Y.	7 32	0 46	3.1	3.7	2.6	6 12	6 10	1 00
Montauk Point, L. I.		N. Y.	8 10	1 42	2.0	2.5	1.4	6 13	6 11	
Sandy Hook		N. Y.	7 29	0 47	4.8	5.6	4.0	6 10	6 15	0 16
New York	Governor's island	N. Y.	8 13	0 46	4.3	5.4	3.4	6 00	6 25	0 28
Long Island Sound.										
Watch Hill		R. I.	9 00	0 23	2.7	3.1	2.4	6 35	5 56	0 14
Stonington	Steamboat wharf	Conn.	9 07	0 30	2.3	3.4	2.1	6 15	6 10	0 25
Little Gull Island		N. Y.	9 38	1 07	2.5	2.9	2.3	6 01	6 21	0 37
New London		Conn.	9 28	0 52	2.6	3.1	2.1	5 56	6 26	0 22
New Haven		Conn.	11 16	1 08	5.8	6.6	5.1	6 24	6 05	
Bridgeport		Conn.	11 11	1 03	6.5	8.0	4.7	6 01	6 07	
Oyster Bay, L. I.		N. Y.	11 7	0 51	7.3	9.2	5.4	6 08	6 24	
Sands' Point, L. I.		N. Y.	11 13	0 31	7.7	8.9	6.4	5 55	6 30	0 14
New Rochelle		N. Y.	11 22	0 32	7.6	8.6	6.6	5 51	6 35	0 12
Throg's Neck		N. Y.	11 20	0 39	7.3	9.2	6.1	5 50	6 33	0 43
Coast of New Jersey.										
Cold Spring Inlet		N. J.	7 32	0 51	4.4	5.4	3.6	6 08	6 18	
Cape May	Landing	N. J.	8 19	0 47	4.8	6.0	4.3	6 11	6 15	0 20
Delaware Bay and River.										
Delaware Breakwater		Del.	8 00	0 50	3.5	4.5	3.0	6 15	6 06	0 26
Higbies	Near Cape May	N. J.	8 33	0 43	4.9	6.2	3.9	6 26	6 00	
Egg Island Light		N. J.	9 04	0 51	6.0	7.0	5.1	5 52	6 27	
Mahon's Ditch		Del.	9 52	1 18	5.9	6.9	5.0	6 11	6 11	
New Castle		Del.	11 53		6.5	6.9	6.6	5 06	6 43	0 47
Philadelphia	Navy-yard	Pa.	13 15	0 54	6.1	7.0	5.2	4 51	7 05	
Do	Walnut-street wharf	Pa.	13 21	0 42	5.9	6.6	5.1	4 52	7 06	
Chesapeake Bay.										
Old Point Comfort		Va.	8 17	0 50	2.5			6 01	6 25	
Point Lookout		Md.	12 58	0 45	1.4	1.9	0.7	5 59	6 19	0 35
Annapolis	Taylor's wharf	Md.	16 38	0 40	0.9	1.0	0.8	6 11	6 15	0 32
Bodkin Light		Md.	17 42	0 48	1.0	1.3	0.8	5 23	7 08	
Baltimore	Jackson's wharf	Md.	18 33	0 43	1.3	1.5	0.9	5 54	6 33	
James River	City Point	Va.	14 14		2.6			5 28	6 52	0 40
Richmond	Rocket's wharf	Va.	16 28		2.9			4 52	7 34	

I—Continued.

Station.	Locality.	State.	Interval between time of moon's transit (southing) and time of high water. Mean.	Difference between greatest & least.	Rise and fall. Mean.	Spring.	Neap.	Mean duration of— Flood.	Ebb.	Stand.
Coast of North Carolina, South Carolina, Georgia, and Florida.			*H. M.*	*H. M.*	*Feet.*	*Feet.*	*Feet.*	*H. M.*	*H. M.*	*H. M.*
Smithville	Barracks wharf	N. C.	7 19	0 47	4.5	5.5	3.8	6 01	6 26	0 26
Charleston	Castle Pinckney	S. C.	7 13	0 36	5.3	6.3	4.6	6 36	6 09	0 33
Savannah River	Fort Pulaski	Ga	7 20	0 41	7.0	8.0	5.9	5 49	6 35	0 26
Savannah City	Dry-dock wharf	Ga	8 13	0 51	6.5	7.6	5.5	5 04	7 22	0 14
Cape Florida	Key Biscayne	Fla	8 26	0 44	1.7	1.2	2.1	5 52	6 28	......
Sand Key	....	Fla	8 40	....	1.2	2.0	0.6	6 31	5 55	0 13
Key West	Fort Taylor	Fla	9 22	1 12	1.4	2.3	0.7	6 59	5 25	0 12
Tampa Bay*	....	Fla	12 29	3 04	1.7	2.5	0.6	......	......	......
Cedar Keys	Depot Key	Fla	13 15	1 55	2.5	2.8	1.8	6 12	6 13	......
Western Coast.										
San Francisco	Rincon Point	Cal	12 03	1 22	3.9	5.0	2.9	6 30	5 52	0 30

* From observations taken under the direction of Commander Powell, U. S. N.

II.—*Mean rise and fall of tides at several stations in the Gulf of Mexico.*

Stations.	Mean rise and fall of tides. Mean.	At moon's greatest declination.	At moon's least declination.	For equinoctial tides, subtract—	For solsticial tides, add—
	Feet.	*Feet.*	*Feet.*		
St. George's Island	1.1	1.8	0.6	....	....
Pensacola, Fla	1.0	1.5	0.4	....	....
Fort Morgan, Mobile bay, Ala	1.0	1.5	0.4	0.2	0.4
Cat Island, Miss	1.3	1.9	0.6	0.1	0.3
Southwest Pass, La	1.1	1.4	0.5	....	....
Isle Dernière, La	1.4	2.2	0.7	....	....
Galveston, Texas	1.1	1.6	0.8	0.4	0.1
Brazos Santiago, Texas	0.9	1.2	0.5	....	....

III.—*Table showing the corrections to be applied to the mean interval between the Moon's southing and the time of High Water for the different hours of Moon's southing.*

Time of moon's southing.	Boston, Mass.	New York, N. Y.	Old Point Comfort, Va.	Smithville, N. C.	Charleston, S. C.	Ft. Pulaski, Savannah river, Ga.	Key West, Fla.	San Francisco, Cal.
Hours.	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*	*Min.*
0	Add 11	Add 7	Add 16	Add 8	Add 18	Add 10	Add 4	Add 1
1	" 1	Subtract 2	" 4	Subtract 1	" 5	Subtract 1	Subtract 10	Subt. 22
2	Subtract 7	" 7	Subtract 8	" 11	Subtract 8	" 9	" 22	" 33
3	" 14	" 18	" 17	" 16	" 22	" 14	" 31	" 34
4	" 20	" 21	" 25	" 17	" 25	" 16	" 33	" 35
5	" 21	" 20	" 29	" 15	" 25	" 16	" 25	" 30
6	" 14	" 14	" 24	" 12	" 20	" 12	" 5	" 4
7	" 2	" 2	" 10	" 2	" 8	" 4	Add 17	Add 33
8	Add 11	Add 10	Add 7	Add 7	Add 11	Add 8	" 30	" 41
9	" 20	" 19	" 23	" 17	" 24	" 19	" 34	" 33
10	" 22	" 22	" 31	" 22	" 29	" 23	" 29	" 27
11	" 22	" 18	" 29	" 17	" 24	" 17	" 17	" 19

IV.

Stations.	Difference in height of a. m. and p. m. tides of same day.				Difference from mean in interval between a. m. and p. m. tides.				Difference in height of highest high tide and lowest low tide of same day.	
	Average of month.		Av'ge when moon's declination is greatest.		Average of month.		Av'ge when moon's declination is greatest.			
	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	H. W.	L. W.	Average.	Greatest.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*H. M.*	*H. M.*	*H. M.*	*H. M.*	*Feet.*	*Feet.*
Salem, Mass	0.7	0.6	1.0	0.7						
Old Point Comfort, Va	0.3				0 04					
Smithville, N. C	0.5	0.2	1.0	0.3						
Fort Pulaski, Ga	0.6	0.3	0.9	0.3						
Key West, Fla	0.5		0.8		0 57		1 40			
Rincon Point, San Francisco, Cal	1.0	2.4	2.1	3.6	1 02	0 45	2 00	1 6	5.1	7.6

V.

Description of Bench-marks.

Station.	Description.	Height above mean low water.
		Feet.
Portsmouth, N. H	(Fort Constitution.) The bench-mark is a cross in head of copper bolt driven into the solid rock, nearly in a line between outer end of wharf and N. side of sallyport, near SW. corner of fort	14.60
Boston	(Charlestown Dry Dock.) Top of stone wall corresponding to division thirty feet of tide-gauge, which is designated by copper figures set in the stone	14.78
New York	(Fort Columbus, Governor's Island.) The bench-mark is the lower edge of a straight line cut in a stone wall at the head of the wooden wharf on Governor's Island. The letters U. S. C. S. are cut on the same stone	14.51
Old Point Comfort	(Fort Monroe.) The bench-mark is a line cut in the wall of the light-house, SW. side, one foot from the ground	11.00
Smithville, N. C	(Barracks Wharf, Fort Johnson.) The bench-mark is the top of a granite post sunk in the ground at foot of first ramp	9.17
Charleston, S. C	(Castle Pinkney.) The bench-mark is the outer and lower edge of embrazure of gun No. 3	10.13
Savannah River	(Fort Pulaski, Cockspur Island.) The bench-mark is the coping of the NE. wharf, and is designated by five copper nails driven into it	9.24
Savannah City	(Dry Dock Wharf.) The coping of the wharf serves as bench-mark, and is designated by five copper nails	8.66
Southwest Pass, La	(East Bayou, Pilot Village.) The tide-gauge was in front of the house of the late Henry Fox. The bench-mark is a cedar post, six feet long, encased in a copper tube, marked "*U. S. Coast Survey*, 1853." It is set into the ground five feet from the northwest corner of the house, and reaches two feet above the ground. The top (not the rim) of the copper tube is the point of reference	2.11
	There is also a circle of copper nails, with one in the centre, on the NW. corner of the house, and a similar one on the left-hand upright at the entrance of the gallery. The centre nails of those two circles are on the same level, and their height above mean low water is	6.57
Isle Dernière, La	The tide-gauge was placed in the mouth of a small bayou on the north side of the island, one-fourth of a mile from the west end, called Racoon Point. Two cedar posts are set in the ground on an east and west line, ten feet apart, and are marked with copper nails, six inches below the top. These nails are above mean low water	2.47
Galveston	The lower edge of a copper plate, 1½ inch square, nailed to a corner post of a warehouse adjoining Doswell's wharf	1.24
Brazos Santiago, Texas	The tide-gauge was placed at the end of the small wharf belonging to the United States Quartermaster's department, in the harbor of Brazos Santiago. Two palmetto posts are set in the ground, respectively, 130 and 136 feet distant from the tide-gauge in a SE. direction. Each of them has a four-inch iron spike, surrounded by copper nails, driven into it on the WSW. side, which is the point of reference	4.50

APPENDIX No. 27.

On the tides at Key West, Florida, from observations made in connexion with the United States Coast Survey, by A. D. Bache, Superintendent.—(Communicated by authority of the Treasury Department.)

Hourly observations of the tides were made at Fort Taylor, Key West, from the 1st of June, 1851, to the 31st of May, 1852, by Mr. J. W. Goss, and other employés of the Coast Survey assisting him. The tides ebb and flow twice in the twenty-four hours, but the diurnal inequality in height is relatively large, amounting at a mean to 0. 55 foot, and reaching, in extreme cases, 0. 83 foot. The mean rise and fall of the tide being about 1. 4 foot, a knowledge of the laws of the diurnal inequality by which successive high or low waters may differ is very important. The corrected establishment of Key West is 9h. 22m. The curves of Plate I, Nos. 1, 2, 3, 4, and 5, show the normal character of the tides at the maximum and zero of the moon's declination at the syzigies and quadratures, and at a mean of declination and six hours of the moon's age. There being two tides in the lunar day, the observations admit of discussion by the ordinary methods, while the large diurnal inequality in height of high water renders it desirable to pursue the mode which I have applied to the tides at Cat island, (Louisiana,) and Fort Morgan, (Alabama.) The reductions by the ordinary methods thus become the tests of those by the other mode. The former were made under my immediate direction by Lieutenant Richard Wainwright, U. S. N., and Mr. M. H. Ober, U. S. Coast Survey, and the latter by Mr. W. W. Gordon, assisted by Messrs. Mitchell, Homans, and others, of the Coast Survey.

The *half-monthly inequality* in time and height as deduced by the usual method is shown in the following Table No. 1, in which the first column contains the moon's age, the second the mean lunitidal interval corresponding, and the fifth the height.

TABLE No. 1.

Half-monthly inequality of tides at Key West from one year's observations.

Moon's age.	Interval.			Height.		
	O.	T.	O.—T.	O.	T.	O.—T.
1.	2.	3.	4.	5.	6.	7.
H. M.	*H. M.*	*H. M.*	*M.*	*Feet.*	*Feet.*	*Feet.*
0 30	9 21	9 21	00	6. 34	6. 34	0. 00
1 30	9 05	9 07	02	6. 31	6. 32	. 01
2 30	8 51	8 54	03	6. 25	6. 26	. 01
3 30	8 47	8 46	01	6. 17	6. 16	. 01
4 30	8 50	8 55	05	6. 08	6. 06	. 02
5 30	8 54	8 58	04	6. 00	5. 97	. 03
6 30	9 22	9 25	03	5. 94	5. 94	. 00
7 30	9 52	9 49	03	6. 00	5. 98	. 02
8 30	9 59	10 00	01	6. 02	6. 08	. 06
9 30	9 59	9 58	01	6. 12	6. 18	. 06
10 30	9 53	9 58	05	6. 22	6. 27	. 05
11 30	9 35	9 35	00	6. 30	6. 33	. 03
	9 22					

The mean interval for this table is 9h. 22m., corresponding to the epoch of the moon's age of 24 minutes, showing that the transit E (of Mr. Lubbock's notation) and not F should be used in the reduction for theoretical purposes.

The comparison between the results of observation and those from the formula for the half-monthly inequality is shown in the fourth and seventh columns, the fourth referring to the interval and the seventh to the height. The difference in the mean is inappreciable, and, at a maximum, is but five minutes of interval, and six hundredths of a foot of height.

A graphic comparison is made on Plate II. The value of the constant (A) of the formula for the interval, $\tan 2\psi = \frac{(A)\sin 2\varphi}{1+(A)\cos 2\varphi}$ is 0. 325, and of E in the formula for the height $h = D + E\,(A)\cos(2\psi - 2\varphi) + \cos 2\psi$ is 0. 620.

The values of the *diurnal inequality* of high and low water, both in time and height, were obtained by comparing the mean value of the interval and height for the first and second six months, with the individual values; they followed closely the law of change with the moon's declination. The inequality in height of high water at a mean is to that of low water as 79 to 61.

As the observations were only made hourly, and the inequality in the interval of high water is small, the minute changes from day to day could not be expected to show themselves. The inequalities were grouped according to the different declinations of the moon into fourteen periods, and the approximate formula, given by Mr. Lubbock, for the variation from the mean, was applied. The agreement with theory, as shown in the annexed table, is very close; G was taken as 1. 15.

TABLE No. 2.

Comparison of the diurnal inequality of high water at Key West, with the formula $d\,\psi = \frac{G \tan \delta'}{1 + (A) \cos 2\varphi}$.

Moon's declination.	Diurnal inequality.		Difference.
	Observed.	Computed.	
° ′	*Minutes.*	*Minutes.*	*Minutes.*
3 55	13	15	—02
7 15	25	29	—04
11 30	48	47	01
15 45	61	64	—03
18 55	74	78	—04
20 55	88	87	01
21 30	100	91	09
21 55	95	92	03
20 15	84	85	—01
17 30	83	72	11
13 55	52	56	—04
9 15	37	38	—01
5 15	25	21	04
2 55	07	11	—04
			—23
			+29
			52

The inequalities of time of high water were also arranged according to the moon's age, but the agreement of the observation with the formula is not as close as in the former case, as must be the case from the small number of observations, and the variation of the inequality following chiefly the law of the declination. The law of change is still evident in the grouping, and the plus and minus quantities balance nearly.

The discussion of the diurnal inequality in height will be resumed in referring to the diurnal wave, after noticing the decomposition of the curve of observation into a semi-diurnal and diurnal curve.

Decomposition of the curves of observation.

As in the discussion presented for the Cat island tides, the curves of observation at Key West were decomposed into two—one representing the semi-diurnal and the other the diurnal tide. The interval, (E) which was in the former case assumed to be constant, was here treated as variable. The observed ordinates being referred to the mean of high and low water of the day as a zero, were tabulated, and the maximum ordinates S and D of the semi-diurnal and diurnal curves of sines found, taking (E) generally at its mean value. From these the ordinates of each curve for the several hours were obtained, and thence the ordinates of the compound curves. These were compared with observation, and E was next made to vary until the value was found, which gave the sum of the differences of computation and observation, without regard to sign, the smallest.

It was next intended, treating this as a first approximation, to take a different zero-point for the semi-diurnal curve, but the labor necessary has prevented this idea from being followed up thus far, and the agreement of the computed and observed curves is quite satisfactory in the cases in which E is not varying too rapidly for safe deductions. The labor and uncertainty of deducing E from the observations in the manner just referred to is very considerable, and, after one full comparison made in this way, the values will be deduced from theory, and applied to the curves.

The approximate compound curve was next projected on a diagram of suitable scale, and the outline cut from the paper so as to apply it to the curve of observation, and thus to find its best position in reference to that curve, and to determine the times of high water. The work referred to in the paragraphs preceding the last is mechanical, but this latter requires much judgment, and has been executed by Mr. W. W. Gordon. Supposing that some discrepancies observed might result from a sort of personal equation in making these comparisons, a second person was engaged to repeat them for verification, and the result showed that the comparison could be depended upon in individual cases to within about five minutes in time in the position of the maximum ordinates.

Specimens of the accordance of observed and computed curves in normal cases are given on Plate I. The cases correspond to the greatest and least, and to the mean values of the magnitude of the diurnal and semi-diurnal waves.

Semi-diurnal Tides.

The times of high water from the semi-diurnal curves being taken from the diagrams, are subject to an error, which Mr. Gordon estimates as from four to five minutes. This, however, does not appear in the final results, which agree as well with theory as those for the heights, not subject to any such error of estimates.

The lunitidal intervals and heights found were tabulated according to the moon's age, as in the following tables, which contain the result for the first and second six months of the year and for the whole year. The fourth and seventh columns contain, respectively, the differences in the interval and height drawn from the curves, and from the formula for the half-monthly inequality referred to in the previous part of this paper:

TABLE No. 3.

First six months.

Moon's age.	Interval.			Height.		
	O.	C.	Difference. O—C.	O.	C.	Difference. O—C.
H. M.	*H. M.*	*H. M.*	*M.*	*Feet.*	*Feet.*	*Feet.*
0 30	8 53	8 54	1	0.75	0.75	0.00
1 30	8 38	8 42	4	.73	.72	.01
2 30	8 29	8 30	1	.64	.66	.02
3 30	8 24	8 24	0	.60	.58	.02
4 30	8 28	8 27	1	.48	.49	.01
5 30	8 42	8 40	2	.45	.43	.02
6 30	9 06	9 03	3	.42	.42	.00
7 30	9 23	9 23	0	.44	.46	.02
8 30	9 31	9 30	1	.53	.54	.01
9 30	9 28	9 28	0	.61	.62	.01
10 30	9 20	9 19	1	.68	.69	.01
11 30	9 09	9 07	2	.75	.74	.01
	8 57					

TABLE No. 4.

Second six months.

Moon's age.	Interval.			Height.		
	O.	C.	O—C.	O.	C.	O—C.
H. M.	*H. M.*	*H. M.*	*M.*	*Feet.*	*Feet.*	*Feet.*
0 30	8 53	8 52	1	0.78	0.77	0.01
1 30	8 42	8 39	3	.72	.75	.03
2 30	8 27	8 28	1	.69	.68	.01
3 30	8 22	8 21	1	.59	.59	.00
4 30	8 22	8 23	1	.49	.49	.00
5 30	8 34	8 38	4	.46	.42	.04
6 30	9 04	9 03	1	.40	.40	.00
7 30	9 22	9 23	1	.44	.45	.01
8 30	9 31	9 31	0	.53	.54	.01
9 30	9 32	9 28	4	.62	.64	.02
10 30	9 20	9 19	1	.69	.72	.03
11 30	9 04	9 06	2	.71	.77	.06
	8 56					

TABLE No. 5.

The whole year.

Moon's age.	Interval.			Height.		
	O.	C.	O—C.	O.	C.	O—C.
H. M.	*H. M.*	*H. M.*	*M.*	*Feet.*	*Feet.*	*Feet.*
0 30	8 53	8 53	0	0.76	0.76	0.00
1 30	8 40	8 40	0	.73	.74	.01
2 30	8 28	8 29	1	.67	.67	.00
3 30	8 22	8 22	0	.59	.59	.00
4 30	8 25	8 25	0	.49	.50	.01
5 30	8 38	8 39	1	.45	.43	.02
6 30	9 05	9 03	2	.41	.41	.00
7 30	9 22	9 23	1	.45	.46	.01
8 30	9 31	9 31	0	.53	.54	.01
9 30	9 30	9 28	2	.62	.63	.01
10 30	9 20	9 19	1	.69	.71	.02
11 30	9 06	9 07	1	.73	.75	.02
	8 57					

Curves showing the result of these comparisons are given in Plate V. The greatest difference for the whole year between the two sets of results is but one minute of time for the interval, and .02 foot in the height.

The results are in apparent time, the substitution of which for mean time was, however, appreciable in but a slight degree.

There are several small corrections suggested by the hypothesis which has been adopted, but the small value of the residuals renders the following of them up unnecessary. To the last computations we have reached no greater accuracy than is presented by these residuals, and could not safely base any conclusions on less quantities.

The ordinates used in the heights are the maximum ordinates of the component curves, and not those of high water of the compound curve; but it is easily shown that when the value of (E,) when most nearly constant, is, as at Key West, between about nine and nine and a half hours, this difference is inappreciable.

The solar day having been used in this decomposition instead of the lunar, the curves are at a mean twenty-five minutes behind their true place, and the mean lunitidal interval differs twenty-five minutes from the truth; adding this quantity, it agrees, as it should do, with the former determination.

For the reason just assigned, these numbers would require correction before using them to determine the constants. This, when made, gives the result as before stated.

Diurnal tides.

The maximum ordinates found for the diurnal tides from the decomposition of the curves of observation were grouped according to the declinations of the moon, by magnitude without regard to sign, as shown in the first and second columns of Table No. 5.

The maximum ordinates may, in this case, be reduced to high water ordinates by a very simple process, and thus a comparison be established between this mode of reduction and the ordinary one. For (E) = 9h. 30m., the high water ordinate is 0.79, the maximum, provided, as in the case at Key West, the time of high water may be taken as that of the semi-diurnal wave.

The following table shows the moon's declination, the corresponding mean maximum ordinate, twice the high water ordinate deduced from this, (which is the diurnal inequality from our mode of reduction,) the diurnal inequality as usually obtained, and the difference.

TABLE No. 6.

Sine twice moon's declination.	Maximum ordinate.	Twice high water ordinate, (C.)	Diurnal inequality, (C'.)	Difference, (C'—C.)
	Feet.	*Feet.*	*Feet.*	*Feet.*
11	0.12	0.20	0.19	—.01
21	.17	.27	.28	.01
35	.28	.44	.44	.00
48	.38	.59	.60	.01
59	.46	.71	.70	—.01
66	.51	.80	.79	—.01
69	.54	.84	.83	—.01
Mean		.55	.55	

The results are represented in diagram No. 3.

The statement made above in relation to the high water ordinates is not true for those of low water, as the consideration of the formula $y = C. \cos 2t + D \cos (t - E) - C$ will show, making $E > 9$ hours. The reverse is the case if $E < 9$ hours, the statement applying then to the inequality of low water and not of high. At Key West, while the high water inequality in height is thus readily found from the maximum ordinate, the low water presents a less accordant result; while at Cedar Keys just the reverse occurs, as should be the case.

It is plain, also, that changes in the coefficients C, D, and in E, will cause the inequalities in times and heights to vary, as well as those of high and low water, losing all correspondence with each other, as is also well shown in the annexed diagram. Mr. Gordon suggests that in the value of (E) will be found the full explanation of the peculiarities of the Petropaulofsk tides described by the Rev. Mr. Whewell.

In diagram No. 1, Plate V, E is assumed 9 hours and $S = D$, and the inequality of high and low water in interval and height correspond to each other. The same is the case for $E = 15$ hours. In No. 2, E is 12 hours, and $S = D$. The inequality in interval of high water is 0h., of low water 4h., when that in height of high water is 2 feet, and of low water 0 feet. For E, 18 hours and $S = D$, these inequalities would be reversed, that of interval of high water being 4h., and of low water 0h, while for height the inequality of high water is 0 feet, and of low water 2 feet.

Using the high water ordinates, determined as before stated, instead of the diurnal inequality in height, from which it has been shown not to differ sensibly, the numbers were compared with those of Mr. Lubbock's formula:

$$dh = B\,(A) \sin 2\,\delta \cos (\psi - \phi) + \sin 2\delta' \cos \psi;$$

Neglecting the variations of $\cos (\psi - \phi) \cos \psi$, the coefficients B and (A) B were found by least squares for the separate six months and for the year, agreeing sensibly in the partial and total determinations. From two years' result $B = 0.56$ and $(A)\ B = 0.16$. The value of (A) thus obtained is, as it should be, the same as deduced from the half-monthly inequality.

The sum of the squares of the difference of the numbers from the formula, and from the computed high water ordinates, is for the year but 0.0087 foot; corrected for the moon's parallax, but 0.0078 foot.

The individual results are given in the annexed table, in which the first column contains the moon's age, the second the difference between the computed high water ordinates and the corresponding quantities from the formula for the variations of the diurnal inequality in height, corrected for parallax, and the third the same, as uncorrected for parallax.

TABLE No. 7.

Moon's age.	Diurnal inequality height; observation—theory.	
	Corrected.	Uncorrected.
H. *M.*		
0 30	005	010
1 30	005	005
2 30	—035	—030
3 30	—035	—035
4 30	—075	—080
5 30	—070	—070
6 30	—080	—085
7 30	—090	—090
8 30	—065	—065
9 30	—020	—020
10 30	—030	—030
11 30	+005	010

The residuals are very small, but follow the law of the half-monthly inequality, as was found, also, from the corresponding results from the Cat Island observations.

The discussion of the value of E, which is in progress, I hope to present at a future meeting of the Association.

Changes of mean level.

The mean level of the water at Key West was seen from the observations to undergo remarkable changes from one period of the year to another. A comparison of the reductions for the first and second six months shows that the high water of neap tides of the first period rises actually to a higher level than the high water of spring tides of the second. The mean level of the high water for the first six months exceeds that for the second by 0.48 foot. The form of the half-monthly inequality is perfectly regular in each six months. The gauge had remained undisturbed; and in seeking for the explanation, it was observed that the mean level of the water varied very materially in the two periods, there being a change which appeared to go through its variations in the course of the year.

The annexed table shows the heights of high water at the several ages of the moon in the first and second six months, referred to the same zero.

TABLE No. 8.

Moon's age.	Height of high water.	
	First six months.	Second six months.
H. M.	*Feet.*	*Feet.*
0 30	6.63	6.05
1 30	.59	.04
2 30	.48	.02
3 30	.38	5.97
4 30	.31	.86
5 30	.26	.75
6 30	.17	.72
7 30	.28	.72
8 30	.26	.79
9 30	.34	.90
10 30	.43	6.01
11 30	.54	.06
	6.39	5.91

I hardly supposed that the numbers representing these changes of level would furnish evidence of the two interesting tides of long period pointed out by Mr. Airy, (Tides and Waves, Ency. Metrop., p. 355;) but they do, and in the case of the moon's action, where the number of averages which can be brought to bear upon a single result is considerable, and the observations run through various parts of the year, the results bear carrying to numerical comparison with the formula. These tides, as far as I am aware, have not been developed from observation, though certain general analogies pointed to their existence. Dividing the numbers showing the daily level of the water into groups of nearly fourteen days, each corresponding to the moon's declination from the maximum to the maximum again, and taking the mean of each set corresponding to the same declination, we obtain a series which is the average of twenty-six numbers in which the irregularities of the depressing and elevating action of the winds will be eliminated, and in which the sun's action will be nearly the same. This series presents a tolerable regularity increasing to a maximum at zero of declination, as shown in the annexed diagram 5, No. 1.

Taking the mean level of the water for each fourteen days, and dividing the results into two groups corresponding to the same declination of the sun, north and south, we have a series of numbers which, though less regular than the others, also rise towards the zero of declination, as shown in diagram 5, No. 2.

The results of the first series of computations bear very well a comparison with the formula given by Mr. Airy: $(1.34 \times \sin^2\mu + 0.61 \times \sin^2\sigma)$ $(\cos 2\lambda + c,)$ in which μ and σ are the declinations of the moon and sun respectively, and λ is the latitude of the place, requiring $C = O$. Those of the second present greater discrepancies and require $C = \frac{1}{3}$, contradicting the former. Though the weight of authority is that in favor of the criterion of the wave theory $C = O$, the result is inconclusive. In either case the whole number involved is less than the tenth of a foot, the theoretical lunar tide being 0.095, and the measured 0.098, while the theoretical solar tide for $C = O$ is 0.046, and the measured is 0.077.

The regularity of the winds of this region, the trade winds taken in connexion with the form of the harbor, point to their action as a source of explanation of this change of level. The meteorological tables kept while the tidal observations were made, furnish means of a complete discussion, which is in progress. I may remark, now, that winds tending to elevate the water in the harbor prevail for six months, from March to August inclusive, and those tending to depress it, for the other six months, from September to February inclusive. The subject is one in which it is difficult to come to numerical results, because the variations in the force of the wind and the duration both enter into the effect, and distant action sometimes causes local effects. The whole rise and fall is nearly three-quarters of a foot.

The mean level of the water deduced from the mean of high and low water in each month is shown in the annexed table

TABLE No. 9.

Month.	Height in feet.	Month.	Height in feet.
June	5.60	December	5.31
July	.78	January	.11
August	.63	February	.15
September	.93	March	.26
October	.90	April	.26
November	.73	May	.32
	5.76		5.24

APPENDIX No. 28.

On the Tides of the Western coast of the United States.—Tides of San Francisco Bay, California, by A. D. Bache, Superintendent U. S. Coast Survey.

Tidal observations have been made, in connexion with the hydrography of the Coast Survey, at several points on the Western coast, agreeing in showing the same interesting fact of the large diurnal inequality of the tides, already traced by Mr. Whewell in the observations at the Russian settlement of Sitka.

The diurnal inequality in height of the tides on the Atlantic coast is much more considerable than in Europe, and the diurnal inequality of interval is also well marked; but both require numerous carefully made observations to establish their laws, in consequence of the particular relation between the semi-diurnal and diurnal waves. On the Gulf of Mexico, west of St. George's island, the semi-diurnal tide is almost merged in the diurnal, but the total rise and fall is quite small.

At Key West, and along the western coast of Florida, where the diurnal inequality is large, the whole rise and fall of the tides is small, rendering numerous observations necessary to obtain reliable numerical results. The same is not the case on the Western coast; observations made for a short period through the whole twenty-four hours showing a peculiarly large diurnal irregularity as the most remarkable phenomenon of the tides. It becomes one of great practical importance to the navigator; for, in San Francisco bay, a rock which has three and a half ($3\frac{1}{2}$) feet of water upon it at the morning high water, may be awash at high water of the afternoon; and charts, of which the soundings are reduced to mean low water, will have no accurate significance, being liable to an average error of the soundings, at either low water of the day, of 1.18 foot.

The results which I now present, and propose to discuss, are of two series of tides observed in connexion with the Coast Survey at Rincon Point, in the city of San Francisco, California. The observations were under the direction of Lieutenant Commanding James Alden, U. S. Navy, one of the assistants in the Coast Survey. They were made hourly, except about the times of high and low water, when the regular intervals were fifteen minutes, and the attempt was made to seize the precise time of high and low water.

The first series extended from January 17 to February 15, 1852, and the second from January 23 to February 17, 1853. Another set of similar observations was made at Saucelito, on the northern side of the Bay of San Francisco, but not with the same care which appears to characterize these. The results are in general accordant with those deduced from the Rincon Point series

The reduction of the work of 1852 was made by Mr. W. W. Gordon, and that of 1853 by Messrs. Fairfield, Mitchell, and Heaton, of the tidal party of the Coast Survey office.

The results of 1852 are projected in the curves shown in diagram A, where the abscissæ represent the times from 0 hours midnight, and the ordinates represent the heights. The scale is such that the intervals between the vertical lines correspond to two hours, and between the horizontal lines to half a foot. The curve begins with midnight of the calendar day, January 16, 17, and ends with noon of February 15. The epochs of the moon's phases, and of zero, and maximum declination of the moon, are marked at the head, and the times of transit at the foot of the diagram, the curves upon which, for convenience of the page, have been divided into two parts, so arranged with respect to each other that the days of corresponding declination fall nearly over and under each other. The curves of the series of 1853 present the same general results, with about the same extent of irregularities.

These tides obviously present a case of large diurnal inequality in height; the interference of the diurnal and semi-diurnal waves going to produce one large and one small tide in the twenty-four lunar hours. When the declination of the moon is at its maximum, the difference in the heights of consecutive high and low waters is nearly at its maximum; and when the declination is nearly zero, the difference is the smallest.

The diurnal inequality in the interval is also perfectly well marked in these tides, amounting, when greatest, to about two hours for high water, and one hour and eleven minutes for low water.

The usual discussions of the times and heights, corresponding to the same time of transit of the moon, were made from the two series of observations, a defect having been found in the operation of referring the level of one tide-gauge to the other, the two series of heights were combined, by assuming the mean height in each series to have been the same. The results were plotted on a diagram like B, but on a larger scale, for the purpose of graphical corrections in the mode used by Mr. Whewell.

The ordinates of the diagrams Nos. 1 and 2, (diagram B,) correspond to the lunitidal intervals, and of Nos. 3 and 4 to the heights—the abscissæ, in each case, to the hours of the moon's transit. The scale is shown at the top and side of each diagram. No. 1, diagram B, shows the results for the half-monthly inequality of interval of high water, and the curves traced by them; No. 2 the same for low water; No. 3 shows the half-monthly inequality in the height of high water, and No. 4 in that of low water; the dots show where the observations fall. The comparison of the curves, with observations, is given in the annexed table:

TABLE No. 1.

Comparison of approximate curves of half-monthly inequality of the tides at Rincon Point, with observations.

Moons' age.	INTERVAL.				HEIGHT.				Moon's age.
	High water.		Low water.		High water.		Low water.		
Transit F.	From curve.	Observat'n. — Curve.	From curve.	Observat'n. — Curve.	From curve.	Observat'n. — Curve.	From curve.	Observat'n. — Curve.	Transit F.
H. M.	*H. M.*	*M.*	*H. M.*	*M.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*H. M.*
0 30	11 59	—10	17 45	— 9	7.90	— 3	3.02	+ 3	0 30
1 30	36	— 2	37	— 3	.75	+ 4	.10	— 8	1 30
2 30	27	0	28	1	.45	+ 2	.20	—20	2 30
3 30	24	7	24	7	.10	+ 2	.38	+29	3 30
4 30	28	— 4	28	— 9	6.90	— 4	.52	— 6	4 30
5 30	48	— 7	42	18	.78	+12	.68	—29	5 60
6 30	12 18	— 1	18 05	— 1	.80	—13	.70	+26	6 30
7 30	43	12	24	— 7	7.00	+00	.67	—18	7 30
8 30	46	—12	33	9	.30	+15	.50	—41	8 36
9 30	39	— 2	27	— 6	.50	—15	.40	+27	9 30
10 30	27	— 1	15	— 3	.69	+ 5	.25	—19	10 30
11 30	11	8	17 57	— 2	.80	— 4	.10	+06	11 30
Mean...	12 03	+27 —39	17 55	+35 —40		+39 —40		+110 —106	

The results, both for interval and height, are very good, considering the small number of observations (four,) of which each is the mean. The heights are, as usual, less regular than the times, and the results for the inequality of the height of low water are the least regular of all.

The approximate mean lunitidal interval for high water, or corrected establishment of Rincon Point, is 12h. 03m. This corresponds to an epoch of 0 hours, showing that the tides belong to the next preceding transit (transit F) of the moon, and not of the fifth preceding, (transit B,) as was found by Mr. Lubbock for the tides of Great Britain. The epoch for low water corresponds also almost exactly to 0 hours. The same thing is shown, less forcibly, however, by the discussion of the observations before referred to at Saucelito.

From curve No. 1, it appears that the difference in the lunitidal intervals for 3h. and for 9h. is 1h. 20m., or (A) of Mr. Lubbock (tan 20°) is 0.342. The difference between the heights of high water, at spring and neap tides, is, from diagram No. 3, 1.12 foot, and E of Mr. Lubbock $\frac{1.12}{2(A)}=1.66$. The two series of observations, discussed separately, gave results which did not differ materially from these. These numbers will serve as a first approximation.

It should not be forgotten that, the observations having been made in successive years in the same month, the moon's age and declination, and the sun's declination, are not very different, and the sun's declination is nearly the same on the corresponding days.

The *diurnal inequality* obtained by the usual method is given in the annexed table, No. 2. The two series are combined by taking the averages for the days on which the declinations correspond in the two series. Each average is thus the mean of four individual results.

TABLE No. 2.

Diurnal inequality of interval and height for high and low water, from observations in January, 1852 *and* 1853, *at Rincon Point, San Francisco, California.*

	High water.		Low water.		
	Interval.	Heights.	Interval.	Heights.	
	H. M.	*Ft.*	*H. M.*	*Ft.*	
	1 44	—1.85	—0 51	3.01	January 19, 1852, and January 25, 1853.
	1 57	—1.81	—1 03	3.44	
	1 47	—1.63	—0 47	3.75	Moon's max. dec.
	2 17	—1.59	—0 40	3.72	
	1 41	—1.62	—0 40	3.46	
	1 43	—1.33	—0 30	3.07	
	1 41	—1.05	—0 23	2.57	
	1 20	—0.66	+0 07	2.00	
	0 39	—0.17	0 38	1.37	Moon's dec. zero.
	0 52	0.32	1 05	0.50	
	0 23	0.71	0 50	—0.41	
	—0 18	1.72	0 58	—1.44	
	—1 01	1.90	1 01	—2.19	
	—1 42	2.01	1 14	—2.85	February 1, 1852, and February 3, 1853.
	—1 55	1.88	1 12	—3.36	
	—2 01	1.86	1 00	—3.48	Moon's dec. max.
	—1 49	1.84	0 57	—3.48	
	—1 12	1.90	0 41	—3.28	
	—1 41	1.65	0 42	—2.99	
	—1 26	1.42	0 35	—2.50	
	—1 09	1.00	0 20	—1.90	
	—0 59	0.29	—0 08	1.29	Moon's dec. zero.
	—0 32	—0.30	—0 35	—0.50	
	—0 09	—0.97	—1 15	0.26	
	0 29	—1.42	—1 17	0.95	
	0 46	—1.56	—1 12	1.85	
	1 51	—1.70	—0 46	2.51	
	1 58	—1.62	—0 30	2.99	February 15, 1852, and February 17, 1853.
	2 11	—1.35	....	....	
Mean	1 21	1.36	0 47	2.36	

These numbers are projected on diagram C, where the ordinates correspond to the intervals for one curve and to the heights for the other, and the abscissæ to the tidal days for both. Notwithstanding the small number of observations, the curves can be traced with tolerable certainty and follow the general law of the inequalities.

Each curve shows an inequality increasing and decreasing with the moon's declination, nearly crossing the zero line at or near the zero of declination, and reaching a maximum or minimum at the maximum of north or south declination. The observations do not furnish sufficient evidence to decide positively that the epochs of the several inequalities coincide with those of the declination or otherwise. On the average, they are about half a day before the corresponding declination.

The inequality in the height of high water and in the interval of low water increase and decrease together, and so of the inequality of high water and height of low water.

The declination of the moon and the inequality in interval of high water and in height of low water have the same sign; the reverse is the case with the other two inequalities.

The inequality in the height of low water is in general greater than that of high water, exceeding it when at the maximum in the proportion of two to one, (nearly 1.9 to 1.) The same relation exists between the maximum inequality in interval of HIGH water as compared with that of LOW, (1.7 to 1.)

The maximum inequality in the height of low water is 3.60 feet, and of high water 1.85 foot. The maximum inequality of interval of high water, as shown by the curve, is 1h. 53m., and of low water 1h. 7m.

I am indebted to Mr. Heaton, of the tidal party, for the decomposition, under the direction of Mr. W. W. Gordon, of the curves of the daily observations in 1852, by the method adopted by me for the discussion of the tides of the Gulf of Mexico. Though, from some trials which I have made, these decompositions may be improved, they are, nevertheless, of great interest, and show well the causes of the forms assumed by the curves of diurnal inequality in height and interval, and for high and low water and their relations. When the observations now in progress on the Western coast shall have given additional results, I propose to take up this branch of the subject again. In the mean time, it appears to me, the results now obtained are of sufficient interest to be presented to the Association.

I have taken, as an example of the decomposition, the curve from the observations of January 21, 1852, the results corresponding nearly to the maximum of the moon's declination and to full moon.

The diurnal curve, the interference of which with the semi-diurnal produces the form shown in diagram A, and also on a larger scale in diagram D, is given on the diagram. Its maximum ordinate, as found by summing the two series of heights from the hourly observations in which the same values of the ordinate of the diurnal curve occur with opposite signs, and referring to the curve of sines for their relation to the maximum ordinate, is 2.20 feet.

The sum of the squares of the differences between observation and computation is the least when the interference takes place, as shown in diagram D, the maximum ordinate of the diurnal curve being seven hours and a half from the maximum ordinate of the semi-diurnal curve. Subtracting the ordinates of the diurnal curve, assumed as a curve of sines for the heights given by the hourly observations, we have a residual curve, which is traced on the diagram. The average of the four loops of this curve is almost precisely a curve of sines, of which the maximum ordinate is 2.30 feet.

The tidal curves near the maximum of declination, and for several days each side of it, result from the interference of a semi-diurnal and diurnal wave, which at the maximum of each are nearly equal in magnitude, the crest of the diurnal wave being at that period about eight hours in advance of that of the semi-diurnal wave.

The annexed table gives the comparison made in the diagram. The first column contains the ordinates of the curve of observation: the second, those of the diurnal curve of sines; the third, those of the residual curve; the fourth, the ordinates of the semi-diurnal curve, which most nearly satisfy the residual; and the fifth, the small remaining differences—on the average, being about 0.14 foot. The crest of the diurnal curve is seven and a half hours from the semi-diurnal, and its maximum ordinate is 2.2 feet.

TABLE No. 3.

Analysis of curve of observations for January 21, 1852. *Rincon Point.*

Ordinates, curve of observations.	Ordinates, diurnal curve of sines.	Ordinates, residual curve.	Ordinates, semi-diurnal curve of sines.	Differences.
Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*
—0.23	—0.28	—0.05	0.00	—0.05
—1.63	—0.83	—0.80	—1.10	.30
—2.98	—1.33	—1.65	—1.82	.17
—3.63	—1.72	—1.91	—2.27	.36
—4.03	—2.00	—2.03	—2.20	.23
—3.68	—2.16	—1.52	—1.70	.18
—2.73	—2.16	—0.57	—0.70	.13
—1.48	—2.00	+0.52	+0.70	—0.18
—0.23	—1.72	1.49	+1.65	—0.16
+0.77	—1.38	2.15	+2.20	—0.05
1.47	—0.83	2.30	+2.30	.00
—1.72	—0.28	2.00	+1.90	.10
—1.52	+0.28	1.24	+1.60	—0.36
.77	.83	— .06	0.00	—0.06
.17	1.33	—1.16	—1.30	+0.14
— .33	1.72	—2.05	—2.05	.00
— .28	2.00	—2.28	—2.28	.00
+ .07	2.16	—2.09	—2.15	.06
.87	2.16	—1.29	—1.50	.21
1.87	2.00	—0.13	—0.20	.07
2.72	1.72	+1.00	+1.20	.20
3.32	1.33	1.99	+1.97	.02
3.27	.83	2.44	2.32	.12
2.62	.28	2.34	2.20	.14

For equal maximum ordinates of the diurnal curve and semi-diurnal curve, 2.1 feet. we have for E=8 hours; the diurnal inequality in height of high water 2.03 feet, or 18 feet greater than the mean found by the curve of diurnal inequality, and of low water 3.57, or .03 foot less than the value given by the curve. So, also, for the inequality in the intervals of high and low water, we have, respectively, 105 and 61 minutes, instead of 113 and 66 given by the diagram, differing but 8 and 5 minutes, respectively, and having the same ratio to each other as the latter numbers. The mode of interference thus explains satisfactorily the curious relations of the inequality of both time and height of high and low water.

Taking the values of the maximum ordinate of the diurnal curve (D) as deduced by Mr. Heaton, tracing a curve for them and folding this over on its greatest ordinate, as a hinge, we bring five values of D to the determination of each point in the curve from the observations of 1852. Treating the curve of twice the sine of the moon's declination in the same way, we obtain a curve for comparison with the former. Neglecting the sun's action, we have for theory m sin. 2δ=D. Taking the mean of the values of D, which nearly correspond to each other in the half declination, and the mean of the corresponding values of the sine of twice the declination, we obtain m=29 nearly.

The following table, No. 4, gives a comparison of the values of the semi-diurnal ordinates, and of m sin. 2δ

I have also deduced the diurnal inequality from Mr. Heaton's compound or interference curves, and have compared it in the same way with m sine 2δ. The value of m found from these, was m=28. The last column of Table No. 4 refers to this comparison.

TABLE No. IV:

Showing the values of the maximum ordinate of the diurnal curve (D) deduced from analyzing the curves of observation and comparison with theory; also the value of comparison of the diurnal inequalities measured on the compound curves.

No.	D.	M sine 2♃.	Difference.	Diurnal inequality—Ht. H. W. from curve.
	Feet.	*Feet.*		*Feet.*
1	2.13	2.17	.04	2.2
2	2.01	2.00	—.01	2.05
3	1.79	1.33	.04	1.85
4	1.54	1.55	.01	1.5
5	1.16	1.20	.04	1.1
6	0.81	0.76	—.05	1.6
7	0.25	0.26	.01	0.0

The agreement of the several results compared appears very satisfactory.

The changes in the value of E have been distinctly traced by Mr. Heaton from the observations; but before presenting the conclusion on this subject, I desire to subject them to the test of further computations, which are now in progress.

In order not to interfere with the regular work of the hydrographic party, a separate tidal party has been organized under the direction of Lieutenant Trowbridge, of the corps of engineers, assistant in the Coast Survey, and supplied with the necessary means for a full investigation of the tides of our Western coast. It is proposed to establish three permanent self-registering tide-gauges, under intelligent supervision, at San Diego, San Francisco, and Columbia river entrance, and to connect them by observations at suitable intermediate points. There are difficulties to be overcome in the character of the coast itself, and of the aborigines who still inhabit portions of it, but I expect, nevertheless, entire success from the zeal and ability of Lieutenant Trowbridge.

The following tide table results from the observations already discussed.

Corrected establishment at Rincon Point: High water, 12 hours 3 minutes; low water, 17 hours 51 minutes.

Mean rise and fall of tides, 3 feet 11 inches; of spring tides, 4 feet 11.8 inches; of neap tides, 2 feet 11 inches.

Mean duration of rise 6 hours 30 minutes, including half the stand; fall 5 hours 52 minutes, including half the stand; stand, 30 minutes.

	High water.	Low water.
Diurnal inequality of height.	*Ft. In.*	*Ft. In.*
Average for the whole month	1 03	2 04
Greatest value	2 11	3 06¼
Diurnal inequality in interval.	*H. M.*	*H. M.*
Average for the whole month	1 02	0 45
Greatest value	2 00	1 06

Difference in height of highest tide and lowest tide in day: average, 5 feet 11 inches; greatest, 7 feet 7 inches.

When the moon's declination is north, the highest of the two high tides of the day is the one which occurs about twelve hours after upper culmination.

I have given elsewhere, for the use of navigators, a set of rules founded on these observations, and containing no technical term unfamiliar to them.

APPENDIX No. 29.

Notes on the Tides at San Francisco, California, by Professor A. D. Bache, Superintendent U. S. Coast Survey.

COAST SURVEY OFFICE, *February* 17, 1853.

SIR: I am at present engaged in preparing notes on the tides of the Western coast of the United States; and believing that, in advance of them, a statement of the general results for San Francisco, California, may be of service to navigators, I have the honor to submit it herewith, and to request authority for its publication. I have avoided the use of scientific terms, except such as are familiar to seamen.

Notes on the tides at San Francisco, California.

Besides the ordinary changes in the time and height of the tides known to all navigators, it is important to note the following, generally applicable to the Western coast, and particularly to San Francisco bay. They relate to peculiarities in the tides which occur on the same day, the necessity for knowing which is shown by the fact that a rock having *three feet and a half* of water upon it at *low tide*, may, at the *succeeding low water*, on the same day, be awash:

1. The tides at Rincon Point, in San Francisco bay, consist generally of a large and small tide on the same day; so that of two successive high waters in the twenty-four hours one is much higher than the other, and of two successive low waters one is much lower than the other.

2. The difference in height of two successive tides (either high or low waters) varies with the moon's declination. When the declination is nothing, the difference is nothing, or very small. When the declination is greatest, whether south or north, the difference is greatest. When the moon's declination is nearly nothing, the intervals between two successive high or two successive low waters are nearly twelve hours, and differ most from this when the moon's declination is greatest.

3. The inequalities in the heights of successive low waters are more considerable than those of successive high waters; while, on the contrary, the inequalities in the times of high water are more marked than those of low.

4. The average difference between the heights of two successive high waters is one foot four and a half inches; and of two successive low waters, two feet and four inches. The average difference of these same heights, when the moon's declination is greatest, is for the successive high waters two feet, and for the low waters three feet six inches.

5. The average variation from twelve hours in the interval between two successive high waters is three quarters of an hour, and between two successive low waters half an hour. The average variations of the same intervals when the moon is furthest from the equator are, respectively, one hour and three quarters of an hour.

6. When the moon's declination is north, the higher of the two high tides of the twenty-four hours is the one which occurs about eleven and a half hours after the moon crosses the meridian, (souths) and when the moon's declination is south, the one which occurs about one hour and a half after the moon's meridian passage, (southing.)

6 *bis*. Or the following rule may be used, which applies when the moon crosses the meridian between midnight and 11½ a. m., or between noon and 11½ p. m.:

If the moon is *south* of the equator, and passes the meridian (souths) in the morning, the morning high water will be higher than the afternoon high water, if, in the afternoon, the afternoon high water will be the higher.

If the moon is *north* of the equator, and passes the meridian (souths) in the morning, the afternoon high water will be the higher; if in the afternoon, the morning high water will be the higher.

7. The lowest of the two successive low waters of the twenty-four hours occurs about seven hours after the highest of the two high waters.

8. The average difference between the height of the highest high water and of the lowest low water is five feet eleven and a half inches, and the greatest difference is seven feet ten inches.

Very respectfully, yours,

A. D. BACHE, *Superintendent.*

Hon. THOMAS CORWIN,
Secretary of the Treasury.

APPENDIX No. 30.

Extracts from letters of L. F. Pourtales, Esq., assistant in the Coast Survey, to the Superintendent, upon the examination of specimens of bottom obtained in the exploration of the Gulf Stream, by Lieuts. Comg. T. A. M. Craven and J. N. Maffitt, U. S. Navy, assistants in the Coast Survey.

DEAR SIR: I have in hands, now, the specimens of bottom from the Gulf Stream, obtained by Lieutenant Craven, and I can say that they are among the most interesting I have ever seen. You recollect that I said in my reports, that with the increase in depth—in the greater depths—the number of individuals appeared to increase. The greatest depth from which I had seen specimens was between two hundred and three hundred fathoms. There the sand contained, perhaps, 50 per cent. of foraminiferæ, in bulk. The specimens now before me go to 1,050 fathoms; and there it is no longer sand containing foraminiferæ, but foraminiferæ containing a little or no sand. The grains of sand have to be searched for carefully, under the microscope, to be noticed at all. The species are the same as found in the deeper soundings in Section II, but the specimens look fresher, and appear somewhat larger. The *Globigerina rubra* of d'Orbigney, which forms the majority, has frequently that delicate pink color to which it owes its name, but which I cannot recollect to have noticed in more northern specimens. There are also some pieces of coral and dead shells from the depth of 1,050 fathoms. The corals do not look much worn, but still appear to have been dead. There are some delicate shells of molluscs from depths beyond 500 fathoms, where they were certainly living.

* * * * * * *

At your request I have examined the specimens of bottom obtained by soundings in the Gulf Stream, executed lately by Lieutenant T. A. M. Craven, U. S. N., assistant in Coast Survey; and I now beg to make the following report on the results of this examination.

The specimens are from thirteen localities, on the edge and in the Gulf Stream, off the eastern coast of the peninsula of Florida. I propose to give now a short description of the characteristics of each of them.

I.—*Position* 2. Lat. 26° 12′, long. 79° 54′, depth 500 fathoms. This specimen consists almost entirely of foraminiferæ, with a very small proportion of quartzose sand, estimated at about 10 per cent. in bulk. *Globigerina rubra* forms the mass, with a pretty large proportion of *Rotalina cultrata*, *Orbulina universa*, and *Textularia turbo*. It also contains minute gasteropods (natica nassa?) and fragments of the shell of a crab. The whole is of a chalky white color, only a few of the globigerinæ being pink.

II.—*Position* 4. Lat. 27° 37′, long. 79° 19′, depth 600 fathoms; has the appearance of fine white mud, mixed with yellow sand. It is composed entirely of foraminiferæ and their fragments, in the form of a fine powder. No silex. Acids dissolve the whole, leaving a flocculent greenish matter—probably animal matter. The species are the same as in the preceding, with the addition of Marginulina Bachei, (rare,) Rotalina Ehrenbergii, a Biloculina and a crimson Rotalina, (both rare;) also small shells, and the habitation of a worm composed of agglutinated foraminiferæ.

III.—*Position* 5. Lat. 28° 04′, long. 80° 13′, depth 15 fathoms. Coarse yellow sand and broken shells; equal proportions of both.

IV.—*Position* 6. Lat. 28° 21′, long. 80° 10′, depth 20 fathoms. Dark-gray sand and broken shells; very little quartz. The black parts of the sand make a dark-gray mark when crushed, and are dissolved with effervescence in acids. Probably a limestone.

V.—*Position* 8. Lat. 28° 21′, long. 79° 52′, depth 100 fathoms. Fine dark-gray mud, composed in part of very fine quartzose sand. Of organized beings it contains a bivalve shell, a few very minute Rotalinæ, spiculæ of sponges, and so-called infusoria, of the genera Coscinodiscus and Triceratium.

VI.—*Position* 11. Lat. 28° 24′, long. 79° 13′, depth 1,050 fathoms. Composed of foraminiferæ; silicious sand in almost imperceptible quantity. A small portion taken from the lower part of the specimen, after shaking it with water, only showed one or two per cent. of silicious sand after dissolution in acid. *Globigerina rubra* (white, yellow, and pink—the two first colors predominant) forms the greater bulk. Also, *Orbulina universa, Rotalina cultrata, Baylcyi* and *Ehrenbergii*. Of other animal remains there were found pieces of coral, (cariophyllia—?—some white and worn, and some brown, and in better condition;) a piece of a large Gasteropod, old; and worn pieces of Anatifa, and very small pteropods, (Spiratella.)

VII.—*Position* 14. Lat. 29° 22′, long. 79° 59′, depth 150 fathoms. Same kind of bottom as No. V; contains a few Biloculinæ.

VIII.—*Position* 15. Lat. 29° 43′ 0″, long. 80° 37′ 0″, depth 19 fathoms. Coarse quartzose sand and broken shells, like No. III.

IX.—*Position* 17. Lat. 29° 50′ 0″, long. 80° 6′ 0″, depth 300 fathoms. Mud, like Nos. V and VII; contains Globigerinæ.

X.—*Position* 20. Lat. 29° 48′ 0″, long. 79° 31′ 0″, depth 560 fathoms. *Globigerina rubra* and *Rotalina cultrata*, in about equal proportions. No quartzose sand or other material.

XI.—*Position* 21. Lat. 29° 48′ 0″, long. 79° 17′ 0″, depth 450 fathoms. *Globigerinæ, Orbulinæ,* and *Rotalinæ,* (R. cultrata.) No quartzose sand. It contains, also, considerable numbers of very delicate shells of pteropod molluscs, belonging to the genera Hyalæa, Spirialis, and Spiratella; also, small pieces of coral.

XII.—*Position* 27. Lat. 31° 2′ 0″, long. 79° 35′ 0″, depth 150 fathoms. A mixture, in about equal proportions, of Globigerinæ and black sand—probably green sand, as it makes a green mark when crushed on paper.

XIII.—*Position* 32. Lat. 30° 50′ 0″, long. 78° 49′ 0″, 520 fathoms. *Globigerinæ, Orbulinæ, Rotalinæ, (cultrata* and *Ehrenbergii,)* small shells, (Spirialis Gouldii, Spiratella,) small spines of Echini. No quartzose sand.

A few interesting remarks suggest themselves from the above examination; but before passing over to them the following question has to be answered: Are these small animals actually living in the localities from which they were obtained, or have they been gradually washed down from the reefs near which the current has passed? I feel inclined to answer that they were living where found, from the fact that the greater number of the individuals are perfect, notwithstanding the great delicacy of their shell. The delicate pink color of the Globigerinæ would scarcely be preserved in specimens transported from a distance.

The best argument in favor of this opinion is, perhaps, the fact that the same species are found in a perfect state as far north as the coast of New Jersey and New York. It is very singular, however, that the same species should also be found living on the shores of Cuba, and of some of the other West India islands, under exceedingly different circumstances of light and temperature.

If we admit their living in the great depths where we have found them in such abundance, we are enabled to extend the limits of animal life to a much greater depth than is usually admitted. Prof. Edward Forbes, in his report on the distribution of Mollusca and Radiata in the Ægean sea, (Reports of the British Association, 1843,) supposes that in depths beyond 300 fathoms animal life does not exist. In a former report on this subject (Proceedings American Association, Charleston meeting) I remarked that the *Globigerinæ rubra* seemed to increase in abundance with depth. I had then seen specimens from depths not exceeding 267 fathoms, and its greatest abundance did not exceed about 50 per cent. of the mass. We have now found a maximum of its occurrence at a depth of 1,050 fathoms, where this and allied forms constitute the entire bottom. It is but reasonable to suppose that still deeper explorations would show a gradual decrease for a considerable depth before it should cease to appear, as was shown for other species living in more shallow water in the report alluded to.

In concluding I would remark, how important a knowledge of the habitation and distribution of the foraminiferæ is for geologists; since, of all classes of the animal kingdom none has contributed so large a share to the formation of rocks, at least in the cretaceous and tertiary formations.

* * * * * * * * *

I have examined the four specimens of bottom obtained by Lieutenant Commanding J. N. Maffitt, in his explorations of the Gulf Stream during the past summer, and subjoin a description of their constituent parts.

Specimen No. 1, Position 5, Section VI, depth from 300 to 400 fathoms, lat. 31° 32′, long. 78° 32, consists in a small angular piece of dark-colored stone.

Specimen No. 2, Section VI, Position 4, depth 600 fathoms, lat. 31° 32′, long. 78° 20′, consists in foraminiferæ and small shells, and in fragments of shells and corals. The foraminiferæ are chiefly larger specimens of a kind of Rotalina, of a rough and heavy appearance. The other kinds found among them present also a similar appearance. The fragments of shells and corals are worn and rounded. Among the shells a species of Concholepas is abundant.

Specimen No. 3, Section VI, position 6, depth 450 fathoms, lat. 31° 16′ 48″, long. 78° 16′. This specimen is on tallow, and consists only in a few small foraminiferæ.

Specimen No. 4, Section VI, Position 9, depth 460 fathoms, lat. 30° 41′ 0″, long. 77° 3′ 30″, foraminiferæ, small shells, and dead corals, (Cyathophyllia,) and fragments of dark stone, like Specimen 1. The foraminiferæ have the same appearance and belong to the same species as those found in the deepest soundings obtained in the Gulf Stream by Lieutenant T. A. M. Craven.

The only specimen presenting anything peculiar is Specimen No. 2. The appearance of the foraminiferæ, and the rounded condition of the corals and fragments of shells, seem to indicate an agitation of the water near the bottom.

Very respectfully, your obedient servant,

L. F. POURTALES.

Prof. A. D. Bache, LL. D.,
Superintendent U. S. Coast Survey.

APPENDIX No. 31.

Report of Professor Benjamin Pierce, to the Superintendent, on the determination of longitudes from observations of moon culminations.

CAMBRIDGE, *October* 17, 1853.

SIR: I have the honor to present the following report on the determination of longitudes from investigations made between the first of October of the last and of the present year.

The subject of research which has been hitherto submitted to me, is that of ascertaining a method of determining the longitude from observed transits of the moon, which shall not be involved in the great and irregular errors of the lunar ephemeris. The usual process consists in a simple interpolation of observed transits at standard observatories. The objections to this method are: 1st. That many observations are lost because there are not the requisite corresponding observations at the fixed observatories. 2d. That the method of differences, by which the interpolation is effected, is liable to introduce errors of a peculiar nature when it is applied to such an irregular sequence as the successive transits of the moon. 3d. That the degree of accuracy of the interpolated result cannot be ascertained.

The obvious substitute for this process consists in the computation of a new ephemeris from an exact theory. The great expense and labor of such an undertaking may not be a sufficient objection to it in a work in which accuracy must be the paramount consideration. But the want of any lunar theory which has been proved capable of standing the test of observation, is decisive; and it is hoped that the method which is now proposed will be found to meet the demands of science.

In order to decide upon the merits of this or any other proposed method, some reliable and practicable test must be devised to which it may be submitted. This is only to be found in observation from which the computed result must not differ more than the amount which may legitimately be regarded as the error of observation. The probable error, therefore, of an observation of this peculiar kind, (that is, of a lunar transit,) must be ascertained by a comparison of observations which shall be instituted quite independently of the defects of theory. Two observatories which are nearly upon the same meridian, present the best opportunity for such an examination. This has been made, under my direction, by Mr. Edward Goodfellow, sub-assistant in the Coast Survey. He has compared observations of the transits of each limb of the moon, made upon the same night, at Greenwich, Cambridge, and Edinburgh, and he has also compared the transits observed with two different instruments at Washington. The probable error of observation resulting from the three hundred and sixty-seven (367) comparisons which have thus been made, is *one-tenth of a second of time.* This interval may then be assumed as the *standard probable error of an observation of a lunar transit,* made at a fixed observatory, in which, however, it is to be noted that the constant errors to which the observations of the different observatories are liable, and which may arise from peculiarities of the instrument or of the mode of observing, are not included. The probable error of this standard determination of the probable error is only about five-thousandths of a second.

The errors of the moon's latitude are rarely of any sensible influence upon the computed transits. It was not thought proper, however, to neglect them; and the corrections of the inclination of the lunar orbit, and of the longitude of its node, have been derived for each year, by the method of least squares, from the observed errors of latitude given in the Greenwich observations. The corresponding corrections of the moon's right ascension have been thence obtained for the observed transits.

An attempt was next made to determine empirical corrections of the elements of the lunar motion, which should satisfy all the observations of longitude made during a year; but the result was unsatisfactory, and a more special examination of the obsersvations, conducted with the aid of diagrams, seemed to indicate that the principal errors consisted of a constant error of epoch and a periodical error, of which the period was half a lunation. For each lunation of the year a special determination was then made by the method of least squares—of empirical corrections possessing these characters. The probable error of observation, which should be obtained by comparing the longitudes of the ephemeris thus corrected with the observed longitudes, should not differ much from *one second and five-tenths of arc,* which corresponds to the standard of one-tenth of a second of time in the transit. The actual result for the year 1847, was a probable error of *one second and forty-eight hundredths.* This seems to be a sufficient test of the value of the proposed method of reduction of the lunar transits, or at least a sufficient warrant for the continuance of the experiment. The Greenwich observations only have hitherto been used; but it is proposed hereafter to include those of Cambridge and Edinburgh in the determination of the longitudes of the eastern coast of America, and also those of Washington in the determination of the longitudes of the Western coast. It is also proposed to introduce corrections of the moon's semi-diameter, corresponding to the corrections of the parallax, which the illustrious astronomer Adams has deduced from Hansen's expression of this parallax.

All which is respectfully submitted by

BENJAMIN PIERCE.

Prof. A. D. BACHE,
Superintendent United States Coast Survey.

APPENDIX No. 32.

Report of Professor W. C. Bond on moon culminations, observed by him during the past year, by the "American method," with remarks on the performance of the "spring governor," the invention of the Messrs. Bond.

HARVARD UNIVERSITY, *Cambridge, November* 16, 1853.

DEAR SIR: In the course of the year fifty-five moon culminations, with the proper stars, have been observed here, all of them by the "American method," with the exception of the two last, when the clock was taken down to apply a new arrangement of the electric circuit. We have also observed twelve occultations of stars by the moon, about one-half of them by two observers, and occasionally by three.

I have also transmitted to Mr. Hein, Professor Pendleton, and other officers of the Coast Survey, fifty-three sheets of former observations, chiefly for the determination of longitudes on the Western coast.

The accuracy of the spring-governor records has been severally and satisfactorily tested in the course of the year by comparison of a large number of passages of the same star over the wires of our great equatorial, recorded *simultaneously* by our own apparatus, and one constructed by us on the same principle for the observatory at Haverford, in Pennsylvania, the only difference being in the lengths of their respective pendulums, one making a vibration in half a second, while the other required six-tenths of a second. The effect of this difference of a tenth of a second in the times of oscillation was to change the relative directions of the motions of the pendulums in regard to each other, as well as to that of the siderial clock, which opened and closed the electric circuit at the same moment for both cylinders, and to show, as evidently would be the case, the sum of the errors, had any such existed, in different parts of a single second, on the supposition that the spring attachment did not fully answer the intended purpose of equalizing the alternate motion and arrest the escapement while the rotary motion of the fly was under the control of the pendulum. The experiment has shown, by the most scrupulous reading of the sheets when taken from the cylinders and compared together, that no discrepancies exceeding three hundred parts of a second could be detected as arising from a defect of this nature.

For your satisfaction on this point I enclose the readings of one hundred and ten observations, as recorded by both cylinders on one circuit. These appear fully to corroborate Mr. Walker's report made to you on the subject in April, 1851, as well as your own impression at that time in regard to the accuracy of the spring-governor.

Respectfully and truly yours,

W. C. BOND.

Professor A. D. BACHE,
Superintendent U. S. Coast Survey.

Comparison of the records made of the same observation by two spring governors, differing one-tenth of a second in the time of vibration of their respective pendulums. (The sheets were read off by a proportional scale) Transits of Spica observed by W. C. B., at Cambridge, August 26, 1853.

Cambridge instrument.			Haverford instrument.			Cambridge instrument.			Haverford instrument.			Cambridge instrument.			Haverford instrument.		
H.	*m.*	*s.*	*M.*	*s.*	*s.*	*H.*	*m.*	*s.*	*M.*	*s.*	*s.*	*H.*	*m.*	*s.*	*M.*	*s.*	*s.*
14	17	21.33	17	21.32	+0.01	14	21	57.71	21	51.74	−0.03	14	27	23.50	27	23.48	+0.02
		27.13		27.10	+ .03		22	20.36		20.39	− .03			51.33		51.33	.00
		49.30		49.27	+ .03			26.00		26.00	.00			57.00		57.00	.00
		55.00		55.05	− .05			49.59		49.59	.00		28	23.07		23.07	.00
	18	29.00		29.00	.00			55.37		55.40	− .03			28.76		28.72	+ .04
		34.62		34.62	.00		23	17.74		17.75	− .01			52.38		52.40	− .02
		55.60		55.62	− .02			23.32		23.33	− .01			58.06		58.05	+ .01
	19	01.20		01.18	+ .02			50.43		50.44	− .01		29	39.95		39.90	+ .05
		26.40		26.40	.00			56.06		56.06	.00			45.63		45.63	.00
		32.18		32.18	.00		24	22.56		22.56	.00		30	41.25		41.25	.00
		34.60		34.57	+ .03			28.27		28.30	− .03			47.00		47.00	.00
		56.48		56.49	− .01			54.41		54.42	− .01		31	21.26		21.26	.00
	20	02.15		02.14	+ .01		25	00.14		00.14	.00			27.12		27.12	.00
		24.34		24.32	+ .02			26.07		26.07	.00			54.67		54.63	+ .04
		30.29		30.27	+ .02			31.70		31.73	− .03		32	00.37		00.34	+ .03
		55.25		55.23	+ .02		26	18.90		18.90	.00			23.68		23.61	+ .07
	21	01.60		1.00	.00			24.66		24.63	+ .03			29.31		29.30	+ .01
		26.13		26.13	.00			43.15		43.14	+ .01			53.57		53.57	.00
		31.74		31.79	− .05			49.00		49.00	.00			59.39		59.38	+ .01
	21	52.00	21	52.00	.00		27	17.74	27	17.74	.00		33	13.90	33	13.88	+ .02

The final result of the trial is that—

1. The two spring governors, *c* and *h*, give records which do not differ by a constant quantity as large as $0^s.001$.

2. The probable difference of the two records, including the error of scale reading, is $= \pm\, 0^s.013$ for a single observation and a single reading.

3. As a part of this is to be attributed to errors of scale reading, the probable error of the record of a single observation on either of these cylinders must be less than $\frac{0^s.013}{\sqrt{2}} = 0^s.009$.

Probable error of a single observation read off from the sheet by a scale, and including error of reading off, is

$$E = \pm\, 0^s.009;$$

including those sources of error to be ascribed properly to the method of observing by electro-magnetism

4. Probable error of a reading of the record by an eye estimate—

$$E = \pm\, 0^s.021.$$

Comparisons continued.

Cambridge instrument.	Haverford instrument.	Cambridge instrument.	Haverford instrument.	Cambridge instrument.	Haverford instrument.	
H. m. s.	*M. s.* *s.*	*H. m. s.*	*M. s.* *s.*	*H. m. s.*	*M. s.* *s.*	
14 33 19.49	33 19.48 + 0.01	14 42 37.22	42 37.22 .00	14 56 50.00	56 50.00 — 0.00	
34 05.90	5.93 — .03	42.90	42.90 .00	51.10	51.10 .00	
11.55	11.57 — .02	56 09.00	56 09.00 .00	51.56	51.58 — .02	
43.34	43.32 + .02	11.80	11.83 — .03			
49.12	49.12 .00	14.80	14.76 + .04			The mean of 113 scale readings gives, for the difference of absolute time of the two records made by *c* and *h*, $c-h=+0.0009\pm0^s.0012$.
35 10.80	10.81 — .01	17.44	17.46 + .02			
16.46	6.45 + .01	19.00	19.00 .00			
36 02.80	12.81 — .01	21.80	21.85 — .05			
8.43	8.41 + .02	25.42	25.41 + .01			
42.64	42.62 + .02	54.30	54.28 + .02			
48.36	48.39 — .03	55.00	55.00 .00			
38 44.93	44.90 + .03	59.00	59.00 .00			
50.41	50.43 — .02	57 06.00	6.00 .00			
39 08.95	8.96 — .01	9.95	10.00 — .05			
14.66	14.62 + .04	17.30	17.29 + .01			
42.82	42.86 — .04	18.18	18.19 — .01			
48.56	48.57 — .01	19.05?	19.00 .00			
40 16.26	16.27 — .01	19.70	19.66 + .04			
22.21	22.23 — .02	37.54	37.52 + .02			
51.16	51.18 — .02	40.00	40.03 — .03			
56.97	57.00 — .03	42.10	42.10 .00			
41 28.00	28.00 .00	44.19	44.17 + .02			
33.53	33.53 .00	45.73	45.72 + .01			
42 04.60	4.57 + .03	48.23	48.22 + .01			
10.13	10.12 + .01	49.23	49.23 .00			

APPENDIX No. 33.

Report of Dr. B. A. Gould, jr, to the Superintendent, upon the results of his observations in the determination of the difference of longitude, by telegraph, between Seaton Station, Washington, and Charleston, South Carolina.

CAMBRIDGE, *September* 30, 1853.

DEAR SIR: I have the honor to submit a report upon the progress of the astronomical and telegraphic operations intrusted to me since my entrance upon the service of the Coast Survey, on the first of December last.

A determination of the difference of longitude between Charleston, S. C., and the Seaton Station in Washington, was first to be made, and this determination subsequently used as one of a series of similar telegraphic longitude connexions which should ultimately give the longitude of the cities of Mobile and New Orleans with the highest precision attainable.

For this purpose, I remained in Washington sufficiently long to make at the Seaton Station, in connexion with Mr. Pourtales, a somewhat extended series of observations for the measurement of the difference of our personal equations; and went thence to Charleston, whence I was to exchange transits of stars with Mr. Pourtales.

Professor Lewis R. Gibbes courteously placed the observatory in his garden at the disposal of the Coast Survey, and such changes were made as were found necessary for the erection of C. S. transit instrument No. 8, and of the Kessels clock, formerly at the Seaton Station, and which, since the fire at that station, had been refitted by Mr. Saxton.

The Saxton register, as well as the ordinary Morse register, were set up, and a battery of forty Grove's caps prepared. A battery of equal power was used at the Seaton Station, and no difficulty was anticipated in communicating directly with Mr. Pourtales, especially as the late Professor Walker had succeeded on February 5, 1850, in communicating directly from Washington to Charleston, and exchanging some observations at that time.

From the middle of December until the middle of February I remained in Charleston, actively engaged in the prosecution of this undertaking, observing on every fair night circumpolar stars with reversals, and both zenith and equatorial stars, chronographically, for the determination of time and instrumental corrections, and, with the assistance of Mr. W. R. Lane, keeping up the reduction of these observations as fast as they were made. Throughout this period, messages concerning the state of the weather were exchanged with Mr. Pourtales every evening; and whenever the sky was unclouded at both stations, the batteries were set up, and the greater part of the night spent in attempts by each of us to obtain direct communication with the other, excepting on those nights when pressure of business prevented the Telegraph Company from affording us the use of the line. This pressure of business sometimes followed the arrival of a transatlantic steamer; but on all other occasions the use of the telegraphic line was gratuitously afforded by the liberality and public spirit of Elam Alexander, Esq., president of the Washington and New Orleans Telegraph Company. We were aided by the operators in Washington, Petersburg, Raleigh, and Columbia, those at Washington and Charleston being in attendance at the astronomical stations.

After a series of the most varied experiments upon the strength, arrangement, and position of the batteries which would afford the greatest efficiency, we were at last reluctantly forced to the conclusion that the condition of the telegraph wires and posts was such that direct telegraphic communication along an unbroken circuit between the two stations was a physical impossibility.

By your instructions, I sent an experienced man along the line between Charleston and Columbia, with proper implements and assistants, to replace insulators, &c., upon the posts, and to replace the wire where it had been lifted out of the insulators by storms; a work which I have reason to believe was accomplished with considerable thoroughness. I had at the time the honor to report the extent of repairs thus made. The facility of communication between Charleston and Columbia was much augmented; but neither then nor at any other time was I able to receive a single signal from Washington, nor Mr. Pourtales one from Charleston. So imperfect, indeed, was the connexion, that on no occasion was the Charleston, and only once the Seaton Station, able to communicate with the telegraph office at Raleigh. Although the operators at the intermediate stations were men of experience and skill, and all of them warmly interested in the success of the enterprise, it appeared desirable to omit no means of guarding against any accidental error in the connexion of the wires for Coast Survey work; and the more, inasmuch as the Bulkley "repeaters" used on this line are very complicated in their arrangement, so that an error of this kind, while it might easily be committed, might also easily escape detection. For this purpose I visited, by your direction, the offices at Raleigh and at Petersburg, and convinced myself, by careful examination, that all the connexions had been correctly made.

It thus became necessary to establish an intermediate station; and one was accordingly erected at Raleigh, N. C., in the grounds of the State-house, permission having been granted by Hon. David S. Reid, governor of the State.

During my charge of the station in Charleston, one hundred and one observations were made for time and instrumental adjustment, and the instrumental peculiarities fully determined.

While the astronomical station at Raleigh was in process of erection, I arranged a series of experiments in continuation of the researches of the late Mr. Walker upon the velocity of transmission of the electro-telegraphic signals, with a view to the still more precise determination of this velocity, of its modifying influences, and the amount of their effect, and especially to the settlement, if possible, of several important theoretical points concerning the mode and medium of their transmission.

By permission of Wm. M. Swain, Esq., president, and Wm. P. Westervelt, Esq., superintendent, of the Magnetic Telegraph Company, four wires of this company, between Washington and New York, were placed at the disposal of the Coast Survey, and these were so connected at the termini as to form one continuous line, which was still further extended towards the south by connecting it with the wire of the Washington and New Orleans Telegraph Company as far as Petersburg, Va.

Experiments were made upon these wires on the nights of March 18 and 22, Dr. Wolcott Gibbs volunteering his assistance in New York, and Professor John F. Frazer in Philadelphia. The reduction of these results is not fully completed, and will be made the subject of a special report.

On the 3d of April I arrived again in Raleigh, and took charge of the station, then nearly completed, setting up C. S. transit instrument No. 3, and zenith telescope No. 1. I was assisted here, as in Charleston, by Mr. Lane, who rendered valuable service in recording, reading, and reducing observations.

As soon as the requisite observations for proper adjustment of the instruments were completed, I satisfied myself, by experiment, that direct communication both with Washington and Charleston was possible, and then commenced a daily exchange of weather-messages with Mr. Pourtales in Washington, and with Professor Gibbes, who assumed the charge of the station in Charleston; and was thus enabled, whenever the weather at Raleigh was favorable and the business of the line did not prevent, to avail myself of a clear sky either at Washington or at Charleston.

None but those who have been personally engaged in the telegraphic determination of differences of longitude between distant stations, can appreciate the numerous and singularly annoying obstacles of every kind, against which it is necessary to contend, many of them of a character which would by no means have been anticipated. I am inclined to believe that in cases where, owing to insufficiency of insulation, or "bad connexions" in the circuit, direct telegraphic communication between distant stations becomes difficult, great advantage might be derived from carrying out your suggestion, that the strength of the transmitted current would be materially increased by an increase in the size of the battery-elements, and that the most efficient battery would be one not much exceeding in the number of its elements that which would suffice on a thoroughly insulated and well-connected line, but in which the extent of generating surface is largely multiplied.

The series of observations was completed on the 14th of May, at which time eighty-four transits of stars had been exchanged with Washington on four nights; fifty-nine exchanged with Charleston on four nights; sixty-five circumpolar stars with reversal, and one hundred and nineteen zenith and equatorial stars observed for instrumental corrections, besides the necessary observations for determining the instrumental constants. These observations are now in course of reduction.

Before passing from this subject, I would avail myself of the opportunity to express my sense of the efficient aid rendered by Messrs. Colton, Dowell, Cameron, Sandford, Lumsden, and DeGrove, operators in charge of the connexions for longitude work at their respective offices. To Mr. L. W. Caldwell, chief operator at the Charleston office, I feel especially indebted, not merely for his uniform courtesy and zeal, but for aid and support, without which the campaign would probably have been much less successful, and certainly much more protracted.

Observations were also made at Raleigh for determining the latitude of the station, the position of which with reference to the State-house was carefully determined. Fifteen pairs of stars were observed with zenith telescope No. 1, and eighty-eight observations made.

On returning North, I again devoted two evenings to observation with Mr. Pourtales, at the Seaton Station in Washington, to obtain our personal difference in registering transits. The comparison with Professor Gibbes, in Charleston, was effected indirectly through the friendly services of Mr. Boutelle, who kindly relieved me from the necessity of visiting Charleston for the purpose, by observing twenty stars with Professor Gibbes in Charleston on the eve of his departure from that city, and again with me in Cambridge immediately after his arrival from Charleston direct.

A number of weeks of the summer have been devoted to a thorough examination and discussion of the results of the Coast Survey observations for the determination of personal equations. The examination and discussion has only been completed for the chronographic observations, upon which I hope soon to be able to present a special report. Some of the chief results were orally communicated to the American Association for the Advancement of Science at its recent meeting in Cleveland. The observations were critically scrutinized, and the greater parts of them re-read. They afford, also, an excellent means of investigating the degree of precision attainable by the American method of observation, and the comparative reliability of the records upon the several kinds of recording apparatus used.

While in Ohio, in attendance upon the meeting of the American Association for the Advancement of Science, I visited Cincinnati, by your direction, to examine the apparatus of Professor O. M. Mitchell, for recording transits of stars. I have already verbally reported to you the results of this examination of an apparatus which has so deservedly added to the reputation of its eminent inventor, and that his well-known ingenuity is still employed in endeavors to increase still further the precision and convenience of the apparatus, which already promises so much.

It is a source of regret that none of the reductions of the year's work are sufficiently advanced to enable me to communicate their results; but the great amount of labor attending them, augmented, probably, by my own want of previous experience in the practical execution of such reductions upon a large scale, renders it impossible.

It has been my privilege to be associated during the greater part of the campaign with Mr. Pourtales, assistant in charge of the Seaton Station, and to his experience, unwearying efforts, and friendly aid, I have been largely indebted since my first connexion with the longitude operations.

I have the honor to remain, with great respect, very faithfully, yours,

B. A. GOULD, Jr.

Professor A. D. Bache,
Superintendent United States Coast Survey.

APPENDIX No. 34.

Report of George P. Bond, Esq., to the Superintendent of the Coast Survey, on the computations of the chronometer expeditions for determining the difference of longitude between Cambridge and Liverpool.

Cambridge, Mass., *September* 30, 1853.

Dear Sir: In compliance with the request contained in your letter of the 2d instant, I communicate the following summary of my reports of April and August last, on the computation of the results of the chronometric expeditions of 1849, 1850, and 1851, between Cambridge and Liverpool.

The transit observations for the determination of the local time, both at Cambridge and Liverpool, had already been reduced in the ordinary course of work at each observatory; but to insure confidence in this element, and especially to guard against any small constant error at either station, they have been re-computed with all possible care, and with express reference to the object to which they were to be applied. In the reduction of the Cambridge observations, the first step was to ascertain the position of the mid-wire in the system of seven wires used in the observations, taking into account the effect of temperature in changing the mutual relation of the wires, and any gradual changes which may have taken place in the interval between July, 1849, and January, 1852. For this purpose sixty transits of Polaris were used. An examination of the probable error of observing the passage of a star over a single wire was made at the same time, from which the following values were obtained:

Declination of star.	
10° 23′	$E = \pm 0.086^s$
12° 42′	.088
38° 39′	.105
50° 03′	.116
51° 30′	.118
62° 33′	.137
74° 46′	.137
81° 31′	± 1.200

The values of a revolution of the micrometer screw were determined by passages of Polaris over whole and half revolutions. Observations for the value of the divisions of the level were twice made during the continuance of the expeditions, and give for one division in seconds of arc, $d = 1''.00 + 0''.0037, (b - 120)$: b being the length of the bubble in divisions of the scale, d will include the proper corrections for temperature. The level error of the Cambridge transit has a mean value through the year of $b = o$, very nearly, and the small variations from this mean follow, with tolerable regularity, a uniform law of annual increase and decrease. The probable error of a single division of the level scale is $\pm 0''.036$. That of an ordinary determination of the inclination of the axis is $\pm 0^s.005$; including errors of figure of the pivots, it is $\pm 0^s.011$. The diameters of the pivots are sensibly equal; that on the illuminated side being least by $0^s.003 \pm 0^s.004$, by sets of levelling in reversed positions of the axis. The probable deviation of the curve described by the axis of collimation of the instrument from a great circle, as far as the indication of the level can be taken as a test, is—

Illumination east $\pm 0^s.009$.
Illumination west ± 0.011.

Reversals on distant marks combined with star transits, give for the effect of irregularities of the pivots upon the collimation and azimuth errors at the north and south horizon $\delta c = 0^s.010 \pm 0^s.012$, and $\delta a = 0^s.033 \pm 0^s.014$.

The apparent places of the stars used for clock and instrumental errors have been derived from a catalogue based upon that of the "Expedition Chronometrique" and the "Positiones Mediæ" of Struve, and upon the "Greenwich Twelve Year Catalogue." Additional authorities were employed for nine of the circumpolar stars. The probable error of the right ascensions of the new catalogue does not surpass $\pm 0^s.03$ for stars south of a declination of 60°.

The azimuth and collimation errors were derived from between five and six hundred equations of condition furnished star transits, each of which was first referred to a common standard of exactness depending on the probable errors of observation, and of the tabular places of the stars, the group being combined by least squares. These were united with one hundred and eleven equations afforded by observation of the meridian marks, and the solution of the whole gave the adopted values of the azimuth and collimation. The following table exhibits the agregate of the probable errors of the azimuth and collimation predicted from the observations of distant terrestrial marks, for the intervals given from the nearest date of observation. They include errors of measuring the angular distances from the mark to the mid-wire, the probable instability of the instrument during the interval, and other sources of uncertainty.

Interval 0.0 days.	$\epsilon = \pm 0^s.006$	Interval 6.0 days.	$\epsilon = \pm 0^s.040$
" 0.1 "	" .012	" 8.0 "	.041
" 1.0 "	" .026	" 10.0 "	.042
" 2.0 "	" .032	" 12.0 "	.042
" 3.0 "	" .035	" 16.0 "	.043
" 4.0 "	$\epsilon = \pm 0.037$	" 20.0 "	$\epsilon = \pm 0.043$

A comparison of all the observations upon the terrestrial marks, shows that the variations of lateral refraction, in the present instance, have a powerful effect of less than $0^s.01$ for all intervals less than an hour.

The personal equations of the observers at Cambridge and Liverpool have been derived from thirty-eight sets of comparisons of twenty passages each.

A copy of the original data employed for the determination of clock errors at Liverpool, has been furnished by Mr. Hartnup for both expeditions. These have been submitted to a thorough examination, following the same order as was pursued with the Cambridge observations. This has been done for the reason already given for repeating the reduction of the latter, to insure entire confidence in the important element of the local time at each station, although, in fact, alterations in essential particulars have, for the most part, been rendered unnecessary by the care taken in the first reduction.

The position of the mid-wire of the Liverpool transit, relatively to the mean of the seven, has been found anew from one hundred and twenty complete transits, the result agreeing perfectly with that employed by Mr. Hartnup. The probable errors of an observed transit have been deduced and employed, together with those of the tabular right ascensions, in assigning the relative weights of clock errors by stars in different declinations. The inclination of the axis of the transit has always been ascertained at least once for each set of star observations, and frequently two or three times. The probable error of a single determination of this element, assumed to indicate the state of the instrument within four hours of the time of observation, is $\pm 0^s.042$. The ordinary values assigned for the inclination of the axis have a probable error of $\pm 0^s.02$. The figure of the pivots has been examined by means of the level by Mr. Hartnup; the correction for inequality of diameters is $+ 0^s.006$ illumination west, to refer the level readings to the mean axis. The use of the instrument about equally in each position of the axis has a tendency to eliminate irregularities of figures in the pivots; in which, however, no indication has been found in comparing results of transits of stars at different altitudes. The collimation error preserved a nearly constant value during both expeditions, never exceeding the amount of $0^s.03$. In deducing anew the clock errors, the right ascensions have been taken from the catalogue before referred to, and all the results have been combined with regard to their probable errors. A special comparison was made for the azimuth and clock errors, by comparing the transits of stars north and south of the zenith. Instances of discrepancies, exceeding the probable errors of the determinations, have always been re-examined. The probable errors of the final results for clock errors, both at Liverpool and Cambridge, do not usually exceed $\pm 0^s.05$ for those dates on which star transits occur.

Having thus obtained the local times at each station for the particular clocks and chronometers used for observing star transits, the next step has been to transfer these results to all the others used on the expeditions; in doing which two sources of error have been considered, besides those due to errors of observations in the transits. 1st, errors in making the comparisons of each chronometer with the standard clock; 2d, irregularities in the rate of the standard clock or chronometers, in the usually short interval between the star observations and the comparisons. The probable amount of these errors has been made a special subject of investigation for the clocks and for each of the comparing chronometers. United with the errors of the transit observations, they indicate, for the probable errors of the values assigned for the errors on mean solar time of each of the expedition chronometers, an amount not ordinarily exceeding $\pm 0^s.06$. The method of ascertaining these errors has been to determine experimentally for each chronometer, from a large number of comparisons, the difference between its true error and its error predicted for the same epoch from a previous knowledge of its rate. This, indeed, seems to be the only proper method of fixing on the individual peculiarities of each chronometer. The same principle has been made use of by Struve in the "Expedition Chronometrique."

Of the remainder of the work, the reductions from sidereal to mean solar time are completed for both stations; and the reductions for the direct and coincidence comparisons will be more than half finished by the first of October. A conclusion of the computations may be anticipated by the first of January.

Respectfully and truly yours,

GEO. P. BOND.

Dr. A. D. BACHE, *Superintendent U. S. Coast Survey.*

APPENDIX No. 35.

Letter from John Hewston, jr., Esq., to the Superintendent of the Coast Survey, reporting the results of analyses of two specimens of deposite taken from the boiler of the Coast Survey steamer Hetzel.

PHILADELPHIA, *April* 30, 1853.

DEAR SIR: The following are the results of the analyses of the two specimens of deposite taken from the boiler of the steamer Hetzel.

The principal mass of the incrustations consists of a fibrous crystalline substance, which the anylysis shows to be anhydrous sulphate of lime, interstratified with a black mass of magnetic oxide of iron, which a powerful microscope shows to be amorphous.

The flat scale contains but a single fine streak of black, which was completely removed from the portion analyzed, and the whitish portion alone, subjected to analysis, gave the result below stated.

The irregular scale contained a much larger proportion of black irregularly stratified; and in order to obtain an average of it, slices were sawed from it at right-angles to the stratification, and roughly crushed. The black portion was then removed, as completely as possible, by a magnet. The remaining light-colored portion, containing a small quantity of black that could not be removed by the magnet, was subjected to analysis, and gave the result as below stated.

By the magnet the irregular scale was found to consist of 17.5 per cent. black portion; 82.5 per cent. light portion.

Under the microscope the black streak consists of white and black particles, irregularly distributed, the black predominating. A very pure piece of black, by analysis, was found to contain 92 per cent. magnetic oxide of iron; 7 per cent. of lime, with a trace of magnesia.

The portion here analyzed was less than 0.5 grain, consequently the per-centage cannot be regarded as absolutely correct.

Analysis of incrustations.

	Flat scale.	Irregular scale.
Lime	30.116	34.692
Magnesia	13.625	4.190
Sulphuric acid	43.931	53.219
Water	7.796	3.064
Chloride of sodium	1.379	1.091
Magnetic oxide of iron	1.111	2.078
Alumina	0.250	0.400
Silica	1.675	0.400
	99.883	99.134

No fluorine could be detected in either assay.

Or, computed in the most probable manner in which the ingredients are combined, the analyses are:

	Flat scale.	Irregular scale.
Sulphate of lime	73.139	84.252
Sulphate of magnesia	1.362	5.489
Hydrate of magnesia	19.098	3.422
Hygroscopic water	1.869	2.002
Chloride of sodium	1.379	1.091
Magnetic oxide of iron	1.111	2.078
Alumina	0.250	0.400
Silex	1.675	0.400
	99.883	99.134

From the very small quantity of alumina, and the large proportion of iron, and from the latter being in the state of magnetic oxide, it is evident that the iron in the assay arises from the oxidation of the boiler.

From inspection of the layers of the irregular piece, it would seem as if the crust had been formed from below as well as from above. The iron has probably been oxidized, forming a scale of rust, which has been displaced by water penetrating beneath it and the incrustation there deposited.

The analyses of the two pieces of scale show a most remarkable difference in the relative amounts of lime and magnesia—the amount of lime differing only a few per cent., whilst the magnesia is more than three times as great in one as in the other. This is very unaccountable, supposing the deposites to come from the same boiler, and consequently from the same water.

By examination of the results of the two analyses, the effect of *high heat*, in the *presence of water*, on sulphate of magnesia, is clearly shown. In the flat scale we find 13.625 magnesia, which would be equivalent to 40.875 sulphate of magnesia, assuming it all to have existed in that state, and there is only 1.362, or one-thirtieth of the whole, left as sulphate, and that twenty-nine thirtieths have been decomposed and converted into hydrate. In the irregular scale the total magnesia is 4.19, equivalent to 12.57 sulphate. The amount of sulphate left in the scale is 5.489, or very nearly five-elevenths of the whole, and only six-elevenths has been decomposed.

In the flat scale, then, which "came from off the arches above the furnace, was nearest the fire," and consequently exposed to a greater heat, we have nearly the whole of the sulphate of magnesia decomposed and converted into hydrate, whilst in the irregular scale, which "came from the bottom of the upper flues," and where the heat was not so intense, we find that only about one-half of the sulphate of magnesia has been decomposed. The chloride of sodium is evidently owing to a small quantity of the sea-water that has adhered to the scale. The earthy matters—silica, iron, and alumina—may be regarded as sedimentary matter from muddy water.

Most respectfully and truly yours,

JOHN HEWSTON, Jr.

Prof. A. D. Bache,
Superintendent United States Coast Survey.

APPENDIX No. 36.

Notes on lithography and lithographic transfers; by Lieutenant E. B. Hunt, Corps of Engineers, assistant in the Coast Survey.

Lithography owes not only its existence, but its possibility, to the fact that several quarries in the vicinity of Munich furnish slabs of a limestone uniform in texture, apparently compact, yet really having a somewhat open grain. Though other localities furnish stones which could be used, the real commerce of lithographic slabs is limited to the Bavarian quarries, especially Pappenheim and Solnhofen. These furnish stones of ordinary sizes quite cheaply, so that new quarries, which are from time to time announced, must encounter a low market at the start, unless they are able to furnish, in all the requisite perfection, the largest sizes used. The qualities of a good stone are homogeneousness, with freedom from veins, specks, and flaws; a yellowish-white or a pearly-gray color which is uniform; a hard, fine, uniform grain; a conchoidal fracture, with a good degree of strength, and a capacity for receiving good grained or polished surfaces, and of being uniformly acted on by acids. The theory of lithography is briefly this: A grained or polished surface of lithographic stone, having a porous structure, absorbs and firmly retains both water and oil, or inks made with oils or fats. Hence, if parts of the stone surface are covered with a drawing in oil or fat, the remaining surface may be wetted without wetting the inked parts, and then if ink be rolled over the stone, it will be turned from the wet parts, and will adhere on the inked parts. Thus any drawing made with fat ink on the stone can have its lines duly charged with ink for printing, while all the rest of the stone continues clear. Impression after impression can thus be taken off by wetting and inking the stone after each printing. In this process the stone is merely the solid support for the ink and water to adhere to, and the whole manipulation has for its object to ink the ink-lines, and them only. If the stone is used when it is too dry, the whole surface takes the ink and prints, thus totally ruining the drawing.

The lithographic press consists essentially of a frame, on which the bed for the stone is so sustained as to run freely on rollers, being thus drawn by a crank movement under a sharp-edged wooden scraper. The tympan, stretched on an iron frame, is a broad leather cover, which folds down upon and protects the stone and paper by directly receiving the wear of the scraper. By a lever movement the scraper is lifted off, when the stone returns to its place after pulling the impression.

There are three distinct methods of drawing on stone—first with a crayon, second with a pen or brush, and third with the dry point or graver. Crayon drawings are made on grained surfaces, ground with sand, but not polished, the quality of the graining requiring to be nicely adapted to the intended subject. The drawing crayons are compounded of some fat basis, usually mutton-tallow and white wax, and of some coloring material, usually lampblack, with some additional ingredients to regulate its consistency. In executing drawings, great care is requisite thoroughly to guard the stone from crayon dust, finger-marks, saliva, &c., which will be found to print. In pen or brush drawing. a liquid ink is used instead of the crayon and in a similar manner, the same precaution being observed to protect the stone. The stones in these cases are carefully polished. The finer the graining or polish, the more delicate may the drawing be made. The dry point or graver cannot produce the finest class of effects, for lines cut in the stone lack the clear, delicate quality which they possess in steel or copper; yet, with sufficient skill, care, and labor, water-lining, hachures, outlines, &c., can be cut with such delicacy and character as to render well extremely fine subjects.

Printing in colors involves the use of two or more stones, with partial drawings on each stone, their number depending on the number of inks to be printed. Each slab has a drawing, covering just the parts intended to receive the particular colored ink used in printing from that stone. Several of the final colors are usually produced by the blending of the overlaying tints. The great difficulty in color printing for fine subjects is, in securing a correct register or overlaying of the successive color impressions. If the paper undergoes any sensible change of dimension during these printings, or if there be any lack of care in placing the sheet on the successive stones, a false superposition results, and hence confusion of outline and incorrect coloring. In large sheets these difficulties are much increased. In all these processes, except that of dry-point engraving, the stone, when the drawing on it is complete, is subjected to the action of a dilute acid, which, acting only on the parts of the face not coated with ink, leaves the inked or printing parts in slight relief, the etching being stopped in time to prevent the relief parts from being eaten away sensibly on their sides. This process is obviously a very critical one, for while its mismangement totally ruins the drawing, its success makes the printing strong and clear. Its utility lies chiefly in its removing all dust from the stone, and in its giving relief, with consequent clearness of impression, to the drawing.

I come now to those lithographic methods in which the drawing is not executed on stone, but is made on paper, steel, or copper, and is thence transferred mechanically and bodily on to the stone. The process of transfer from an engraved stone on to another polished stone, already alluded to, involves no such important peculiarities as to demand special mention here, it being based, indeed, on the same principles as all other transfer processes. The term transfer is applied to stone on whose polished face the ink from an original writing or drawing, or from an impression on paper, has been so thrown down as to admit of printing in the same manner as a drawing first made on stone, thus indefinitely reproducing an original. By this means an unlimited number of copies can be procured from an engraved plate without sensible wear in the engraving. If the engraved surface be small, several transfers may be put on one stone, so as to print several on a sheet, and several such stones can be prepared for printing in a short time, thus presenting peculiar facility for multiplying copies rapidly. Parts from different plates, borders, letter-press notes, views, &c., can be separately printed and put into new combinations during the transfer process, so as to make almost any desired re-arrangement of materials without re-engraving. Indeed, the piecing together of parts from different plates is a too frequent mode of making new maps, in which no single element except the combination is new. Most school atlases are printed by transfer; and generally, when a greater number of impressions is wanted than the engraved plate would give, either an electrotype reproduction of the plate, or a transfer on to stone, must be resorted to, or else the plate must be wholly re-engraved as many times as there will be plates worn out.

In respect to style of work which transfer printing can now give, it is certain that, with equal care, plate printing gives decidedly the best impressions, though it is possible even now, by sufficient care, to print transfer impressions fully equal to the ordinary plate impressions. There can hardly be a doubt that such improvements will in time be made as to render the style of transfer printing nearly as strong and delicate as that of plate printing. The existing imperfections are nearly always due to some discoverable omission of care or lack of skill in managing the numerous details which influence the transferring and printing.

Autographic printing is not now much used, at least in this country, though cases frequently occur in which it is very convenient, or even important. In this method, the writing, drawing, music, or other subject for fac simile, is written or drawn on autographic paper with autographic ink, just as it is to be printed. This manuscript is then placed face downwards on the stone, and run through the press until the ink firmly adheres, when the paper, by wetting, can be smoothly stripped off, leaving the ink behind. On cleaning the stone, it can be printed as usual. As this process requires for its successful application a careful observance of sundry precautions, and a special preparation both of the paper and the ink, all of which belong properly to the professional lithographer, the cases are rare in which amateurs will find an advantage in attempting the preparation of autographic material for the transferer. Indeed, the lithographer would generally prefer to write or draw any subject on the stone rather than to execute it on paper, and then have to make a transfer. For these reasons I need not enlarge on this method.

In the transfer process as applied to copper and steel engraved plates, the following are the chief points requiring attention: First of all, the plates themselves must be in proper condition, and appropriately engraved for transferring. If it is known from the first that a plate is to be printed chiefly by transfer, great care should be taken to insure the clear, firm entering of all fine lines into the metal, while the heavy lines should be cut rather shallow, nearly a uniform depth being used for all the work. Very lightly cut lines are apt to be lost in transferring and printing, while very deep ones hold so much ink that in printing they smash out and spread, giving a blotched and ragged effect. Water-lining, hachures, machine ruling, scales, &c., should be engraved firmly, with the lines not too close, as the slightest spreading of close lines causes them to run together and print as a black mass. It is well, when possible, to avoid placing heavy and light parts together, as they are not apt to harmonize in printing. Clear letters, with firm hair-strokes, with open pointed M's, N's, V's, and open top e's, with the heavy strokes not very broad relative to the light strokes, and in general so cut as to give a rather light and uniform effect, will be found to give better transfers, which will print long numbers without filling in or losing hair-lines. By keeping in mind that transfer impressions are printed from a flat surface, and that the lines have no relief except what the ink produces, and also that when lines spread so as to unite, there is no chance of restoring distinctness, an intelligent engraver can generally avoid those failures of adaptation to transferring which result in blotches or missing lines. Yet this study of adaptation has a greater importance than is generally attached to it, and the routine methods of engravers make a serious obstacle to insuring it proper attention.

In packing plates for transportation, the engraved faces should be well wax-coated, and on this coating a piece of fine paper should be stuck down tightly and the plate then embedded in cotton or paper, free from dust, grit, or lumps. The plates should not be accumulated in contact with each other, and but few should be put in one box, and all of these should be so secured as not to be capable of sliding in their beds. When an engraved plate is to be transferred, all the lines of the engraving should be cleaned, washing, if necessary, with spirits of turpentine, or with a solution of potassa for copper-plates. All scratches or spots in the plane surface should be removed by coaling, in the manner of engravers when removing the burr from engravings, or the burnisher may be used if there be both skill and care.

The ink employed in taking plate-transfer impressions requires to be specially prepared for this use, as the effect of variations in its composition will be greatly to modify the success and printing qualities of the transfer. Its consistency must be so fine and soft that it can be forced into all the engraved lines, and yet the transfer must have its lines clear, sharp, and hard, so that at working temperatures the lines will not spread or break. The composition requires to be varied somewhat, according to the work to be printed. It usually consists of lithographic printing ink, (four parts,) what is called transfer ink, (six parts,) mutton-tallow, (one part,) linseed oil, (two parts,) and weak varnish, (two parts.) The transfer ink is composed of yellow wax, (ten parts,) mutton-tallow, (one part,) white soap, (three parts,) resin, (five parts,) weak varnish, (ten parts,) and lampblack enough to give a sufficient shade, though the less of this the better. Great care is requisite in all lithographic operations to procure pure materials, as the effect of impurities cannot be calculated. The method of inking plates is either that pursued by the copperplate printer, when the transferer possesses the requisite skill, or the following, which is the usual mode: The plate is heated over a stove or furnace until it is hot enough to soften the ink; the ink tampon, firmly held in the hand, is rubbed slowly, with a rocking motion, over the entire engraved surface of the plate, until all the lines are thoroughly charged with ink; then the plate is carefully wiped with several successive rags, until all the surplus ink is removed from the face, great care being taken not to wipe out too much ink from the lines, but so to manage the quantity left in as to give the best relief to all the lines in the impression.

All things being thus ready, an impression is taken with the ordinary copperplate printing press, and in the ordinary manner, though either an unsized China paper or a specially prepared autographic paper is used. The autographic paper is prepared by brushing or sponging over a paper, which moisture does not much affect, a coating of starch or paste, mixed with gum, glue, isinglass, gamboge, and sometimes other ingredients, in proportions varied by each transferer. This paper, when smoothly coated and dried, is delicately moistened between damp blotters for printing, and takes a very perfect impression, in which all the small scratches and clouds of the plate are reproduced. Inspection shows if an impression is proper for transfer; as in that case all the parts are clear and perfect, of a light tone of shade, and of uniform character. Impressions more than a week old are not good for transferring.

Having obtained a satisfactory impression, the transfer proper is then effected. A polished stone of the proper size is carefully dried and bedded on a lithographic press, and all things arranged for printing, the transfer impression being in the mean time moistened slightly between damp blotters. The backing papers are so arranged as to bring all parts under the requisite pressure. If several pieces from different plates are to be combined in transferring, the parts are pasted together so as to present the final arrangement. If several copies of the plate go on one stone, they are transferred in succession. When all is ready, the transfer proof is laid, face downwards, on the stone, the backers and tympan are folded down, and the stone is run under the scraper two or three times, the pressure being increased each time. By this means the ink lines are made to adhere firmly to the stone. When water is applied freely to the back of the transfer proof, the starch or paste preparation on its face becomes so softened as to permit the easy separation of the paper from the stone, leaving the ink lines transferred bodily on the stone. China paper detaches itself and floats off, while autographic paper is readily stripped off. After this the stone is carefully washed until only the ink lines remain. Then it is acidulated, gummed, and thoroughly dried, a short interval being allowed before inking. A weak ink is used for the first inking, and is rolled on very deliberately, the stone being kept well wetted. The stone soon becomes fit to put in the printer's hands, who needs to manage cautiously for the first hundred impressions to avoid injuring the transfer. The first impressions are generally too light or gray, the best impressions being usually the second or third hundred. A good transfer sometimes gives as many as five thousand unimpaired impressions, though usually they become too much worn after about two thousand printings. The printer can, by skill or the lack of it, greatly affect the durability of any transfer, by looking out constantly for incipient defects, and by a uniform, easy manipulation of the ink-roller.

The quality of paper used has a decided effect, both on the clearness of the printing and the duration of the transfer. Soft, thick paper, with little or no sizing, is generally used where strength is not important; but a clear, half-sized paper, not highly calendered, prints very well if it contain no improper ingredients, such as alum or plaster. The paper surface needs to have a slight harshness of feel, or tooth for ink, as it is called, else fine lines are apt to be lost. It is only by a careful selection, both of paper and of ink, that even a good printer can do justice to a fine-engraved plate, while with every possible aid a bad printer will produce very imperfect work; the general shade of his impressions running quite uneven, and portions of his transfer being soon filled in or worn away. The printer must maintain a proper temperature of his stone, cooling it with iced water in hot summer days, and having the room well heated in the winter's cold, or the ink of the transfer will be affected, and blotching will result. Also, the regulating of printing pressure presents considerable difficulty, and needs watchfulness. There are many such details which make the need of an intelligent and energetic supervision one of the first necessities for good lithography.

The process now described is one which, even as it is now practised, must be called eminently useful. Senefelder himself used it, though quite imperfectly, of course; but it is only during the last twenty years that its capacities have been really developed. The rapid improvements it has experienced make it almost certain that before many years more it will have become quite perfect and certain in its results. It is now very far advanced in France—the true home of lithographic art and science—as the maps of departments printed by the government fully establish. The plates of the great topographical survey of the interior of France are re-arranged by transfer into excellent maps of the departments, with special borders and titles, and with full letter-press statistical notes, printed from moveable types, and transferred into the proper spaces. In England and Scotland plate-transfer printing is prosecuted as a business, though with what success I have not the means of knowing. In this country, the great amount of transfer from stone on to stone, in making up checks, bills, labels, &c., supplies many shops with petty jobs in one species of transfer, but a few only are engaged in transferring large steel or copper plates. To do this well requires a man to make plate transferring his business; and otherwise, not only will he fail of success, but he will be apt to seriously injure and deface plates intrusted to his handling. Our principal establishments in which plate-transfer printing is extensively executed are J. Ackerman's, 379 Broadway, New York; D. McLellan's, 26 Spruce street, New York; Wagner & McGuigan's, Franklin square, Philadelphia; and Duval's, Philadelphia.

The plates of the Coast Survey report have been in part printed by each of these establishments, though sometimes the work has furnished but little evidence of skill in managing this process. It was by being for the last two seasons assigned to the charge of inspecting the work on these plates, executed by the two first-named establishments, that I was led to such an acquaintance with the subject as to induce me to make this communication.

APPENDIX No. 37.

Letter of Lieutenant E. B. Hunt, U. S. Corps of Engineers, assistant in the Coast Survey, to the Superintendent, describing an instrument invented and called by him the interranger.

COAST SURVEY OFFICE,
Washington, November 11, 1853.

DEAR SIR: In compliance with your request, I will now present a descriptive and analytical report on the new instrument to which I have given the name of *the interranger.*

This is an exceedingly simple device, having for its main object to facilitate the running of sounding-boats on *lines between signals.* It may also prove valuable to vessels entering harbors, &c., by making available any desirable sailing-line indicated by two marks or signals—one over the bow, and one astern. I am not aware of any means now in use whereby an observer can at a glance, and conveniently, see whether he is on the line joining two opposite stations; and yet, in sounding rivers and narrow bodies of water, this is the case of sounding which most frequently occurs. No small inconvenience is involved in the necessity of prolonging back from the shore all the boat sounding ranges; and in such instances as in the gorge of the Highlands, or where woods come down on flat shores to the water, it becomes virtually impossible to make these prolongations. It was to meet this class of cases, and to enable the steersman of a sounding-boat to keep himself in line *between* fore-and-aft signals, and so to run with certainty from one point to another without prolonging their range, that I devised this interranger.

It consists simply of two plane-mirrors, set at an angle of 90°, and so mounted as to be held in the hand at the distance of about a foot in front of the eye. The angle of junction between the two mirrors being held vertical, the opposite images, which are seen in juxtaposition along the junction, belong to objects on opposite sides, and located in the same vertical plane through the mirror-edges; so that if there be two signal poles or flags which are seen to come together on the edge, the observer is correctly aligned between them. If, when one is on the edge, the other is seen some distance off from it, then he is off the line, and must move in the opposite direction to that in which he looks; and if he can only catch one at a time, he must move forward until the second comes in sight. In steering a boat, if the steersman, in looking to the right, sees only one signal, on this being brought to the edge he must change his course to the right until both come in sight on the edge; and if, when one is on the edge, the other be visible off the edge, he must change his course to the left. By looking first to the right, and then to the left, he can verify his position very closely. The observer should first bring one signal on the edge, and then look for the other image, when he can govern his course according to its appearance or non-appearance.

Fortunately, it does not matter at what angle the eye looks on the edge, as in all cases objects seen in juxtaposition on the edge are in the same right line passing through it. For this reason, if the edge be turned horizontally, and if the eye look down upon it, the line of interrange is still subject to the same conditions. Thus this device will show if an eminence on which the observer stands is high enough to cut off the line of sight between two opposite eminences or points; and hence in reconnaissance it will serve to test the availability for observation of certain lines without going to the limiting stations. The only case in which the use of the interranger, in sounding, will present difficulties, is when the signals are one or both much above the water. In running between such signals the edge requires, for perfect accuracy, to be held vertical, though cases would be very rare when the eye would not give to this verticality all requisite accuracy. In this case the signals come on the edge one above the other, when the alignment is correct. The edge, in fact, always gives the picture of objects, located in a plane through the edge, and making with the two mirrors, respectively, the same angle as the ray from the eye, perpendicular to their common edge.

In preparing this instrument for use, its mounting is encased in a semi-cylinder with solid discs at the ends. The rounded part consists of two small doors, closing with a clasp, which protect the mirrors when not in use. These doors, when folded back, form a very convenient handle. The thumb is inserted between them under an elastic band, while the fingers lightly grasp the doors. The mirrors are about an inch square, and when thus borne on the raised hand, the eye can rapidly sweep over the objects in sight. An arrangement for a staff mounting is readily attached, but for boat use this is unnecessary. I am expecting soon to have a prism of speculum metal introduced in place of the two glass mirrors, and in this form I trust it can, with due care, be used at sea without tarnishing too much. If practicable, this will be better, as it will give a better edge, and as no disarrangement of adjustment will be possible with a solid prism.

A modification of this mirror-combination, by which it will become both an *interranger and an offset instrument,* remains to be executed. For this purpose, one of the mirrors must be extended beyond the other, and a third mirror must be employed to reflect to the eye the image of its pupil when it is on the perpendicular to the interrange line from the edge. By first using the interranger portion, the instrument will be planted at the point where an offset is required. It will then be so turned as that one of the signals is seen on the prolonged mirror-edge from that position of the eye in which its pupil reflection from the third mirror is bisected by the prolonged edge; the eye then looking past the prolonged edge, will see the perpendicular plane just past this edge. Thus the offset direction can be indicated and verified. By removing the eye as far as compatible with distinct vision of the pupil and signal images, the offset line will be more accurately given. A speculum metal prism is also likely to prove most appropriate for this interranger and offset instrument, though the third mirror will doubtless have to be a glass one. The special use of this instrument will be as an aid in surveying those lines, irregular roads, and boundaries, where offsets are employed.

My first idea of an interranger was that of applying the rectangular mirror-combination to the object-glass of the ordinary spy-glass, so that the edge would bisect the field, when the superposed images might be sufficiently distinct to give the desired alignment. Some trials showed that this could be done when the objects were very distinct, and at about equal distances. At quite unequal distances the lack of a special focal adjustment for each view produces too much indistinctness. It was, moreover, difficult to catch the two objects at once. Abandoning this, I tried placing one of the mirrors opposite to each object-lens of an opera-glass; this gave better results, and a larger field, but the lack of two focal adjustments was again felt. It was interesting to observe the degree of independence in the vision of the two eyes. When the two pictures were illuminated about equally, both were very distinct; but when the light on one was very much the strongest, the other faded from sight. I thought that an effect the reverse of stereoscopic could be observed, or that the natural relief of a view was flattened into a plane pictorial appearance. This device offers some advantages for testing the inter-dependence of the two eyes in vision; and I am confident that some additional knowledge of visual psychology might be gained by careful experiments with the interranging opera-glass.

I next tried a combination of camera-lucida prisms, so placed that the two faces towards the eye were in one plane, and that their edges joined. This gave highly perfect results, and made a very satisfactory interrange. By so mounting them as to look through a lens, or by superadding a third mirror to image the pupil of the eye, it would serve also as an offset instrument; but its field is rather limited, and good, correct prisms are too costly. Last of all, I tried the two plane mirrors, which give the simplest possible form of interranger, and on the whole I think quite the best. When properly mounted in this form, it becomes a convenient pocket instrument, which is brought into play with great facility, and is readily borne on the thumb and in the hand for use; a glance gives the desired indication, and it is not difficult to catch sight of the two signals at once. Magnifying power is usually quite superfluous. I found it practicable to observe interranges when riding in an omnibus and over a pavement—a case much less favorable for the purpose than any boat in working weather would offer. A little practice in this, as in using the sextant, is necessary for acquiring facility.

For sounding between signals, for sailing on interrange lines in entering harbors, for interrange and offset surveying, the right-angled prismatic mirror is certainly available, and will probably be found useful: it is, however, still only on trial, and the results must be awaited. It will possibly prove of considerable importance in general navigation, should it afford a sufficiently ready means of interrange-sailing to authorize the incorporation of such lines in sailing directions. The appeal must soon be made to a more extensive experience; and I trust this will confirm all present anticipations.

Yours, truly,

E. B. HUNT,
Lieut. U. S. Engineers, Asst. in Coast Survey.

Professor A. D. BACHE,
Superintendent United States Coast Survey.

APPENDIX No. 38.

Description, by Lieutenant E. B. Hunt, U. S. Corps of Engineers, assistant in the Coast Survey, of the self-registering tide-gauge, arranged for the Coast Survey by Joseph Saxton, Esq.

This gauge has for its object to afford a continuous automatic or mechanical record of the exact time and amount of all the risings and fallings of the water surface, produced, in a limited period, by the various tidal movements at its locality. Due allowance being made for the irregular effect of winds, the ocean level at any point is constant, except for the fluctuations due to the tides. The vertical variations of the surface level, relative to any fixed standard plane, when duly corrected for meteorological conditions, are, therefore, unmixed effects of the general tidal movements, as modified at the locality of observation. In the self registering tide gauge, these vertical oscillations are made to record themselves in a continuous curve, whose ordinates undergo variations proportional to the absolute rise or fall. The corresponding abscissas are also proportional to the times at which these fluctuations of height occur. The record-curve thus presents to the eye a complete picture of the vertical tidal movements during the time of record, as well as a positive measurement of the tide height at each moment of time.

The principle on which the gauge operates, is simple in idea. A float, rising and falling with the tides, is so connected with the recording pencil as to cause it to traverse across the record sheet whenever the float moves vertically. A clock-work moves the record sheet lengthwise under the pencil, and pricks into it the hours and half-hours. From these motions of the pencil and the paper, the record-curve results. In arranging his tide-gauge according to these principles, Mr. Saxton has drawn entirely from his own resources, his design having been matured in 1845, wholly without knowledge of Mitchell's, Moxton's, Hewitson's, Newman's, or any other, so that his construction is in no sense a reproduction of any other gauge. Whatever semblance may exist is due, not to imitation, but to that almost inevitable similitude of results which the same conditions will most naturally produce under different master hands. The gauge, as arranged by Mr. Saxton, is very perfect in its combinations, and it has been found fully adequate to thoroughly reliable recording, when under the charge of a competent person. Its main features will be at once seen on inspecting the drawings. (See Sketch No. 54.)

Two principal movements are provided for in this gauge, the first being a uniform movement, proportional to time, of the record sheet under the pencil, and the second being a transverse movement of the pencil, strictly proportional to the absolute rise or fall of the float.

To give a uniform motion to the sheet of paper, a clock-work is used. The moving parts of the old-fashioned eight-day clocks, with the striking parts taken out, are employed for this purpose, and are found to be well adapted. The clock-work gives a uniform motion of rotation to a cylindrical roller, (R^2) making it revolve once in twelve hours—the connexion between the clock and roller being made by means of a milled-head clamp-screw, on loosening which the roller is freed from the clock. Projecting from the surface of this roller near its extremities, and separated by an interval of one foot, are two circular rows of sharp steel points, twenty-four in each circle, and so placed as to give on the long sheet or fillet, which runs over the roller, two parallel straight lines of half-hourly dots, or punctures, one foot apart, and so arranged that the two dots corresponding to the same time are on the same perpendicular to the lines of dots. These points not only record the time, but they also drag the paper with the revolving roller so firmly as to make slipping nearly impossible, and the dots which they make, when in proper adjustment, correspond exactly in time with the indications of the hands on the clock face. Thus, were the roller for any reason to revolve irregularly, the clock hands would show it at once by an irregular rate. The force derived from the clock-weight for governing the movement of the sheet is almost null, and is so nearly constant that the clock actually keeps a very uniform rate during the whole month in which a sheet is receiving its record-curve. The paper used is a long fillet-shaped sheet, about the thickness of heavy quarto book-paper, the length being so determined as to make a single sheet serve for one month. It is wound up smoothly, by the aid of a crank, on the first roller, (R) which has limiting brass disks on its ends, between which the sheet fits rather closely. The outer end of the paper is then passed over the roller (R^2) connecting with the clock under the light roller, (R^3) which is unshipped for the purpose, and is finally attached to the last roller (R^4) by doubling the end under a small embedded brass bar. The roller above the sheet (R^3) has two small circular grooves around its extremities, into which the points fall as they successively pierce the paper. Two counterpoising weights (E and E) are suspended from the first and last rollers (R and R^4) at their ends farthest from the clock. These serve to keep the paper uniformly well stretched, and the one running down from the receiving roller (R^4) is made enough heavier than the other just to propel the record sheet, thus relieving the clock and insuring the smooth winding up of the paper. All the rollers are made of well-seasoned white pine wood, and their mountings are of brass. A study of the drawings will best show how the clock and rollers connect with the supporting frame, as also the character and dimensions of the frame itself. A wooden box-covering (supposed removed in the drawings) protects the clock movements.

The second principal movement in the gauge is that which originates in the vertical oscillations of the float, and extends to the recording pencil. The float (F) is an air-tight cylindrical or canister-shaped copper box, which is first thoroughly painted for protection. A small ballasting weight is attached to the centre of its bottom. On its top is an eye, in which is fastened the end of a chain, wire, or cord, leading up through the float box. This box is a water-tight wooden case, large enough to permit a free play of the float, and terminating at the bottom in a funnel, with an orifice at its apex, about one-eighth of an inch in diameter, through which the water can pass as rapidly as necessary, but not so freely as to make the float oscillate sensibly with the surface waves. The funnel serves also to discharge any sediment which might otherwise interfere with the float. The bottom of the box extends below lowest low tide, and its top comes up to the level of the floor on which the gauge stands. The wire, chain, or cord, must be made secure against variations in length. The lower portion may well be of copper wire, but of the upper part a length somewhat exceeding the greatest extent of tide range must be adapted to winding on the receiving wheel above (W). Fine silver wire and silver chain have thus far been used for the winding part, but it is hoped that a cord, which will not be too much affected in its length by moisture, &c., may soon be procured. The varying weight of the chain, as it runs off or winds up, at first gave some trouble, and has led to the use either of light silver wire or of a special counterpoise, either of which sufficiently obviates all derangements from varying weights. On the axle of the receiving wheel, (W) a small cylinder (W') is attached. The relation between the circumferences of the wheel and cylinder is so adjusted as to make the entire record-curve fall between the lines of dots. This is done by making the small cylinder radius somewhat less than 1-n^{th} that of the wheel, n being the maximum range of rise or fall expressed in feet. By providing several sizes of cylinders, the same gauge can be used in succession at places where the tides range very unequally. A silver chain attached to, and winding on the cylinder, (W') leads up over a pulley (N) to the small brass frame which carries the pencil (P). A small cord leads from the frame over an opposite pulley to a weight (E''). As the float rises, this weight draws the pencil towards its side of the sheet, and, indeed, keeps the chain and cord always stretched from the weight to the float. On the prolonged axle of the float-wheel is arranged a fusee, or spiral winding-block, from which is suspended a counterpoise to the float-chain, the spiral being so determined as to make the counterpoising perfect, whatever length of chain be unwound. By this means the weight (E'') which draws back the pencil can be reduced to the value most advantageous for the pencil chain. The pencil frame slides freely across the paper on the roll, (g g) and the end bearing the pencil (P) can, at will, be folded back by turning it around the supporting rod as a hinge. A small weight bears down the lead on the paper with the force required for a clear and permanent mark, the bearing being on the top of the time-marking roller (R^3). A soft lead is used, as a hard one soon glazes on the end and slides over the paper without marking.

The two movements now described, with the details requisite for their perfect execution, constitute the whole of the tide-gauge proper. In setting it up for a series of records, there are, however, some other matters requiring attention. First of all, its location should be so chosen as to present correctly the tidal characteristics of its vicinity. Its support should be as solid as practicable, to prevent the irregular effects of shocks and waves in the record, and to save the machinery from jars. There is also a superstructure requisite, of size sufficient to protect the gauge from the weather, and to afford the requisite access for inspecting and regulating its workings. Then the pencil chain has to be so adjusted by two or three days' trial as to give the record-curve a location midway, or nearly so, between the two lines of dots. A staff-gauge is also required to be set up as near by as may be, and the corresponding readings observed. A bench-mark, for permanent reference, must always be carefully established, and the self-registering gauge zero referred to it by means of the staff-gauge and a level. All these points being duly attended to, and the gauge being put in operation by a good mechanic, the duty of the attendant or tidal observer begins.

When the gauge is placed near a wharf which is liable to jars from vessels, a separate framing of pile work should be made for its support. These shocks and jars from the waves, and from vessels touching the wharf, have caused the failure of some of the records by stopping the clock, and otherwise deranging the apparatus.

The difficulties caused by the freezing of the water in the box at the northern stations during the severity of winter, have not entirely been obviated, but experiments are making which it is hoped may lead to their removal.

It is the observer's business, at first, to visit the gauge daily until fully assured that all is proceeding correctly, when a visit every other day will suffice. The duty of supervision involves a careful watch on all the details requisite for the correct working of the mechanical arrangements. The rod must be kept well cleaned, and be oiled neatly once a week, care being taken to remove all surplus oil, and not to touch the pencil frame or paper. In gauges where the float chain is not counterpoised by a weight suspended on a fusee, it may be necessary, in case of very low tides, to add slightly to the pencil counterpoise. The clock must, of course, be punctually wound, and should never be stopped except from an absolute necessity, when the time both of stopping and of starting should be distinctly recorded on the sheet. The clock should keep mean solar time. The observer should record on the sheet the time and date of the first hour-dot on each sheet, and of all stops and starts, the 12 m. hour-dot of the fifth day of each month, H. W. and L. W. respectively on the high and low water edges of the sheet at the beginning and end of the curve, the number and scale of the gauge, the locality of observation, and his own name. In case of any clock derangement which iterrupts the continuity of record, the staff-gauge readings during the break should be entered on the sheet, with a note explanatory of the circumstances. In changing the sheet of paper at the beginning of the month, a time midway between high and low water should be chosen, and the clock should not be stopped.

The sheet should be wound on to the first roller (R) by running it over the light roller, (R^3) and then removing the light roller while it is started on the receiving roller, (R^4.) It is alike important for the observer to do what he can in keeping all the gauge arrangements in perfect order, and to refrain from interfering with matters beyond his mechanical skill.

In reading the record sheets, they are run over a special reading table, which has two flanges—one fixed and one moveable—between which the sheet passes under the reading scale fixed at right-angles to the flanges, and mortised through the moveable one. A transparent scale, on which is drawn a set of slightly converging lines corresponding to the five-minute intervals of a half-hour, is used for taking times intermediate between dots, the divergence serving to make the scale always applicable. By this means very rapid readings are made.

This tide-gauge has been tested by about eighteen months of experience. The minor difficulties encountered during this period are now so generally overcome, that its workings are justly regarded as highly satisfactory. Fourteen gauges have already been put in operation, and a considerable body of curve records has accumulated. Six of these have been sent to the Western coast—three for permanent and three for moveable stations. The advantages of replacing the discontinuous, imperfect, and not always honest reading of the staff-gauge by purely mechanical and continuous records, is so great and obvious, that the self-registering gauge must come more and more into use. It is not here necessary to compare the two methods, as the points of relative advantage are quite apparent.

APPENDIX No. 39.

*Tables for projecting maps, with notes on map projections.**

MAP PROJECTIONS CLASSIFIED AND DEFINED.

That department of descriptive geometry, or analysis, which treats of map and chart projections, has to deal solely with the terrestrial spheroid, and especially with the representation of the parallels and meridians subdividing its surface. As all localities, both on land and sea, are most readily and generally determined by latitude and longitude observations, so it is the most available and universal method, in constructing maps, to refer all positions to meridians and parallels as co-ordinate lines.

If we conceive the earth's surface reticulated by a complete framework of parallels and meridians, it is then the specific and uniform object of all modes of projection to represent these lines on a plane surface, in the most advantageous manner. But, as the spheroid is incapable of direct development on a plane, it only remains to present, in projection, the *best* approximation to similitude in form, relation, and proportional area in the parts of the earth's surface to be represented.

Ptolemy, Lambert, Euler, Lagrange, De L'Isle, Monge, La Croix, Puissant, Henry, Gauss, and others, have treated of projections in more or less detail, and some of them by methods of the highest grasp and compass.† This general problem has led to the following modes of projections, (all technically, though some quite incorrectly so called,) each of which has been used, and most of which possess advantages for some descriptions of maps or charts. This classified synopsis will serve to show more precisely the relative value and precise character of the polyconic projection.

CLASS I.—Perspective projections on planes	Orthographic. Globular, or equidistant. Stereographic. Gnomonic, or central.
CLASS II.—Developed perspective projections	By a tangent cylinder. By a secant cylinder. By a tangent cone. By a secant cone.
CLASS III.—Projections by developing elements	Cassini's. Flamstead's. Bonne's, or the modified Flamstead's. Polyconic, (U S. Coast Survey.)
CLASS IV.—Projections conformed to some arbitrary condition	The flat chart, with equal latitude degrees. The flat chart, with latitudes = radius × sine of latitude. De Lorgna's. Ptolemy's modified conic. Mercator's.

CLASS I.

All simple perspective projections are made by supposing the eye at some particular point, and the plane of projection or representation to be pierced by all the rays, or rays prolonged, between the eye and all points of the parallels and meridians. The curves composed of all these piercing points of rays constitute a perspective projection. A projection is practicable for any possible position of the eye or plane, (except when the eye is in the plane,) but only a few among this infinite number of perspectives are convenient or eligible for construction.

In the *orthographic* projection the eye is assumed at an infinite distance, and the projecting rays are parallel lines to which the plane of projection is perpendicular at any point desired. By this method circles are projected into ellipses, and the outer parts of the projected hemisphere are very much crowded.

---

* The notes on projections were prepared by Lieutenant E. B. Hunt, U. S. Engineers, and the formulæ and tables were arranged by Mr. Charles A. Schott, of the Computing Division.

† Reference on this subject may be made with advantage to the following general treatises: Puissant, "Traité de Topographie," 1805; Henry, "Memoire sur la projection des Cartes," 1810; "Memorial du Depot de la Guerre," Tome II and IV; La Croix, "Precis Astronomique," in "Pinkerton's Geography;" Barbie, Dubocage, and La Croix, vol. I, "Memorial Topographique et Militaire," Francoeur's "Traite de Geodesie;" Gehler, "Physickalisches Worterbuch;" Mayer's "Practical Geometry," 1828; "Littrow's Astronomy," 1812; Narren's "Astronomy and Geodesy," 1845; Jackson's "Chartography," in "Manual of Geographical Science," 1852.

In the *globular* or *equidistant* projection, originated by La Hire, the eye is placed at a distance from the centre of the earth = Radius + sine 45° = $(1 + \sqrt{\frac{1}{2}})$ radius. The plane of projection passes through the centre perpendicular to the central ray. This projection obviates the orthographic contraction or crowding and the stereographic exaggeration in the outer rim of a projected hemisphere.

In the *stereographic* projection, the eye is taken on the surface of the earth at the pole of the great circle used as a plane of projection. Circles are stereographically projected into circles. An increasing exaggeration of parts from the centre outwards is its great defect.

In the *gnomonic* or central projection, the projection is on a tangent plane—the eye is taken at the centre of the sphere. Great circles are gnomonically projected into straight lines, and all small circles into curves of the second order or conic sections. The entire hemisphere cannot thus be projected, and the portions become rapidly exaggerated in receding from the tangent points.

CLASS II.

Instead of projecting directly on planes, an intermediate cylinder or cone is employed in this class to receive the projection which is there developed or rolled out on a tangent plane. The cylinder and cone being the only surfaces which can be developed by simple rolling out, and without elementary resolution, this class always requires the auxiliary use of one of these surfaces, which may be assumed, subject to several different conditions.

The projection on a *tangent cylinder* for development is made by placing the eye at the centre of the earth, and projecting the parallels and meridians on a cylinder tangent around the equator. On development, the parallels and meridians are found projected into perpendicular straight lines.

A *secant cylinder* may be so determined that the entire area of the spherical zone projected shall be exactly equivalent to its projection. These methods are limited in their advantageous application to a moderate equatorial belt.

In projecting perspectively on a *tangent cone* for development, the eye is assumed at the earth's centre, and the cone is taken tangent around the middle parallel of the zone to be projected. On developing this cone, the meridians appear as straight lines radiating from its vertex, and the parallels as circular arcs concentric around this point, the middle parallel being in its true length.

A *secant cone* may be taken which will give two parallels of correct length in the development, and much reduce the distortion of the extreme belts. This method of Ptolemy was revived by Mercator, and was used by De l'Isle in his map of Russia. Murdoch proposed to make the area of the conic frustrum used equal to that of the projected spherical zone—a good condition, though inconvenient in construction. De l'Isle proposed to use a cone, through the limiting parallels. Euler proposed and determined the cone which equalizes the errors and distortion on the central and the two limiting parallels. The use of two conic frustrums—one for the north and one for the south half—has also been attempted, and advocated.

CLASS III.

The class of projections in which positions of the spherical surface are developed by being resolved into their differential elements, which are successively developed, is characterized by a peculiar elegance, and is of the highest importance. By this means, any portion of a spherical or spheroidal surface may be reconstructed on a plane with the most perfect attainable preservation of the relations and dimensions of its parts. This class of projections is far the best for representing limited areas, and can even be extended with advantage in some forms to *mappe-mondes*, or maps of the entire earth's surface.

Cassini's projection is made by first developing the central meridian of the area for projection into a straight line. A series of prime verticals or great circles perpendicular to their central meridian is passed at elementary distances along the meridian arc, all of which circles intersect in the spheric poles of the central meridian. These divide the surface into elementary rectangular isosceles triangles, or sectors, basing on the meridian elements. When the meridian is developed, these elementary triangles are conceived to be carried with it, and then to be severally developed into plane triangular elements. The elementary opening out between these developed areas may be neglected for some distance from the central meridian. Accordingly, a series of perpendicular straight lines through the graduations of the developed central meridian is taken as a substitute for parallels, and may be used as far as the opening out between elements can be neglected. Cassini's Map of France is thus projected; but, as its inaccuracy on the extreme east and west sheets amounts to 150 toises in 40,000, the use of this projection is not to be recommended for areas thus extensive. Du Séjour has developed the theory and formulæ of this method. As parallels of latitude do not enter, the latitudes of places must be derived indirectly, except on the central meridian.

Flamstead's projection is based on a resolution of the earth's surface into elementary zones or rings by parallels of latitude taken at successive elementary distances laid off along the central meridian of the area to be projected. Having developed this centre meridian on a straight line of the plane of projection, a series of perpendiculars is conceived to be erected at the elementary distances along this line. On or between these perpendiculars the elementary zones are conceived to be developed in their correct relations to each other and to the central meridian. Each zone being of uniform width, occupies a constant breadth along its entire developed length, and consequently the area of the plane projection is exactly equal to that of the spheroidal surface thus developed. This demonstration applies directly to an analogous plane development of the surface of all supposable surfaces of revolution, be the generating meridian curve what it may, and even though the generatrix be one of double curvature. The meridians of the developed spheroid are traced through the same points of the parallels in which they before intersected them. They all cut the parallels obliquely, and are concave towards the central meridian. Thus, while each quadrilateral between parallels and meridians contains the same area and points after development as before, the form of configuration is considerably distorted in receding from the central meridian, and the obliquity of intersections between parallels and meridians grows to be highly unnatural.

Bonne's, or the *modified Flamstead's* projection, to a great extent obviates this defect. It is the same as Flamstead's, except that the elementary zones, instead of being developed on right lines, are rolled out on concentric circular arcs described from the vertex of the cone tangent along the central parallels for their common centre. The great importance and wide use of this method induce a more detailed treatment of it under a subjoined heading.

The *polyconic projection*, being that for which the following tables are prepared, will be specially explained further on in its proper place.

CLASS IV.

In addition to the perspective projections, the developed perspective, and the elementary development projections, there is a class in which some extraneous, arbitrary mathematical condition is imposed, giving rise to constrained or distorted delineations. The assumed condition is usually due to some practical consideration.

The *flat-chart* projection, with *equal latitude* degrees, is a rude method once much in use for charts. Two sets of equidistant perpendicular lines, composing a series of equal squares, were arbitrarily assumed as parallels and meridians to which all localities were referred by latitudes and longitudes. Hence resulted a gross distortion of figures, areas, and directions.

Another *flat-chart* projection was sometimes used, in which equidistant straight lines served as meridians; and for parallels a second set of straight perpendiculars at distances from the equator equal to those of the respective terrestrial parallels for which they stand. This is a radial projection on the circumscribing cylinder tangent along the equator, the radii of parallels being the only projecting lines. Hence resulted a very distorted picture, but one in which each quadrilateral contains an area equal to and corresponding with its spherical correlative—a direct result of the relation between the sphere and circumscribing cylinder. This was the sole recommendation of the method.

De Lorgna's projection is chiefly employed as a polar projection of a hemisphere, for which use it is well adapted. A circle is determined equivalent in area to the hemisphere to be projected. Radii drawn to the graduations of its circumference represent meridians. A radius, graduated into ninety equal parts, is sometimes used as the latitude scale; but the chords of the polar distance of the parallels should be always employed. Hence results equality of areas between the projected and resultant quadrilaterals in general. Outlines are traced by latitudes and longitudes, as usual. For projecting a polar hemisphere, this method is most excellent, as rectangular intersection is combined with conservation both of figure and area.

Ptolemy's modified conic projection is made by using the concentric parallels of the pure conic development, and tracing curved or elliptical meridians across these in place of radial lines. By turning the convexities of these curves from the central line, and by skilful choice of curves, much of the distortion due to the extension of extreme parallels in development is obviated. This projection has been much used for maps of Asia, Africa, and America.

Mercator's projection is truly invaluable for navigators in laying long courses when out of sight of land, as these courses are always straight lines on the chart. Meridians are represented by equidistant parallel straight lines, and the parallels by a perpendicular set of parallel straight lines, whose distances from each other increase from the equator towards the poles in precisely the same ratio as the corresponding longitude degrees diminish. This projection results from the development of a cylinder tangent along the equator; the meridians being projected on their tangent elements, and the parallels being assumed as circles of right cross section at distances from the equator equal to the meridian arc of latitude divided by the cosine of the latitude—the earth's compression being neglected. By this means the relation of length between the latitude and longitude measurements on the chart is preserved uniformly the same as it is on the earth's surface. Tables of the increasing degrees have been computed, and are in general use for laying down parallels. Distances and areas are increasingly exaggerated and distorted as this projection is pushed towards the pole, making the scale very variable from point to point of an extended chart; but as the navigator computes his distance run, this variable scale is not by any means so serious a defect as to offset the invaluable facility with which Mercator's principle enables him to run directly from one point to another. For the polar portion of the earth in which this projection totally fails, a central projection can be used to some distance. A projection on Mercator's principle might be made relative to the prime meridian instead of the equator, its prime verticals serving as the equidistant parallels, (as in Cassini's,) and the circles parallel to the prime meridian being projected by the table of increasing degrees. This would require the investigation of the formulæ for conversion of co-ordinates in this case. The parallels and meridians of the earth might then be constructed by points. Another mode would be to make a radial and concentric circular projection around the pole, in which the length of the latitude degree should be deduced from the same condition as in Mercator's method, the divergence of meridians being duly considered. The amount of distortion in Mercator's projection wholly unfits it for land maps; and the variation of its scale in different parts would give rise to endless inconvenience were it applied to any other purpose than that of nautical off-shore charts, in which direction is so much more important than area or distance.

BONNE'S OR THE MODIFIED FLAMSTEAD'S PROJECTION.

This method of projection is that which has been almost universally applied to the detailed topographical maps based on the trigonometrical surveys of the several States of Europe. It was originated by Bonne, was thoroughly investigated by Henry and Puissant in connexion with the map of France, and tables for France were computed by Plessis.

In constructing a map on this projection, a central meridian and a central parallel are first assumed. A cone tangent along the central parallel is assumed, the central meridian is developed on that element of this cone which is tangent to it, and the cone is then developed on a tangent plane. The parallel falls into an arc with its centre at the vertex, and the meridian into a graduated right line. Concentric circles are conceived to be traced through points of this meridian taken at elementary distances along its length. The zones of the sphere lying between the parallels through these points are next conceived to be developed each between its corresponding arcs. Thus, all the parallel zones of the sphere are rolled out on a plane in their true relations to each other and to the central meridian, each having in projection the same width, length, and relation to its neighboring zones, as on the spheroidal surface. As there are no openings between consecutive developed elements, the total area must in this case, and in all like developments of surfaces of revolution, remain wholly unaltered by the development. Each meridian of the projection is so traced as to cut each parallel in the same point in which it intersected it on the sphere.

If the case in hand be that involving the greatest extension of the method, or that of the projection of the entire spheroidal surface, a prime or central meridian must first be chosen, one half of which gives the central straight line of the development, and the other half cuts the zones apart, and becomes the outer boundary of the total developed figure. Next, the latitude of the governing parallel must be assumed; thus fixing the centre of all the concentric circles of development. Having then drawn a straight line and graduated it from 90° north latitude to 90° south latitude, and having fixed the vertex or centre of development on it, concentric arcs are traced from this centre through each graduation. On each parallel the longitude graduations are then laid off, and the meridians are traced through the corresponding points. There results from this process one oblong kidney-shaped figure, which represents the entire earth's surface, and the boundary line of which is the double developed lower half of the meridian first assumed. If the vertex of the governing cone be removed to an infinite distance, the equator becomes the governing parallel, the parallels all fall into straight lines, and Flamstead's projection results. The kidney-shaped figure becomes an elongated oval, with the half meridian for one axis, and the whole equator for the other. A somewhat similar figure is obtained by placing the vertex at the pole, and reducing the tangent cone to a plane. An indented cusp at one end, and a rounding out at the other, will give an approximate pear-shape. Ptolemy's modified conic method reaches its full geometrical result in these forms, derived from the condition of *preserving areas* in tracing meridian curves.

Bonne's method is rarely applied to areas exceeding the limits of a State, but is invaluable for topographical maps of this description. The projection is made at once for the whole territory of the map, and the rectangular system of sheets laid out on the projection. Each sheet is numbered, and the co-ordinates of the corners are determined, so that the co-ordinates of intersection between parallels and meridians falling on each sheet are referred to its neat lines as axes.

This projection preserves in all cases the areas developed without any change. The meridians intersect the central parallel at right-angles; and along this, as along the central meridian, the map is strictly correct. For moderate areas, the intersections approach tolerably to being rectangular. All distances along parallels are correct; but distances along the meridians are increased in projection in the same ratio as the cosine of the angle between the radius of the parallel and the tangent to the meridian at the point of intersection is diminished. Thus, in a full earth projection, the bounding meridian is elongated to about twice its original length. While each quadrilateral of projection preserves its area unchanged, its two diagonals become unequal; one increasing and the other diminishing in receding towards the corners of the map, the greatest inequality being towards the east and west polar corners. Though great circles between stations on the earth are generally projected into curves, the amount of deviation for moderate limits is very slight on a Bonne projection. The scale is nearly uniform over the entire projection, being accurate along the parallels and along their radii, but being too great along one diagonal of the quadrilaterals, and too small along the other. In an area of 120° longitude and 70° latitude, a distance of 7,000 miles is in error but $\frac{1}{35}$th. This projection has thus many excellent qualities for topographical maps; and its defects of oblique intersections of unequal diagonals, and of scales varying with the point of the compass, are not very serious in a limited area, as in the map of France, or that of England and Wales. A special set of tables for each central parallel is required in this method; and the extent of these is so vast as to make impracticable the conception of a universal set of tables. The French tables of Plessis are based on the parallel of 50gr. or 45°, and are available for any area centered on this line, except that the old compression was used in computing them. But to construct tables for Bonne's projection for use in the disconnected local maps of our country was impracticable, as no central parallel could be assumed for them all. Were a general topographical map of the United States to be made, a central parallel might be assumed for that purpose; but even in this case the question should be carefully weighed, whether the Bonne projection would be as desirable as the rectangular polyconic.

THE POLYCONIC PROJECTION,* ITS PROPERTIES AND VARIETIES.

The operations of the Coast Survey being limited to a narrow belt along the seaboard, and not being intended to furnish a map of the country in regular uniform sheets, it is preferred to make an independent projection for each plane-table and hydrographic sheet, by means of its own central meridian. These sheets embrace areas so limited as to exhibit in projection no sensible distortion of figure, and they individually agree with nature far more perfectly than they would if arranged as parts of a rectangular series projected on Bonne's method. In fact, each sheet is projected strictly as a local map, and its connexion with the adjoining sheets is established solely by the points of triangulation. In reductions, including several sheets, the plotting of points is the first step, and the change of scale is then made by corresponding squares. By the aid of the subjoined tables a *rectangular polyconic* projection can at once be made for each locality or subdivision of the United States, or for the United States as a whole.

The name *rectangular polyconic* projection is applied to the method in which each parallel of the spheroid is developed symmetrically from an assumed central meridian by means of the cone tangent along its circumference. Supposing each element thus developed relative to the common central meridian, it is evident that a projection results in which all intersections of parallels and meridians take place at right-angles.

Let the most general case, or that of the entire spheroid, be first assumed, the development being made, for instance, relative to the meridian of Washington. Starting at the north pole, the tangent cone there has then its limiting form, or it coincides with the tangent plane. Taking then the elementary parallels successively southward, the vertex of the moving tangent cone recedes along the prolonged earth's axis, giving to the developed parallels a receding centre and an increasing radius as the latitude diminishes. At latitude 45° the terrestrial and development radii become equal. At the equator the vertex recedes to an infinite distance north, or the cone becomes a cylinder, and the equator falls in a straight line perpendicular to the meridian. On passing to the south the vertex approaches from an infinite distance south, the parallels change their concavity southward, while the curvature, increasing in an inverse order, becomes infinite at the pole, or the polar parallel falls in a point. There results from this process a biaxial figure, with four equal quadrants, the short axis being the rectified Washington meridian, (180° in length) and the long axis being the entire rectified equator, or about twice the length of the shorter one. A re-entering cusp marks the bounding curve at each pole, and the meridian, 180° from Washington, which circumscribes each half of the figure, is elongated on each side to more than twice its original length by the development. Over the entire area of this projection all parallels and meridians intersect at right-angles, and the diagonals of each projected quadrilateral are everywhere nearly equal to each other. The scale on N. and S. lines near the border is somewhat enlarged, but is very correct on E. and W. lines, while along both diagonals it is somewhat enlarged, though nearly equally so on each. On the whole there results from this method much less of local distortion than from Bonne's projection. Equality between the spheroidal and developed areas is not preserved, but the departure from equivalency is not great in amount.

As rectangular intersections and preservation of areas are not both attainable at once, it becomes a question of preference between them in each case. It is also a question whether it might not in some cases be advantageous still further to sacrifice the preservation of areas so as to make the same scale applicable in all azimuths at each point. This would require the longitude degrees to increase from the centre meridian outwards in the same ratio as the corresponding projected meridional degrees. This condition would determine a new polyconic projection, whose scale, from point to point, (an element which in Bonne's, and the simple polyconic projection, is a function both of the central meridian distance, and azimuth) would become a function of the central meridian distance only, and would increase alike in all directions on receding from this line. Such a projection would reduce distortion of local configuration to an absolute minimum, and the areas in projection would be proportional to the squares of their local graphic degrees. This would enable us to take strict account of those irregularities of scale which now lurk in disguise. But it would be a great labor to prepare the tables requisite for its ready use, and there would be some valid objections to its results. In a large topographical map thus projected, the scale of each sheet could be derived and engraved on its plate, making the sheet quite homogeneous on that scale, and perfect in the preservation of its configuration. Were a topographical map of the United States to be undertaken on a liberal scale, this projection might be found superior to any other, as in each sheet areas, dimensions, relations, and rectangular intersections, would be well preserved according to its own scale, giving it the greatest local perfection, while it would also combine correctly in its proper place. It should be stated that this projection is novel and untried.

---

* It is hoped at some future time to present some further information on the history of the polyconic projection, and on the applications of it which have been made, the materials now available for this purpose being too limited to authorize attempting this branch of the subject.

The method of projection in common use in the Coast Survey office for small areas, such as those of plane-table and hydrographic sheets, may be called the *equidistant polyconic*. This ought to be regarded rather as a convenient graphic approximation, admissible within certain limits, than as a distinct projection, though it is capable of being extended to the largest areas, and with results quite peculiar to itself. In constructing such a projection the central meridian and a central parallel are chosen, and they are constructed just as in the rectangular polyconic method. The top or bottom parallel, and a sufficient number of intermediate ones to determine the meridians with proper correctness, are constructed by the tables, and the meridians are drawn. Then starting from the central parallel, the distance to the next parallel is taken from the central meridian and laid off on each other meridian. A parallel is traced through the points thus found. Each parallel is constructed by laying off equal distances on the meridians in like manner, and the tabular auxiliary parallels are, all except the central one, erased. In fact, as only the points of intersection are required, the auxiliary parallels should not be actually drawn. From this process of construction results a projection in which equal meridian distances are everywhere intercepted between the same parallels.

If we conceive this projection extended to include the entire earth, a singular result appears. Taking the equator as the central parallel, all the parallels become concave towards this line; for the distance between parallels measured along the curved meridians being constructed equal to that along the central straight meridian, it is evident that the parallels must converge in receding from the central meridian. The parallel of 90°, or the polar point, becomes extended into a curve, whose length approaches that of the developed equator. It will be seen that each parallel falls nearer the equator than it would in Flamstead's projection, being, indeed, tangent on the equatorial side of the Flamstead perpendicular. Thus, in this method the projected area is less than that of the spheroidal surface. If an equidistant polyconic projection be made on the same central meridian and parallel as a Bonne projection, its area will in like manner be less for each rectangle and for the aggregate; hence this projection, where extended to a great surface, always gives its area too small. It also makes its meridian arcs unduly short, and the extreme parallels much too long; giving a grotesqueness to the polar regions bordering on that of a Mercator projection. The scale becomes in some parts excessively dependent on azimuth; the distortion in the polar corners is very great; the intersections are far from rectangular, and they are so conditioned as not to be readily computed. From these defects, so gross in the developed spheroid, and still great even in a map of the United States, it is clear that the *polyconic-equidistant* projection ought by no means to be extended beyond the most moderate limits. A square degree, on a scale of $\frac{1}{10000}$, may be taken as a limit, beyond which no convenience of graphic construction should induce the use of this approximation. Beyond this limit the *rectangular-polyconic* method should be employed, at least in all Coast Survey projections.

The polyconic method of projection has been developed in the Coast Survey office, and the subjoined tables, prepared for facilitating its use, were there computed, and are now first published.

Formulæ used for the computation of the Projection Tables in use at the Coast Survey office.

The data upon which the tables are founded are derived from a discussion of the magnitude and figure of the earth, commenced by Mr. Bessel in "Schumacher's Astronomishe Nachrichten," No. 333, and continued and corrected in No. 438 of the same work by the same writer.

Formulæ for calculating the elements for the projection of maps

Let a be the equatorial radius;

b the polar radius;

e the eccentricity $= \sqrt{1-\frac{b^2}{a^2}}$;

L the geodetic latitude;

D_m the length, in metres, of a meridional degree;

D_p the length, in metres, of a degree of the parallel;

R_m the radius of curvature in the meridian;

R_p the radius of curvature in the parallel.

Then,

$$R_m = \frac{a(1-e^2)}{(1-e^2 \sin^2 L)^{\frac{3}{2}}} = \frac{1}{B \sin 1''} \qquad B = \frac{(1-e^2 \sin^2 L)^{\frac{3}{2}}}{a(1-e^2)\sin 1''}, \qquad B = \frac{1}{R_m \sin 1''}$$

$$R_p = \frac{a \cos L}{(1-e^2 \sin^2 L)^{\frac{1}{2}}} = \frac{\cos L}{A \sin 1''} \qquad A = \frac{(1-e^2 \sin^2 L)^{\frac{1}{2}}}{a \sin 1''} \qquad A = \frac{\cos L}{R_p \sin 1''}$$

Length of a minute in the meridian $= 60\, R_m \sin 1'' = \frac{60}{B}$.

Length of a minute in the parallel $= 60\, R_p \sin 1'' = \frac{60 \cos L}{A}$.

Tables containing the values of A and B have been computed in this office, forming a part of tables for the computation for differences of geodetic latitudes, longitudes, and azimuths.

The following formulæ may also be used:

$$D_m = 111120^m.619 - 558^m.080 \cos 2L + 1^m.168 \cos 4L - 0^m.002 \cos 6L;$$

$$D_p = 111399^m.675 \cos L - 93^m.212 \cos 3L + 0.116 \cos 5L;$$

or, making $\sin L' = e \sin L$;

$$\log D_p = 5.0465208 + \log. \cos L - \log. \cos L'.$$

Table of constants and their logarithms.

	Logarithms.
$a = 3272077.14$ toises	6.5148235337
$b = 3261139.33$ toises	6.5133693539
1 toise = 1.94903631 metres, (December 10, 1799)	0.2898199300
1 metre = 0.513074074 toises	9.7101800700
$a = 6377397.16$ metres	6.8046434637
$b = 6356078.96$ metres	6.8031892839
$a : b :: 299.1528 : 298.1528$	
$e = 0.081696830$	8.9122052
$e^2 = 0.006674372$	7.8244104
$a^2 = 40671194485356$ metre sq	13.6092869274
$b^2 = 40399739783891$ metre sq	13.6063785678
arc 1″ or sin 1″	4.6855748668
$a\,(1 - e^2)$	6.8017351
111120.619	5.0457946543
111399.675	5.0468839231
a sin 1″	1.4902183305

For the curvature of the parallels we have the following formulæ:

$$\text{Radius of curvature equal tangent ending on the minor axis} = \frac{a \operatorname{cotg} L}{(1 - e^2 \sin^2 L)^{\frac{1}{2}}}.$$

For convenience sake, co-ordinates for the curvature have been computed:

Let x' be the abscissa from the principal meridian;

y the corresponding ordinate;

n the number of minutes of longitude; and

$\frac{1}{2}\theta$ the corresponding angle between the tangent and the chord, at the intersection of the parallel and middle meridian.

Then,

$$\sin \tfrac{1}{2}\theta = 30\, n \sin L \sin 1'';$$

$$x_{,} = 60\ n\ R_p \sin 1'' \cos \tfrac{1}{2}\theta;$$

$$y = 60\, n\, R_p \sin 1'' \sin \tfrac{1}{2}\theta;$$

n minutes on the arc of parallel $= 60\, n\, R_p \sin 1''$, and subtracting $x_{,}$ we obtain $x =$ difference $= (1 - \cos \frac{1}{2}\theta)\, 60\, n\, R_p \sin 1''$. This quantity x is to be laid off in a direction towards the middle meridian; x and y may be expressed in the following convenient form for computation:

$$y = \frac{1800\, n^2 \sin L \cos L \sin 1''}{A};$$

$$x = y\,(15\, n \sin L \sin 1'');$$

which latter formula is very nearly strict; the error $\frac{x^3}{y^2}$ is not perceptible in any of the maps in use. In order to lay off more accurately the lengths of arcs on the parallels in large projections, the length of the chord may be computed.

Explanation of the tables.

TABLE I.—This is a table of constants, for use in the conversion of units.

TABLE II.—To facilitate the conversion of—

A. Metres into statute miles, from 1 to 100,000.
B. Statute miles into metres, from 1 to 100.
C. Metres into yards, from 1 to 100,000.
D. Yards into metres, from 1 to 100,000.
E. Yards into statute miles, from 1 to 100,000.

TABLE III.—Length of a meridian degree for each 5° of latitude, from 20° to 50° latitude, expressed in statute and nautical miles.

TABLE IV.—Length of a longitude degree on each degree parallel, from 17° to 50° latitude, expressed in—

A. Nautical miles.
B. Statute miles.
C. Metres.

TABLE V.—For use in projecting maps covering an extended area. It gives the requisite values of the meridian and parallel arcs, (Table V—A) and of X and of Y, (Table V—B) for 70° in total longitude, on each degree parallel of latitude from 17° to 50° latitude. Taking the meridian of Galveston, or 95° W. of Greenwich, for the central meridian, this table extends 35° E. and 35° W. of it, or from longitude 60° to longitude 130° W. of Greenwich. This embraces the entire United States, Nova Scotia, and about 5° of the Pacific ocean, in the northern United States latitudes. The southern limit, latitude 17°, includes the four principal West India Islands; and the northern limit, latitude 50°, embraces a narrow belt of British America. For projections of so great an extent, the successive parallels and meridians will not be less than a degree apart. This table will be found to suffice for extended maps of the United States, in whole or in part. When a more detailed projection is required, and in all cases of local maps, recourse should be had to the following table:

TABLE VI.—This table presents the requisite lengths of latitude and longitude arcs on meridians, and on parallels, with the corresponding values of X and of Y, for all local projections of large scale, which can be desired between the parallels 24° and 50°. The arcs of parallels are given to seconds for each minute of latitude, and the other elements to a corresponding degree of accuracy. The minuter arcs being only required in using large scales, it was unnecessary further to extend the arcs of parallels. Interpolations may be resorted to if desired.

In Tables V and VI, the arcs on each page, from 1″ to 6″ of longitude, are obtained by shifting the decimal point one place to the left, in the columns from 10″ to 60″.

Graphic construction of polyconic projections—Coast Survey methods.

Having fixed the limits to be covered by the projection, the central meridian is represented by a straight line, as nearly as practicable, through the centre of the sheet. From an assumed starting-point on this line are laid off the successive meridian arcs, as taken from the tables.

Rectangular polyconic method.

Through each point of division on the central meridian, given by these tabular arcs, erect a perpendicular to it by means of a well-tested right-angled ruler, with twenty-four-inch legs, and a hard pencil; or first carefully construct a single accurate perpendicular by sweeping intersecting arcs with the beam-compass, and then draw on each side a parallel to the central meridian, on which lay off the meridian distance from the perpendicular, and draw the parallel lines through the three equidistant points thus obtained for each. Take from the tables for each required point of intersection between parallels and meridians, its appropriate length of arc of parallel, from which subtract the corresponding X. Lay off this difference from the central meridian each way on its proper perpendicular, and erect, towards the pole, at the point so formed; a perpendicular equal to the corresponding value of Y in the tables—its extremity is the point of intersection required. Through all the corresponding points of intersection trace the parallels and the meridians. Erase the auxiliary lines, and write on the margin the numerical latitude and longitude.

The following mode is more rapid and better checked: Lay off first the longest arcs of parallel, and then take the length of a single subdivision of the parallel in a pair of hair-spring dividers, and step it off on the perpendicular to the right and left of the central meridian, being careful not to prick the paper. Having adjusted the dividers so as to bring the extreme points thus obtained to a perfect agreement, prick lightly the subdivision points. Take from the tables the successive values of X for each point, and when these are sensible on the scale used, lay them off back towards the central meridian from the points before obtained, and erect, at the last points, perpendiculars equal to their respective values of Y. As X is always small, and for some entire projections quite insensible, this method is much more convenient than that of all the while using long distances; but the check of a total measurement on each parallel is quite indispensable, as an insensible error in taking the subdivision distances grows, by repetition, to be very evident in the check measurement.

Equidistant polyconic method—(☞ Inadmissible in projections covering more than one square degree.) Proceed as before to graduate the central meridian, and to construct a central parallel. Construct the points of meridian intersection with the top and bottom parallels, and as many intermediate parallels as are requisite closely to determine the meridians. Through these points then draw the meridians. Starting now from the central parallel, lay off on each meridian the distance to the required parallel equal to that on the central meridian, and trace the parallels through these points. Proceed in like manner to construct the others, using always the central parallel as a base, and the totals measured from it along the central meridian in laying off.

This method requires much less recourse to the tables than the other, and is sufficiently accurate, within a square degree, on a scale of $\frac{1}{10000}$. The X and Y may often be neglected as insensible in small projections; but no value of X, which is at all appreciable on the scale used, should be neglected. The Y, for the auxiliary parallels, affects the meridian less rapidly, but its palpably sensible values should always be used.

The following quantities are sensible, yet only barely sensible, on the scales affixed:

12	metres on a scale of		$\frac{1}{80000}$.
10	"	"	$\frac{1}{60000}$.
8	"	"	$\frac{1}{40000}$.
6 or 5	"	"	$\frac{1}{30000}$.
3	"	"	$\frac{1}{20000}$.
[illegible] or 2	"	"	$\frac{1}{10000}$.

These quantities are quite overshadowed in large sheets by the expansion and shrinkage of drawing-paper from day to day. In both methods the X and Y should always be used for good projections when they would be sensible on the scale in use. And it is peculiarly essential to accurate projections that the hygrometric condition of the paper be kept as uniform as possible during all the time that measured distances are being laid down. It is often better to mark simply the intersection points by a small cross +, and to omit the remainder of the parallels and meridians. For plotted points this is also the best indication, if the cross lines are stopped on each side of the point, just far enough off to leave the dot distinct.

For drawing parallels and meridian curves a long, slender, flexible ruler of straight-grained cedar, or other compact wood, is employed. Its cross section is three sixteenths ($\frac{3}{16}$) of an inch by two sixteenths ($\frac{2}{16}$) of an inch. A specially designed steel ruler might be found preferable. There is a small groove on the top of the ruler, and its ruling edge is slightly levelled. Leaden, paper-covered, beak weights, of about 4 pounds weight each, are used to hold the ruler in place from point to point. These are so shaped as not to incommode the hand in ruling, and each has a hooked beak, ending in a knife-edge, turned downwards, which, resting in the ruler groove, throws the main bearing of the weight on the ruler, while its small end rests on the paper. The beak weights in use are five (5) inches long, two and one-eighth ($2\frac{1}{8}$) wide, and two and one-eighth ($2\frac{1}{8}$) deep, the beak being five-eighths ($\frac{5}{8}$) of an inch long, and turned down one-fourth ($\frac{1}{4}$) inch. The mass of lead is nearer the beak end. Having placed the ruler approximately, it is so adjusted under a beak weight to the first point that the curve will be ruled exactly through it. It is then adjusted under a second weight to the next point, and then bent to the next in like manner, and so on until the entire curve is completed. Before ruling this the eye should criticise it carefully, as a check on graphic errors. For fine projections the hardest pencils are best; and in inking, the lines should be drawn as delicately as clearness permits.

When no metre scale is at hand, the tabulated distances can be converted into yards by Table II, or by the constants of Table I; or, when the greatest accuracy is not important, a metre scale can readily be constructed from a yard or foot scale by proportionality. Thus, rule two parallel scales, one of yards and one of five-sixths ($\frac{5}{6}$) yards, and draw a third parallel, whose distance outside the yard scale is $\frac{3.2882}{6}$th of that between the yard and five-sixths yard scales. Through the similar graduations draw straight lines; these will give a metre scale by their intersections. If space permits, a point may be substituted for the five-sixths ($\frac{5}{6}$) yard scale. The projection once constructed, may be used independent of the unit of the tables.

TABLE I.

Relation between the measures of length used in different countries.

Derived from 1 metre at 32° Fah. = 39.36850535 U. S. standard inches at 62° Fah.

Units.	American feet.	English feet.	Metres.
American yard	3.	3.00017409	0.91443654
American foot	1.	1.00005803	0.30481218
English yard	2.99982591	3.	0.91438347
English foot, (Kater's value)	0.99994197	1.	0.30479449
Metre	3.28070878	3.28089917	1.
French toise	6.394219	6.394590	1.9490366

TABLE II.—A.

Table for converting metres into statute miles.

1 metre = 0.000621346 mile.

[6.7933335.]

Metres.	Miles.	Metres.	Miles.	Metres.	Miles.	Metres.	Miles.
100000	62.135	....	....	....	....	....	....
90000	55.921	9000	5.592	900	0.559	90	0.056
80000	49.708	8000	4.971	800	0.497	80	0.050
70000	43.494	7000	4.349	700	0.435	70	0.044
60000	37.281	6000	3.728	600	0.373	60	0.037
50000	31.067	5000	3.107	500	0.311	50	0.031
40000	24.854	4000	2.485	400	0.249	40	0.025
30000	18.640	3000	1.864	300	0.186	30	0.019
20000	12.427	2000	1.243	200	0.124	20	0.012
10000	6.213	1000	0.621	100	0.062	10	0.006

TABLE II.—B.

Table for converting statute miles into metres.

1 mile = 1609.40831 metres.

[3.2066665.]

Miles.	Metres.	Miles.	Metres.	Miles.	Metres.	Miles.	Metres.
100	160940.83	....	....	....	....	....	....
90	144846.75	9	14484.68	0.9	1448.47	0.09	144.85
80	128752.66	8	12875.27	0.8	1287.53	0.08	128.75
70	112658.58	7	11265.86	0.7	1126.59	0.07	112.66
60	96564.50	6	9656.45	0.6	965.65	0.06	96.56
50	80470.41	5	8047.04	0.5	804.70	0.05	80.47
40	64376.33	4	6437.63	0.4	643.76	0.04	64.38
30	48282.25	3	4828.23	0.3	482.82	0.03	48.28
20	32188.17	2	3218.82	0.2	321.88	0.02	32.19
10	16094.08	1	1609.41	0.1	160.94	0.01	16.09

TABLE II.—C.

Table for converting metres into yards.

1 metre = 1. 09356959 yard.

[0. 0388464.]

Metres.	Yards.	Metres.	Yards.	Metres.	Yards.	Metres.	Yards.	Metres.	Yards.
100000	109356. 96								
90000	98421. 26	9000	9842. 13	900	984. 21	90	98. 42	9	9. 84
80000	87485. 57	8000	8748. 56	800	874. 86	80	87. 49	8	8. 75
70000	76549. 87	7000	7654. 99	700	765. 50	70	76. 55	7	7. 65
60000	65614. 18	6000	6561. 42	600	656. 14	60	65. 61	6	6. 56
50000	54678. 48	5000	5467. 85	500	546. 79	50	54. 68	5	5. 47
40000	43742. 78	4000	4374. 28	400	437. 43	40	43. 74	4	4. 37
30000	32807. 09	3000	3280. 71	300	328. 07	30	32. 81	3	3. 28
20000	21871. 39	2000	2187. 14	200	218. 71	20	21. 87	2	2. 19
10000	10935. 70	1000	1093. 57	100	109. 36	10	10. 94	1	1. 09

TABLE II.—D.

Table for converting yards into metres.

1 yard = 0. 91443654 metre.

[9. 9611536.]

Yards.	Metres.	Yards.	Metres.	Yards.	Metres.	Yards.	Metres.	Yards.	Metres.
100000	91443. 65								
90000	82299. 29	9000	8229. 93	900	822. 99	90	82. 30	9	8. 23
80000	73154. 92	8000	7315. 49	800	731. 55	80	73. 16	8	7. 32
70000	64010. 56	7000	6401. 06	700	640. 11	70	64. 01	7	6. 40
60000	54866. 19	6000	5486. 62	600	548. 66	60	54. 87	6	5. 49
50000	45721. 83	5000	4572. 18	500	457. 22	50	45. 72	5	4. 57
40000	36577. 46	4000	3657. 75	400	365. 78	40	36. 58	4	3. 66
30000	27433. 10	3000	2743. 31	300	274. 33	30	27. 43	3	2. 74
20000	18288. 73	2000	1828. 87	200	182. 89	20	18. 29	2	1. 83
10000	9144. 37	1000	914. 44	100	91. 44	10	9. 14	1	0. 91

TABLE II.—E.

Table for converting yards into miles.

1 yard = 0. 000568182 mile.

[6. 7544873.]

Yards.	Miles.	Yards.	Miles.	Yards.	Miles.	Yards.	Miles.
100000	56. 818						
90000	51. 136	9000	5. 114	900	0. 511	90	0. 051
80000	45. 455	8000	4. 545	800	0. 455	80	0. 045
70000	39. 773	7000	3. 977	700	0. 398	70	0. 040
60000	34. 091	6000	3. 409	600	0. 341	60	0. 034
50000	28. 409	5000	2. 841	500	0. 284	50	0. 028
40000	22. 727	4000	2. 273	400	0. 227	40	0. 023
30000	17. 045	3000	1. 705	300	0. 170	30	0. 017
20000	11. 364	2000	1. 136	200	0. 114	20	0. 011
10000	5. 682	1000	0. 568	100	0. 057	10	0. 006

Blank page retained for pagination

Blank page retained for pagination

TABLE V.—B.

Co-ordinates of curvature for each degree of longitude, from 1° to 35°, between the latitudes 17° and 50°.

Degrees of longitude.	Latitude 17°.		Latitude 18°.		Latitude 19°.		Latitude 20°.		Latitude 21°.		Latitude 22°.		Latitude 23°.	
	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.
°	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*
1	0	272	0	286	0	299	0	312	1	325	1	338	1	350
2	3	1,087	3	1,142	3	1,196	4	1,249	4	1,300	4	1,350	5	1,398
3	9	2,445	10	2,570	11	2,692	13	2,811	14	2,926	15	3,038	16	3,146
4	22	4,347	25	4,569	27	4,786	30	4,997	33	5,202	35	5,400	38	5,593
5	43	6,792	48	7,139	53	7,478	58	7,808	64	8,127	69	8,438	75	8,738
6	75	9,780	83	10,280	92	10,768	101	11,243	110	11,704	119	12,151	129	12,583
7	119	13,311	132	13,992	146	14,657	160	15,303	174	15,931	189	16,539	204	17,127
8	178	17,386	197	18,276	218	19,143	239	19,987	260	20,807	282	21,602	305	22,370
9	253	22,004	281	23,130	310	24,228	339	25,296	370	26,334	402	27,340	435	28,312
10	347	27,166	385	28,556	425	29,911	466	31,230	509	32,511	552	33,753	596	34,954
11	461	32,871	512	34,552	566	36,193	620	37,789	677	39,339	734	40,841	793	42,294
12	599	39,119	666	41,120	734	43,072	805	44,972	879	46,816	953	48,604	1,030	50,333
13	762	45,910	846	48,260	934	50,550	1,024	52,779	1,117	54,944	1,212	57,043	1,310	59,072
14	951	53,245	1,056	55,970	1,166	58,626	1,279	61,211	1,395	63,722	1,514	66,156	1,635	68,510
15	1,170	61,123	1,300	64,251	1,434	67,300	1,573	70,268	1,716	73,150	1,862	75,944	2,011	78,646
16	1,420	69,545	1,577	73,103	1,740	76,573	1,909	79,950	2,082	83,229	2,260	86,408	2,441	89,482
17	1,703	78,510	1,892	82,526	2,088	86,443	2,290	90,255	2,498	93,958	2,711	97,546	2,928	101,016
18	2,021	88,017	2,246	92,521	2,478	96,912	2,719	101,186	2,965	105,337	3,218	109,360	3,475	113,250
19	2,377	98,069	2,641	103,087	2,914	107,980	3,197	112,741	3,487	117,366	3,784	121,849	4,087	126,183
20	2,772	108,664	3,080	114,224	3,399	119,645	3,729	124,921	4,067	130,045	4,414	135,013	4,767	139,815
21	3,210	119,801	3,566	125,932	3,935	131,909	4,316	137,725	4,708	143,375	5,110	148,851	5,519	154,146
22	3,690	131,483	4,100	138,207	4,524	144,770	4,963	151,155	5,413	157,355	5,875	163,364	6,345	169,176
23	4,217	143,708	4,685	151,061	5,170	158,230	5,671	165,210	6,185	171,985	6,713	178,554	7,251	184,905
24	4,791	156,475	5,323	164,482	5,874	172,289	6,443	179,886	7,028	187,266	7,627	194,418	8,238	201,334
25	5,415	169,787	6,016	178,474	6,639	186,945	7,282	195,189	7,913	203,196	8,620	210,957	9,312	218,461
26	6,091	183,641	6,767	193,038	7,468	202,200	8,192	211,116	8,935	219,777	9,697	228,171	10,474	236,287
27	6,821	198,040	7,579	208,172	8,364	218,052	9,174	227,668	10,006	237,008	10,859	246,060	11,730	254,813
28	7,608	212,980	8,452	223,878	9,328	234,504	10,231	244,845	11,160	254,889	12,111	264,624	13,082	274,037
29	8,452	228,465	9,391	240,155	10,363	251,553	11,367	262,646	12,399	273,421	13,455	283,863	14,534	293,961
30	9,357	244,493	10,396	257,003	11,472	269,201	12,584	281,072	13,726	292,602	14,896	303,777	16,090	314,584
31	10,324	261,064	11,470	274,422	12,658	287,447	13,885	300,122	15,145	312,431	16,436	324,367	17,753	335,906
32	11,356	278,180	12,617	292,412	13,923	306,291	15,272	319,797	16,658	332,916	18,078	345,631	19,527	357,926
33	12,454	295,837	13,837	310,973	15,270	325,733	16,749	340,097	18,270	354,049	19,827	367,571	21,416	380,646
34	13,621	314,038	15,133	330,106	16,700	345,774	18,318	361,022	19,981	375,832	21,684	390,185	23,422	404,065
35	14,859	332,782	16,508	349,809	18,218	366,413	19,982	382,570	21,796	398,264	23,654	413,475	25,550	428,183

TABLE V—B.—*Co-ordinates of curvature for each degree of longitude, &c.*—Continued.

Degrees of longitude.	Latitude 24°.		Latitude 25°.		Latitude 26°.		Latitude 27°.		Latitude 28°.		Latitude 29°.		Latitude 30°.	
	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.
0	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*
1	1	361	1	372	1	383	1	393	1	403	1	412	1	421
2	5	1,445	5	1,489	6	1, 32	6	1,573	7	1,612	7	1,649	7	1,684
3	17	3,250	19	3,350	20	3,447	21	3,539	22	3,626	24	3,710	25	3,789
4	41	5,778	44	5,956	47	6,127	50	6,291	53	6.447	56	6,595	59	6,735
5	80	9,028	86	9,307	92	9,574	97	9,830	103	10,073	109	10,305	115	10,524
6	138	13,000	148	13,401	158	13,786	168	14,154	178	14,506	188	14,839	198	15,154
7	220	17,695	235	18,241	251	18,765	267	19,266	283	19,744	299	20,198	315	20,627
8	328	23,112	351	23,825	375	24,509	399	25,164	423	25,788	446	26,380	470	26,941
9	467	29,251	500	30,153	534	31,020	568	31,848	602	32,638	636	33,388	669	34,097
10	641	36,112	686	37,226	732	38,296	779	39,319	825	40,293	872	41,219	918	42,095
11	853	43,696	914	45,044	975	46,338	1,037	47,575	1,099	48,755	1,161	49,875	1,222	50,935
12	1,107	52,001	1,186	53,606	1,266	55,146	1,346	56,618	1,426	58,022	1,507	59,356	1,587	60,617
13	1,408	61,029	1,508	62,913	1,6 9	64,720	1,711	66,448	1,813	68,095	1,916	69,660	2,018	71,141
14	1,759	70,780	1,881	72,964	2,010	75,060	2,137	77,061	2,265	78,975	2,393	80,789	2,520	82,506
15	2,163	81,252	2,317	83,759	2,472	86,165	2,629	88,466	2,786	90,630	2,943	92,743	3,100	94,714
16	2,625	92,447	2,816	95,300	3,000	98,037	3,190	100,655	3,381	103,151	3,571	105,521	3,762	107,763
17	3,149	104,364	3,372	107,584	3,600	110,674	3,827	113,630	4,055	116,447	4,284	119,123	4,512	121,655
18	3,738	117,003	4,003	120,614	4,272	124,078	4,542	127,392	4,814	130,550	5,085	133,550	5,356	136,388
19	4,396	130,364	4,708	134,387	5,024	138,247	5,342	141,940	5,661	145,459	5,981	148,801	6,299	151,963
20	5,127	144,449	5,492	148,906	5,860	153,182	6,231	157,273	6,603	161,173	6,976	161,877	7,317	168,380
21	5,935	159,254	6,357	161,167	6,784	168,884	7,213	173,394	7,644	177,693	8,075	181,777	8,505	185,639
22	6,824	174,782	7,309	180,176	7,800	185,351	8,293	190,300	8,789	195,019	9,284	199,501	9,779	203,740
23	7,798	191,033	8,352	196,928	8,912	202,584	9,476	207,994	10,066	213,151	10,6[illegible]9	218,050	11,174	222,683
24	8,869	208,005	9,490	214,424	10,126	220,583	10,767	226,473	11,410	232,089	12,054	237,4[illegible]3	12,696	242,468
25	10,014	225,700	10,726	232,665	11,445	239,348	12,170	245,739	12,897	251,833	13,624	257,620	14,349	263,094
26	11,264	244,117	12,065	251,651	12,874	258,878	13,689	265,792	14,507	272,382	15,325	278,642	16,141	284,563
27	12,615	263,257	13,512	271,381	14,418	279,175	15,330	286,639	16,246	293,738	17,162	300,488	18,076	306,873
28	14,069	283,118	15,069	291,855	16,080	300,238	17,097	308,255	18,119	315,899	19,141	323,160	20,160	330,026
29	15,631	303,702	16,742	313,074	17,865	322,066	18,995	330,667	20,130	338,866	21,266	346,654	22,398	354,019
30	17,304	325,008	18,535	335,038	19,778	344,660	21,029	353,865	22,286	362,630	23,542	370,973	24,796	378,856
31	19,093	347,036	20,450	357,746	21,822	368,021	23,203	377,849	24,589	387,218	25,976	396,117	27,359	404,534
32	21,091	369,787	22,494	381,199	24,003	392,147	25,522	402,620	27,046	412,603	28,572	422,085	30,093	431,053
33	23,031	393,200	24,669	405,396	26,324	417,039	27,990	428,176	29,662	438,793	31,335	448,877	33,004	458,416
34	25,190	417,455	26,981	430,337	28,790	442,697	30,612	454,520	32,441	465,790	34,271	476,494	36,096	486,619
35	27,478	442,372	29,432	456,024	31,406	469,121	33,394	481,649	35,389	493,592	37,385	504,935	39,375	515,665

TABLE V—B.—*Co-ordinates of curvature for each degree of longitude, &c.*—Continued.

Degrees of longitude.	Latitude 31°.		Latitude 32°.		Latitude 33°.		Latitude 34°.		Latitude 35°.		Latitude 36°.		Latitude 37°.	
	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.
0	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres*	*Metres.*	*Metres.*
1	1	429	1	437	1	444	1	451	1	457	1	462	1	468
2	8	1,717	8	1,748	8	1,776	9	1,803	9	1,827	10	1,850	10	1,870
3	26	3,863	27	3,932	28	3,997	30	4,057	31	4,112	32	4,162	33	4,207
4	62	6,867	65	6,991	68	7,106	70	7,212	73	7,310	76	7,399	79	7,479
5	121	10,730	126	10,923	132	11,103	137	11,269	143	11,422	148	11,561	153	11,686
6	208	15,451	218	15,729	228	15,988	237	16,228	247	16,448	256	16,647	265	16,827
7	331	21,031	347	21,409	362	21,762	377	22,088	392	22,387	407	22,659	421	22,903
8	494	27,469	517	27,963	540	28,424	563	28,849	585	29,240	607	29,595	628	29,915
9	703	34,765	736	35,391	769	35,974	802	36,513	834	37,007	865	37,456	895	37,861
10	965	42,920	1,011	43,692	1,055	44,412	1,100	45,077	1,143	45,688	1,186	46,243	1,227	46,742
11	1,284	51,933	1,345	52,868	1,405	53,738	1,464	54,544	1,522	55,282	1,579	55,954	1,634	56,558
12	1,667	61,805	1,746	62,917	1,824	63,953	1,901	64,911	1,976	65,790*	2,049	66,590	2,121	67,308
13	2,119	72,535	2,220	73,840	2,319	75,056	2,416	76,180	2,512	77,212	2,606	78,151	2,697	78,994
14	2,647	84,123	2,772	85,637	2,896	87,047	3,018	88,351	3,138	89,548	3,254	99,636	3,368	91,614
15	3,255	96,570	3,410	98,308	3,562	99,927	3,712	101,424	3,859	102,798	4,003	104,047	4,142	105,169
16	3,951	109,875	4,138	111,853	4,323	113,694	4,505	115,398	4,684	116,961	4,858	118,342	5,027	119,659
17	4,739	124,038	4,963	126,271	5,185	128,350	5,404	130,273	5,618	132,038	5,827	133,642	6,030	135,084
18	5,625	139,060	5,892	141,563	6,155	143,894	6,414	146,050	6,669	148,029	6,917	149,827	7,158	151,443
19	6,616	154,941	6,949	157,730	7,239	160,327	7,544	162,729	7,843	164,933	8,135	166,937	8,417	168,738
20	7,716	171,679	8,082	174,770	8,443	177,647	8,799	180, 3·9	9,147	182,752	9,488	184,972	9,819	185,967
21	8,932	189,276	9,356	192,683	9,774	195,856	10,185	198,791	10,589	201,484	10,983	203,932	11,367	206,132
22	10,270	207,732	10,757	211,471	11,233	214,953	11,711	218,174	12,175	221,130	12,629	223,816	13,066	226,230
23	11,735	227,046	12,292	231,133	12,841	234,939	13,382	238,459	13,912	241,639	14,430	244,625	14,934	247,264
24	13,334	247,218	13,966	251,668	14,590	255,812	15,205	259,645	15,807	263,162	16,395	266,350	16,968	269,233
25	15,071	268,249	15,785	273,077	16,491	277,574	17,185	281,733	17,865	285,550	18,531	289,020	19,178	292,136
26	16,952	290,138	17,756	295,369	18,549	300,223	19,331	304,722	20,097	308,850	20,845	312,602	21,573	315,974
27	18,985	312,885	19,885	318,518	20,774	323,762	21,649	328,613	22,506	333,065	23,344	337,111	24,159	340,748
28	21,173	336,491	22,177	342,548	23,169	348,189	24,144	353,406	25,100	358,194	26,055	362,545	26,944	366,456
29	23,524	360,956	24,639	367,453	25,740	373,504	26,824	379,100	27,887	384,235	28,925	388,904	29,935	393,099
30	26,042	386,278	27,277	393,232	28,496	399,707	29,696	405,697	30,873	411,191	32,022	416,187	33,140	420,676
31	28,734	412,460	30,096	419,884	31,442	426,798	32,766	433,193	34,064	439,061	35,332	444,395	36,566	449,189
32	31,606	439,499	33,104	447,410	34,584	454,777	36,040	461,592	37,468	467,844	38,863	473,528	40,219	478,636
33	34,662	467,397	36,306	475,810	37,928	483,645	39,526	490,892	41,091	497,541	42,621	503,586	44,109	509,018
34	37,919	496,153	39,707	505,094	41,482	513,101	43,229	521,093	44,911	528,152	46,614	534,570	48,242	540,335
35	41,354	525,768	43,315	535,234	45,251	514,045	47,156	552,198	49,025	559,677	50,849	566,477	52,625	572,587

TABLE V—B.—*Co-ordinates of curvature for each degree of longitude, &c.*—Continued.

Degrees of longitude.	Latitude 38°.		Latitude 39°.		Latitude 40°.		Latitude 41°.		Latitude 42°.		Latitude 43°.		Latitude 44°.	
	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.
°	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*
1	1	472	1	476	1	479	1	482	1	484	1	485	1	486
2	10	1,887	10	1,903	11	1,916	11	1,927	11	1,935	12	1,941	12	1,945
3	34	4,247	35	4,281	36	4,311	37	4,335	38	4,354	39	4,367	40	4,375
4	81	7,549	84	7,611	86	7,663	88	7,706	90	7,740	92	7,764	94	7,779
5	158	11,796	163	11,892	168	11,974	172	12,041	177	12,093	180	12,131	184	12,154
6	274	16,986	282	17,125	290	17,242	298	17,339	305	17,414	312	17,469	318	17,502
7	435	23,120	448	23,308	462	23,469	473	23,600	484	23,703	495	23,777	505	23,822
8	649	30,198	669	30,444	688	30,653	706	30,824	723	30,959	739	31,055	754	31,114
9	925	38,219	952	38,530	979	38,795	1,005	39,012	1,030	39,182	1,053	39,304	1,074	39,378
10	1,267	47,184	1,306	47,568	1,343	47,895	1,379	48,163	1,412	48,373	1,444	48,524	1,474	48,615
11	1,687	57,092	1,739	57,558	1,788	57,953	1,835	58,278	1,880	58,531	1,922	58,713	1,961	58,825
12	2,190	67,944	2,257	68,498	2,321	68,969	2,382	69,355	2,440	69,657	2,495	69,874	2,546	70,006
13	2,785	79,740	2,870	80,390	2,951	80,942	3,029	81,396	3,103	81,750	3,172	82,005	3,237	82,160
14	3,478	92,480	3,585	93,234	3,686	93,874	3,783	94,400	3,875	94,811	3,962	95,107	4,043	95,286
15	4,278	106,164	4,408	107,029	4,534	107,764	4,653	108,367	4,767	108,839	4,873	109,178	4,973	109,385
16	5,192	120,790	5,350	121,775	5,502	122,611	5,647	123,298	5,785	123,835	5,914	124,221	6,036	124,455
17	6,227	136,361	6,417	137,472	6,600	138,416	6,774	139,192	6,939	139,798	7,094	140,234	7,240	140,499
18	7,392	152,875	7,618	154,121	7,833	155,180	8,041	156,049	8,237	156,728	8,421	157,217	8,594	157,514
19	8,694	170,333	8,959	171,722	9,216	172,901	9,457	173,869	9,687	174,626	9,904	175,171	10,107	175,502
20	10,140	188,735	10,450	190,273	10,744	191,580	11,030	192,653	11,299	193,492	11,552	194,095	11,788	194,462
21	11,738	208,081	12,097	209,776	12,440	211,217	12,768	212,400	13,080	213,325	13,372	213,990	13,646	214,394
22	13,496	228,369	13,908	230,230	14,304	231,811	14,681	233,110	15,038	234,125	15,375	234,855	15,690	235,299
23	15,422	249,602	15,892	251,636	16,344	253,364	16,775	254,784	17,184	255,893	17,569	256,691	17,929	257,176
24	17,522	271,778	18,057	273,993	18,570	275,875	19,059	277,420	19,524	278,628	19,961	279,497	20,370	280,025
25	19,805	294,898	20,409	297,302	20,989	299,343	21,542	301,020	22,068	302,331	22,562	303,273	23,024	303,846
26	22,278	318,962	22,958	321,562	23,610	323,770	24,232	325,584	24,823	327,001	25,379	328,021	25,899	328,640
27	24,947	343,969	25,710	346,773	26,440	349,154	27,137	351,110	27,805	352,639	28,421	353,738	29,004	354,407
28	27,824	369,921	28,674	372,936	29,488	375,496	30,266	377,600	31,003	379.244	31,698	380,426	32,347	381,145
29	30,913	396,815	31,857	400,049	32,762	402,796	33,626	405,053	34,445	406,816	35,217	408,085	35,938	408,856
39	34,223	424,654	35,267	428,114	36,269	431,054	37,226	433,469	38,132	435,356	38,987	436,714	39,786	437,539
31	37,760	453,436	38,913	457,131	40,018	460,270	41,074	462,849	42,074	464,864	43,017	466,313	43,898	467,194
32	41,534	483,162	42,801	487,099	44,017	490,444	45,178	493,191	46,279	495,339	47,316	496,883	48,285	497,822
33	45,551	513,831	46,940	518,019	48,274	521,576	49,547	524,498	50,754	526,781	51,893	528,424	52,955	529,422
34	49,818	545,444	51,339	549,889	52,798	553,665	54,190	556,767	55,509	559,191	56,753	560,934	57,916	561,994
35	54,344	578,001	56,003	582,711	57,594	586,713	59,113	590,000	60,553	592,568	61,910	594,416	63,178	595,539

TABLE V—B.—*Co-ordinates of curvature for each degree of longitude, &c.*—Continued.

Degrees of longitude.	Latitude 45°.		Latitude 46°.		Latitude 47°.		Latitude 48°.		Latitude 49°.		Latitude 50°.	
	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.	X.	Y.
°	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*	*Metres.*
1	2	486	2	486	2	485	2	484	2	482	2	479
2	12	1,946	12	1,945	12	1,941	13	1,936	13	1,927	13	1,917
3	41	4,378	41	4,376	42	4,368	42	4,355	43	4,337	43	4,313
4	96	7,784	98	7,780	99	7,765	100	7,743	102	7,710	102	7,668
5	188	12,162	191	12,155	194	12,134	196	12,098	198	12,046	200	11,981
6	324	17,513	330	17,504	335	17,473	339	17,420	343	17,347	346	17,252
7	515	23,837	523	23,824	531	23,782	538	23,711	544	23,611	549	23,483
8	768	31,135	781	31,118	793	31,062	803	30,969	812	30,839	820	30,671
9	1,094	39,405	1,113	39,383	1,129	39,313	1,144	39,196	1,157	39,030	1,168	38,817
10	1,501	48,648	1,526	48,621	1,549	48,535	1,569	48,390	1,587	48,186	1,602	47,923
11	1,998	58,864	2,031	58,831	2,061	58,727	2,088	58,552	2,112	58,305	2,132	57,987
12	2,594	70,053	2,637	70,014	2,676	69,890	2,711	69,681	2,742	69,387	2,768	69,009
13	3,298	82,215	3,353	82,170	3,403	82,024	3,447	81,779	3,486	81,434	3,519	80,989
14	4,119	95,350	4,188	95,298	4,250	95,129	4,306	94,844	4,354	94,444	4,395	93,929
15	5,066	109,458	5,150	109,397	5,227	109,204	5,296	108,877	5,355	108,418	5,406	107,826
16	6,148	124,539	6,251	124,470	6,344	124,250	6,427	123,878	6,499	123,355	6,561	122,682
17	7,374	140,592	7,497	140,515	7,610	140,266	7,709	139,847	7,796	139,257	7,870	138,497
18	8,753	157,619	8,900	157,532	9,033	157,252	9,152	156,783	9,254	156,122	9,342	155,270
19	10,295	175,619	10,467	175,522	10,624	175,212	10,762	171,688	10,884	173,950	10,987	173,001
20	12,008	194,592	12,209	194,484	12,391	194,140	12,553	193,559	12,694	192,743	12,815	191,691
21	13,900	214,533	14,133	214,419	14,344	214,040	14,531	213,399	14,695	212,499	14,834	211,340
22	15,982	235,456	16,250	235,326	16,492	234,910	16,708	234,207	16,896	233,219	17,056	231,947
23	18,262	257,347	18,568	257,206	18,844	256,750	19,091	255,982	19,306	254,902	19,489	253,511
24	20,749	280,212	21,097	280,058	21,411	279,562	21,691	278,726	21,936	277,550	22,144	276,035
25	23,452	304,049	23,845	303,882	24,200	303,314	24,517	302,437	24,793	301,161	25,028	299,517
26	26,381	328,860	26,822	328,679	27,222	328,097	27,578	327,116	27,889	325,735	28,153	323,958
27	29,543	354,643	30,038	354,448	30,485	353,821	30,884	352,762	31,232	351,274	31,529	349,357
28	32,949	381,400	33,500	381,190	34,000	380,515	34,444	379,377	34,833	377,776	35,163	375,714
29	36,607	409,129	37,220	408,904	37,774	408,180	38,268	406,959	38,700	405,242	39,067	403,030
30	40,526	437,831	41,204	437,590	41,818	436,816	42,365	435,509	42,843	433,671	43,249	431,305
31	44,715	467,506	45,463	467,249	46,141	466,422	46,744	465,027	47,272	463,064	47,720	460,538
32	49,183	498,155	50,006	497,880	50,752	496,999	51,416	495,512	51,995	493,422	52,488	490,729
33	53,940	529,776	54,843	529,484	55,660	528,547	56,388	526,966	57,024	524,742	57,565	521,879
34	58,993	562,370	59,981	562,060	60,875	561,065	61,671	559,387	62,367	557,026	62,958	553,987
35	64,354	595,937	65,431	595,609	66,405	594,555	67,274	592,776	68,033	590,275	68,678	587,054

TABLE VI.—*Projection Tables, giving latitude and longitude arcs, and co-ordinates of curvature, from latitude 24° to latitude 50°.*

LATITUDE 24° 00′.

Min.	Length in metres of arcs parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	197.8	226.1	254.3	282.6	565.2	847.8	1130.4	1413.1	1695.66
1	7.8	6.1	4.3	2.6	5.1	7.7	0.3	2.9	5.44
2	7.8	6.0	4.3	2.5	5.1	7.6	0.2	2.7	5.23
3	7.8	6.0	4.3	2.5	5.0	7.5	0.0	2.5	5.01
4	7.7	6.0	4.2	2.5	4.9	7.4	1129.9	2.3	4.79
5	7.7	5.9	4.2	2.4	4.9	7.3	9.7	2.1	4.57
6	197.7	225.9	254.2	282.4	564.8	847.2	1129.6	1412.0	1694.35
7	7.6	5.9	4.1	2.4	4.7	7.1	9.4	1.8	4.13
8	7.6	5.9	4.1	2.3	4.6	7.0	9.3	1.6	3.91
9	7.6	5.8	4.1	2.3	4.6	6.8	9.1	1.4	3.69
10	7.6	5.8	4.0	2.2	4.5	6.7	9.0	1.2	3.47
11	197.5	225.8	254.0	282.2	564.4	846.6	1128.8	1411.0	1693.25
12	7.5	5.7	4.0	2.2	4.3	6.5	8.7	10.9	3.03
13	7.5	5.7	3.9	2.1	4.3	6.4	8.5	10.7	2.81
14	7.5	5.7	3.9	2.1	4.2	6.3	8.4	10.5	2.59
15	7.4	5.6	3.9	2.1	4.1	6.2	8.2	10.3	2.37
16	197.4	225.6	253.8	282.0	564.0	846.1	1128.1	1410.1	1692.15
17	7.4	5.6	3.8	2.0	4.0	6.0	8.0	1409.9	1.93
18	7.4	5.6	3.8	2.0	3.9	5.9	7.8	9.8	1.71
19	7.3	5.5	3.7	1.9	3.8	5.7	7.7	9.6	1.49
20	7.3	5.5	3.7	1.9	3.8	5.6	7.5	9.4	1.27
21	197.3	225.5	253.7	281.8	563.7	845.5	1127.4	1409.2	1691.05
22	7.3	5.4	3.6	1.8	3.6	5.4	7.2	9.0	0.82
23	7.2	5.4	3.6	1.8	3.5	5.3	7.1	8.8	0.60
24	7.2	5.4	3.6	1.7	3.5	5.2	6.9	8.7	0.38
25	7.2	5.4	3.5	1.7	3.4	5.1	6.8	8.5	0.16
26	197.2	225.3	253.5	281.7	563.3	845.0	1126.6	1408.3	1689.94
27	7.1	5.3	3.5	1.6	3.2	4.9	6.5	8.1	9.71
28	7.1	5.3	3.4	1.6	3.2	4.7	6.3	7.9	9.49
29	7.1	5.2	3.4	1.6	3.1	4.6	6.2	7.7	9.27
30	7.1	5.2	3.4	1.5	3.0	4.5	6.0	7.5	9.05

Meridional arcs.	
1″	30.8
2	61.5
3	92.3
4	123.1
5	153.8
6	184.6
7	215.3
8	246.1
9	276.9
10	307.6
20	615.3
30	922.9
40	1230.5
50	1538.2
1′ 00	1845.8
2	3691.6
3	5537.4
4	7383.1
5	9228.9
6	11074.7
7	12920.5
8	14766.3
9	16612.1
10	18457.8
11	20303.6
12	22149.4

Co-ordinates of curvature. Minutes of longitude.	X. Arc. par.	Y.
1′	—.0	.1
2	.0	.4
3	.0	.9
4	.0	1.6
5	.0	2.5
6	.0	3.6
7	.0	4.9
8	.0	6.4
9	.0	8.1
10	.0	10.0
15	.0	22.6
20	.0	40.1
25	.0	62.7
30	.1	90.3
35	.1	122.9
40	.2	160.5
45	.3	203.1
50	.4	256.8
55	.5	303.5
1° 00	.6	361.1
1 10	1.0	491.5
1 20	1.5	642.0
1 30	2.2	812.5
1 40	3.0	1003.1
1 50	3.9	1213.8
2 00	5.1	1444.4

15*

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 24° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	197.1	225.2	253.4	281.5	563.0	844.5	1126.0	1407.5	1689.05
31	7.0	5.2	3.3	1.5	2.9	4.4	5.9	7.4	8.82
32	7.0	5.1	3.3	1.4	2.9	4.3	5.7	7.2	8.60
33	7.0	5.1	3.3	1.4	2.8	4.2	5.6	7.0	8.38
34	7.0	5.1	3.2	1.4	2.7	4.1	5.4	6.8	8.16
35	196.9	5.1	3.2	1.3	2.6	4.0	5.3	6.6	7.93
36	196.9	225.0	253.2	281.3	562.6	843.9	1125.1	1406.4	1687.71
37	6.9	5.0	3.1	1.2	2.5	3.7	5.0	6.2	7.49
38	6.8	5.0	3.1	1.2	2.4	3.6	4.8	6.0	7.26
39	6.8	4.9	3.1	1.2	2.3	3.5	4.7	5.9	7.04
40	6.8	4.9	3.0	1.1	2.3	3.4	4.5	5.7	6.81
41	196.8	224.9	253.0	281.1	562.2	843.3	1124.4	1405.5	1686.59
42	6.7	4.8	3.0	1.1	2.1	3.2	4.2	5.3	6.36
43	6.7	4.8	2.9	1.0	2.0	3.1	4.1	5.1	6.14
44	6.7	4.8	2.9	1.0	2.0	3.0	4.0	4.9	5.92
45	6.7	4.8	2.9	0.9	1.9	2.8	3.8	4.7	5.69
46	196.6	224.7	252.8	280.9	561.8	842.7	1123.6	1404.6	1885.47
47	6.6	4.7	2.8	0.9	1.7	2.6	3.5	4.4	5.24
48	6.6	4.7	2.8	0.8	1.7	2.5	3.4	4.2	5.02
49	6.6	4.6	2.7	0.8	1.6	2.4	3.2	4.0	4.79
50	6.5	4.6	2.7	0.8	1.5	2.3	3.0	3.8	4.57
51	196.5	224.6	252.7	280.7	561.4	842.2	1122.9	1403.6	1684.34
52	6.5	4.5	2.6	0.7	1.4	2.1	2.8	3.4	4.12
53	6.5	4.5	2.6	0.6	1.3	1.9	2.6	3.2	3.89
54	6.4	4.5	2.5	0.6	1.2	1.8	2.4	3.0	3.66
55	6.4	4.5	2.5	0.6	1.1	1.7	2.3	2.9	3.44
56	196.4	224.4	252.5	280.5	561.1	841.6	1122.1	1402.7	16 3.21
57	6.3	4.4	2.4	0.5	1.0	1.5	2.0	2.5	2.99
58	6.3	4.4	2.4	0.5	0.9	1.4	1.8	2.3	2.76
59	6.3	4.3	2.4	0.4	0 8	1.3	1.7	2.1	2.53
60	6.3	4.3	2.3	0.4	0.8	1.2	1.5	1.9	2.31

Meridional arcs.	
1″	30.8
2	61.5
3	92.3
4	123.1
5	153.8
6	184.6
7	215.4
8	246.1
9	276.9
10	307.6
20	615.3
30	922.9
40	1230.6
50	1538.3
1′ 00	1845.9
2	3691.8
3	5537.7
4	7383.7
5	9229.5
6	11075.4
7	12921.3
8	14767.2
9	16613.1
10	18459.0
11	20304.9
12	22150.9

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.4
3	.0	.9
4	.0	1.6
5	.0	2.5
6	.0	3.7
7	.0	5.0
8	.0	6.5
9	.0	8.3
10	.0	10.2
15	.0	22.9
20	.0	40.7
25	.0	63.7
30	.1	91.7
35	.1	124.8
40	.2	163.0
45	.3	206.3
50	.4	254.7
55	.5	308.2
1° 00	.7	366.7
1 10	1.1	499.2
1 20	1.6	652.0
1 30	2.2	825.2
1 40	3.1	1018.7
1 50	4.1	1232.7
2 00	5.3	1467.0

TABLE VI.—*Projection Tables*—Continued.

Latitude 25° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	196.3	224.3	252.3	280.4	560.8	841.2	1121.5	1401.9	1682.31
1	6.2	4.3	2.3	0.3	0.7	1.0	1.4	1.7	2.08
2	6.2	4.2	2.3	0.3	0.6	0.9	1.2	1.5	1.85
3	6.2	4.2	2.2	0.3	0.5	0.8	1.1	1.4	1.62
4	6.2	4.2	2.2	0.2	0.5	0.7	0.9	1.2	1.39
5	6.1	4.2	2.2	0.2	0.4	0.6	0.8	1.0	1.17
6	196.1	224.1	252.1	280.2	560.3	840.5	1120.6	1400.8	1680.94
7	6.1	4.1	2.1	0.1	0.2	0.4	0.5	0.6	0.71
8	6.1	4.1	2.1	0.1	0.2	0.2	0.3	0.4	0.48
9	6.0	4.0	2.0	0.0	0.1	0.1	0.2	0.2	0.26
10	6.0	4.0	2.0	0.0	0.0	0.0	0.0	0.0	0.03
11	196.0	224.0	252.0	280.0	559.9	839.9	1119.9	1399.8	1679.80
12	5.9	3.9	1.9	9.9	9.9	9.8	9.7	9.6	9.57
13	5.9	3.9	1.9	9.9	9.8	9.7	9.6	9.5	9.34
14	5.9	3.9	1.9	9.9	9.7	9.5	9.4	9.3	9.11
15	5.9	3.9	1.8	9.8	9.6	9.4	9.3	9.1	8.88
16	195.8	223.8	251.8	279.8	559.5	839.3	1119.1	1398.9	1678.65
17	5.8	3.8	1.8	9.7	9.5	9.2	9.0	8.7	8.42
18	5.8	3.8	1.7	9.7	9.4	9.1	8.8	8.5	8.20
19	5.8	3.7	1.7	9.7	9.3	9.0	8.6	8.3	7.97
20	5.7	3.7	1.7	9.6	9.2	8.9	8.5	8.1	7.74
21	195.7	223.7	251.6	279.6	559.2	838.8	1118.3	1397.9	1677.51
22	5.7	3.6	1.6	9.5	9.1	8.6	8.2	7.7	7.28
23	5.7	3.6	1.6	9.5	9.0	8.5	8.0	7.5	7.05
24	5.6	3.6	1.5	9.5	8.9	8.4	7.9	7.3	6.81
25	5.6	3.5	1.5	9.4	8.9	8.3	7.7	7.2	6.59
26	195.6	223.5	251.5	279.4	558.8	838.2	1117.6	1397.0	1676.36
27	5.5	3.5	1.4	9.4	8.7	8.1	7.4	6.8	6.12
28	5.5	3.5	1.4	9.3	8.6	7.9	7.3	6.6	5.89
29	5.5	3.4	1.3	9.3	8.6	7.8	7.1	6.4	5.66
30	5.5	3.4	1.3	9.2	8.5	7.7	6.9	6.2	5.43

Meridional arcs.	
1″	30.8
2	61.5
3	92.3
4	123.1
5	153.8
6	184.6
7	215.4
8	246.1
9	276.9
10	307.7
20	615.3
30	923.0
40	1230.7
50	1538.4
1′ 00	1846.0
2	3692.1
3	5538.1
4	7384.1
5	9230.1
6	11076.2
7	12922.2
8	14768.2
9	16614.2
10	18460.3
11	20306.3
12	22152.3

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.4
3	.0	.9
4	.0	1.6
5	.0	2.6
6	.0	3.7
7	.0	5.1
8	.0	6.6
9	.0	8.4
10	.0	10.3
15	.0	23.3
20	.0	41.4
25	.0	64.6
30	.1	93.1
35	.1	126.7
40	.2	165.5
45	.3	209.4
50	.4	258.5
55	.5	312.8
1° 00	.7	372.3
1 10	1.1	506.7
1 20	1.6	661.8
1 30	2.3	837.6
1 40	3.2	1034.1
1 50	4.2	1251.2
2 00	5.5	1489.1

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 25° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″	Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
30′	195.5	223.4	251.3	279.2	558.5	837.7	1116.9	1396.2	1675.43	1′	30.8	1′	—.0	.1
31	5.4	3.4	1.3	9.2	8.4	7.6	6.8	6.0	5.20	2	61.5	2	.0	.4
32	5.4	3.3	1.2	9.2	8.3	7.5	6.6	5.8	4.97	3	92.3	3	.0	.9
33	5.4	3.3	1.2	9.1	8.2	7.4	6.5	5.6	4.74	4	123.1	4	.0	1.7
34	5.4	3.3	1.2	9.1	8.2	7.3	6.3	5.4	4.51					
35	5.3	3.2	1.1	9.0	8.1	7.1	6.2	5.2	4.27	5	153.8	5	.0	2.6
										6	184.6	6	.0	3.8
36	195.3	223.2	251.1	279.0	558.0	837.0	1116.0	1395.0	1674.04	7	215.4	7	.0	5.1
37	5.3	3.2	1.1	9.0	7.9	6.9	5.9	4.8	3.81	8	246.2	8	.0	6.7
38	5.3	3.1	1.0	8.9	7.9	6.8	5.7	4.6	3.58	9	276.9	9	.0	8.5
39	5.2	3.1	1.0	8.9	7.8	6.7	5.6	4.4	3.34					
40	5.2	3.1	1.0	8.8	7.7	6.6	5.4	4.3	3.11	10	307.7	10	.0	10.5
										20	615.4	15	.0	23.6
41	195.2	223.1	250.9	278.8	557.6	836.4	1115.3	1394.1	1672.88	30	923.1	20	.0	42.0
42	5.1	3.0	0.9	8.8	7.5	6.3	5.1	3.9	2.65	40	1230.8	25	.1	65.6
43	5.1	3.0	0.9	8.7	7.5	6.2	4.9	3.7	2.41	50	1538.5	30	.1	94.4
44	5.1	3.0	0.8	8.7	7.4	6.1	4.8	3.5	2.18					
45	5.1	2.9	0.8	8.7	7.3	6.0	4.6	3.3	1.95	1′ 00	1846.2	35	.1	128.5
										2	3692.3	40	.2	168.0
46	195.0	222.9	250.8	278.6	557.2	835.9	1114.5	1393.1	1671.71	3	5538.5	45	.3	212.4
47	5.0	2.9	0.7	8.6	7.2	5.7	4.3	2.9	1.48	4	7384.6	50	.4	262.3
48	5.0	2.8	0.7	8.5	7.1	5.6	4.2	2.7	1.25	5	9230.8	55	.5	317.3
49	5.0	2.8	0.7	8.5	7.0	5.5	4.0	2.5	1.01	6	11076.9			
50	4.9	2.8	0.6	8.5	6.9	5.4	3.9	2.3	0.78			1° 00	.7	377.7
										7	12923.1	1 10	1.1	514.0
51	194.9	222.7	250.6	278.4	556.8	835.3	1113.7	1392.1	1670.55	8	14769.2	1 20	1.7	671.4
52	4.9	2.7	0.6	8.4	6.8	5.2	3.5	1.9	70.32	9	16615.4	1 30	2.4	849.7
53	4.8	2.7	0.5	8.3	6.7	5.0	3.4	1.7	70.08	10	18461.6	1 40	3.3	1049.1
54	4.8	2.6	0.5	8.3	6.6	4.9	3.2	1.6	69.84	11	20307.7	1 50	4.4	1269.4
55	4.8	2.6	0.4	8.3	6.5	4.8	3.1	1.4	69.61	12	22153.9	2 00	5.7	1510.6
56	194.8	222.6	250.4	278.2	556.5	834.7	1112.9	1391.2	1669.37					
57	4.7	2.6	0.4	8.2	6.4	4.6	2.8	1.0	9.14					
58	4.7	2.5	0.3	8.1	6.3	4.5	2.6	0.8	8.90					
59	4.7	2.5	0.3	8.1	6.2	4.3	2.5	0.6	8.67					
60	1.6	2.5	0.3	8.1	6.1	4.2	2.3	0.4	8.43					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 26° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″	Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
0′	194.6	222.5	250.3	278.1	256.1	834.2	1112.3	1390.4	1668.43	1″	30.8	1′	.0	.1
1	4.6	2.4	0.2	8.0	6.1	4.1	2.1	0.2	8.20	2	61.5	2	.0	.4
2	4.6	2.4	0.2	8.0	6.0	4.0	2.0	0.0	7.96	3	92.3	3	.0	1.0
3	4.6	2.4	0.2	8.0	5.9	3.9	1.8	1389.8	7.72	4	123.1	4	0	1.7
4	4.5	2.3	0.1	7.9	5.8	3.7	1.7	9.6	7.49					
5	4.5	2.3	0.1	7.9	5.7	3.6	1.5	9.4	7.25	5	153.8	5	.0	2.7
										6	184.6	6	.0	3.8
6	194.5	222.3	250.1	277.8	555.7	833.5	1111.3	1389.2	1667.02	7	215.4	7	.0	5.2
7	4.5	2.2	0.0	7.8	5.6	3.4	1.2	9.0	6.78	8	246.2	8	.0	6.8
8	4.4	2.2	0.0	7.8	5.5	3.3	1.0	8.8	6.54	9	276.9	9	.0	8.6
9	4.4	2.2	249.9	7.7	5.4	3.2	0.9	8.6	6.31					
10	4.4	2.1	9.9	7.7	5.4	3.0	0.7	8.4	6.07	10	307.7	10	.0	10.6
										20	615.4	15	.0	23.9
11	194.3	222.1	249.9	277.6	555.3	832.9	1110.6	1388.2	1665.83	30	923.1	20	.0	42.6
12	4.3	2.1	9.8	7.6	5.2	2.8	0.4	8.0	5.60	40	1230.9	25	.1	66.5
13	4.3	2.0	9.8	7.6	5.1	2.7	0.2	7.8	5.36	50	1538.6	30	.1	95.7
14	4.3	2.0	9.8	7.5	5.0	2.6	0.1	7.6	5.12					
15	4.2	2.0	9.7	7.5	5.0	2.4	1109.9	7.4	4.88	1′ 00	1846.3	35	.1	130.3
										2	3692.6	40	.2	170.2
16	194.2	222.0	249.7	277.4	554.9	832.3	1109.8	1387.2	1664.65	3	5538.8	45	.3	215.4
17	4.2	1.9	9.7	7.4	4.8	2.2	9.6	7.0	4.41	4	7385.1	50	.4	265.9
18	4.2	1.9	9.6	7.4	4.7	2.1	9.4	6.8	4.17	5	9231.4	55	.6	321.8
19	4.1	1.9	9.6	7.3	4.6	2.0	9.3	6.6	3.93	6	11077.7			
20	4.1	1.8	9.5	7.3	4.6	1.8	9.1	6.4	3.69			1° 00	.7	383.0
										7	12924.0	1 10	1.2	521.2
21	194.1	221.8	249.5	277.2	554.5	831.7	1109.0	1386.2	1663.46	8	14770.2	1 20	1.7	680.8
22	4.0	1.8	9.5	7.2	4.4	1.6	8.8	6.0	3.22	9	16616.5	1 30	2.5	861.6
23	4.0	1.7	9.4	7.2	4.3	1.5	8.6	5.8	2.98	10	18462.8	1 40	3.4	1063.7
24	4.0	1.7	9.4	7.1	4.2	1.4	8.5	5.6	2.74	11	20309.1	1 50	4.5	1287.1
25	4.0	1.7	9.4	7.1	4.2	1.2	8.3	5.4	2.50	12	22155.4	2 00	5.9	1531.8
26	193.9	221.6	249.3	277.0	554.1	831.1	1108.2	1385.2	1662.26					
27	3.9	1.6	9.3	7.0	4.0	1.0	8.0	5.0	2.02					
28	3.9	1.6	9.3	7.0	3.9	0.9	7.9	4.8	1.78					
29	3.9	1.5	9.2	6.9	3.8	0.8	7.7	4.6	1.55					
30	3.8	1.5	9.2	6.9	3.8	0.7	7.5	4.4	1.31					

TABLE VI.—*Projection Tables*—Continued.

Latitude 26° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	193.8	221.5	249.2	276.9	553.8	830.7	1107.5	1384.4	1661.31
31	3.8	1.5	9.2	6.8	3.7	0.5	7.4	4.2	1.07
32	3.8	1.4	9.1	6.8	3.6	0.4	7.2	4.0	0.83
33	3.7	1.4	9.1	6.8	3.5	0.3	7.1	3.8	0.59
34	3.7	1.4	9.1	6.7	3.4	0.2	6.9	3.6	0.35
35	3.7	1.3	9.0	6.7	3.4	0.1	6.7	3.4	0.11
36	193.7	221.3	249.0	276.6	553.3	829.9	1106.6	1383.2	1659.87
37	3.6	1.3	8.9	6.6	3.2	9.8	6.4	3.0	9.63
38	3.6	1.3	8.9	6.6	3.1	9.7	6.3	2.8	9.38
39	3.6	1.2	8.9	6.5	3.0	9.6	6.1	2.6	9.14
40	3.5	1.2	8.8	6.5	3.0	9.5	5.9	2.4	8.90
41	193.5	221.2	248.8	276.4	552.9	829.3	1105.8	1382.2	1658.66
42	3.5	1.1	8.8	6.4	2.8	9.2	5.6	2.0	8.42
43	3.5	1.1	8.7	6.4	2.7	9.1	5.5	1.8	8.18
44	3.4	1.1	8.7	6.3	2.6	9.0	5.3	1.6	7.94
45	3.4	1.0	8.7	6.3	2.6	8.8	5.1	1.4	7.70
46	193.4	221.0	248.6	276.2	552.5	828.7	1105.0	1331.2	1657.45
47	3.3	1.0	8.6	6.2	2.4	8.6	4.8	1.0	7.21
48	3.3	0.9	8.5	6.2	2.3	8.5	4.6	0.8	6.97
49	3.3	0.9	8.5	6.1	2.2	8.4	4.5	0.6	6.73
50	3.2	0.9	8.5	6.1	2.2	8.2	4.3	0.4	6.49
51	193.2	220.8	248.4	276.0	552.1	828.1	1104.2	1380.2	1656.24
52	3.2	0.8	8.4	6.0	2.0	8.0	4.0	0.0	6.00
53	3.2	0.8	8.4	6.0	1.9	7.9	3.8	1379.8	5.76
54	3.1	0.7	8.3	5.9	1.8	7.7	3.7	9.6	5.51
55	3.1	0.7	8.3	5.9	1.8	7.6	3.5	9.4	5.27
56	193.1	220.7	248.3	275.8	551.7	827.5	1103.4	1379.2	1655.03
57	3.1	0.6	8.2	5.8	1.6	7.4	3.2	9.0	4.78
58	3.0	0.6	8.2	5.8	1.5	7.3	3.0	8.8	4.54
59	3.0	0.6	8.1	5.7	1.4	7.2	2.9	8.6	4.30
60	3.0	0.5	8.1	5.7	1.3	7.0	2.7	8.4	4.05

Meridional arcs.	
1″	30.8
2	61.5
3	92.3
4	123.1
5	153.9
3	184.6
7	215.4
8	246.2
9	277.0
10	307.7
20	615.5
30	923.2
40	1230.9
50	1538.7
1′ 00	1846.4
2	3692.8
3	5539.2
4	7385.6
5	9232.0
6	11078.4
7	12924.8
8	14771.3
9	16617.7
10	18464.1
11	20310.5
12	22156.9

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.4
3	.0	1.0
4	.0	1.7
5	.0	2.7
6	.0	3.9
7	.0	5.3
8	.0	6.9
9	.0	8.7
10	.0	10.8
15	.0	24.3
20	.0	43.1
25	.1	67.4
30	.1	97.0
35	.2	132.1
40	.2	172.5
45	.3	218.3
50	.4	269.5
55	.6	326.1
1° 00	.8	388.1
1 10	1.2	528.3
1 20	1.8	690.0
1 30	2.5	873.3
1 40	3.5	1078.1
1 50	4.6	1304.6
2 00	6.0	1552.5

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 27° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	193.0	220.5	248.1	275.7	551.3	827.0	1102.7	1378.4	1654.05
1	2.9	0.5	8.1	5.6	1.3	6.9	2.5	8.2	3.81
2	2.9	0.5	8.0	5.6	1.2	6.8	2.4	8.0	3.57
3	2.9	0.4	8.0	5.6	1.1	6.7	2.2	7.8	3.32
4	2.9	0.4	8.0	5.5	1.0	6.5	2.1	7.6	3.08
5	2.8	0.4	7.9	5.5	0 9	6.4	1.9	7.4	2.83
6	192.8	220.3	247.9	275.4	550.9	826.3	1101.7	1377.2	1652.59
7	2.8	0.3	7.9	5.4	0.8	6.2	1.6	7.0	2.34
8	2.7	0.3	7.8	5.4	0.7	6.0	1.4	6.7	2.10
9	2.7	0.2	7.8	5.3	0.6	5.9	1.2	6.5	1.86
10	2.7	0.2	7.7	5.3	0.5	5.8	1.1	6.3	1.61
11	192.7	220.2	247.7	275.2	550.5	825.7	1100.9	1376.1	1651.36
12	2.6	0.1	7.7	5.2	0.4	5.6	0.8	5.9	1.12
13	2.6	0.1	7.6	5.1	0.3	5.4	0.6	5.7	0.87
14	2.6	0.1	7.6	5.1	0.2	5.3	0.4	5.5	0.63
15	2.5	0.1	7.6	5.1	0.1	5.2	0.3	5.3	0.38
16	192.5	220.0	247.5	275.0	550.0	825.1	1100.1	1375.1	1650.13
17	2.5	0.0	7.5	5.0	0.0	4.9	1099.9	4.9	49.89
18	2.5	0.0	7.4	4.9	549.9	4.8	9.8	4.7	49.64
19	2.4	219.9	7.4	4.9	9.8	4.7	9.6	4.5	49.39
20	2.4	9.9	7.4	4.9	9.7	4.6	9.4	4.3	49.15
21	192.4	219.9	247.3	274.8	549.6	824.5	1099.3	1374.1	1648.90
22	2.3	9.8	7.3	4.8	9.5	4.3	9.1	3.9	8.65
23	2.3	9.8	7.3	4.7	9.5	4.2	8.9	3.7	8.41
24	2.3	9.8	7.2	4.7	9.4	4.1	8.8	3.5	8.16
25	2.3	9.7	7.2	4.7	9.3	4.0	8.6	3.3	7.91
26	192.2	219.7	247.1	274.6	549.2	823.8	1098.4	1373.1	1647.67
27	2.2	9.7	7.1	4.6	9.1	3.7	8.3	2.8	7.42
28	2.2	9.6	7.1	4.5	9.1	3.6	8.1	2.6	7.17
29	2.1	9.6	7.0	4.5	9.0	3.5	8.0	2.4	6.92
30	2.1	9.6	7.0	4.4	8.9	3.3	7.8	2.2	6.68

Meridional arcs.	
1″	30.8
2	61.5
3	92.3
4	123.1
5	153.9
6	184.7
7	215.4
8	246.2
9	277.0
10	307.8
20	615.5
30	923.3
40	1231.0
50	1538.8
1′ 00	1846.5
2	3693.1
3	5539.6
4	7386.2
5	9232.7
6	11079.2
7	12925.8
8	14772.3
9	16618.8
10	18465.4
11	20311.9
12	22158.4

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.4
3	.0	1.0
4	.0	1.7
5	.0	2.7
6	.0	3.9
7	.0	5.4
8	.0	7.0
9	.0	8.8
10	.0	10.9
15	.0	24.6
20	.0	43.7
25	.1	68.3
30	.1	98.3
35	.2	133.8
40	.2	174.7
45	.3	221.2
50	.5	273.0
55	.6	330.4
1° 00	.8	393.2
1 10	1.2	535.2
1 20	1.8	699.0
1 30	2.6	884.6
1 40	3.6	1092.0
1 50	4.8	1321.5
2 00	6.2	1572.8

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 27° 30′.

Length in metres of arcs of the parallel, (arc par.)

Min.	7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	192.1	219.6	247.0	274.4	548.9	823.3	1097.8	1372.2	1646.68
31	2.1	9.5	7.0	4.4	8.8	3.2	7.6	2.0	6.43
32	2.1	9.5	6.9	4.4	8.7	3.1	7.5	1.8	6.18
33	2.0	9.5	6.9	4.3	8.6	3.0	7.3	1.6	5.93
34	2.0	9.4	6.9	4.3	8.6	2.8	7.1	1.4	5.68
35	2.0	9.4	6.8	4.2	8.5	2.7	6.9	1.2	5.43
36	191.9	219.4	246.8	274.2	548.4	822.6	1096.8	1371.0	1645.18
37	1.9	9.3	6.7	4.2	8.3	2.5	6.6	0.8	4.94
38	1.9	9.3	6.7	4.1	8.2	2.3	6.5	0.6	4.69
39	1.9	9.3	6.7	4.1	8.1	2.2	6.3	0.4	4.44
40	1.8	9.2	6.6	4.0	8.1	2.1	6.1	0.2	4.19
41	191.8	219.2	246.6	274.0	548.0	822.0	1096.0	1370.0	1643.94
42	1.8	9.2	6.6	3.9	7.9	1.8	5.8	69.7	3.69
43	1.7	9.1	6.5	3.9	7.8	1.7	5.6	9.5	3.44
44	1.7	9.1	6.5	3.9	7.7	1.6	5.5	9.3	3.19
45	1.7	9.1	6.4	3.8	7.6	1.5	5.3	9.1	2.94
46	191.6	219.0	246.4	273.8	547.6	821.3	1095.1	1368.9	1642.69
47	1.6	9.0	6.4	3.7	7.5	1.2	5.0	8.7	2.44
48	1.6	9.0	6.3	3.7	7.4	1.1	4.8	8.5	2.19
49	1.6	8.9	6.3	3.7	7.3	1.0	4.6	8.3	1.94
50	1.5	8.9	6.3	3.6	7.2	0.8	4.5	8.1	1.69
51	191.5	218.9	246.2	273.6	547.1	820.7	1094.3	1367.9	1641.44
52	1.5	8.8	6.2	3.5	7.1	0.6	4.1	7.6	1.18
53	1.4	8.8	6.1	3.5	7.0	0.5	4.0	7.4	0.93
54	1.4	8.8	6.1	3.4	6.9	0.3	3.8	7.2	0.68
55	1.4	8.7	6.1	3.4	6.8	0.2	3.6	7.0	0.43
56	191.4	218.7	246.0	273.4	546.7	820.1	1093.5	1366.8	1640.18
57	1.3	8.7	6.0	3.3	6.6	820.0	3.3	6.6	39.93
58	1.3	8.6	6.0	3.3	6.6	819.8	3.1	6.4	39.68
59	1.3	8.6	5.9	3.2	6.5	819.7	3.0	6.2	39.42
60	1.2	8.6	5.9	3.2	6.4	819.6	2.8	6.0	39.17

Meridional arcs.

1″	30.8
2	61.6
3	92.3
4	123.1
5	153.9
6	184.7
7	215.4
8	246.2
9	277.0
10	307.8
20	615.5
30	923.3
40	1231.1
50	1538.9
1′ 00	1846.7
2	3693.3
3	5540.0
4	7386.7
5	9233.3
6	11080.0
7	12926.7
8	14773.3
9	16620.0
10	18466.7
11	20313.3
12	22160.0

Co-ordinates of curvature.

Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.4
3	.0	1.0
4	.0	1.8
5	.0	2.8
6	.0	4.0
7	.0	5.4
8	.0	7.1
9	.0	9.0
10	.0	11.1
15	.0	24.9
20	.0	44.2
25	.1	69.1
30	.1	99.5
35	.2	135.5
40	.2	176.9
45	.3	223.9
50	.5	276.5
55	.6	334.5
1° 00	.8	398.1
1 10	1.3	541.9
1 20	1.9	707.8
1 30	2.7	895.8
1 40	3.7	1105.9
1 50	4.9	1338.1
2 00	6.4	1592.5

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 28° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	191.2	218.6	245.9	273.2	546.4	819.6	1092.8	1366.0	1639.17
1	1.2	8.5	5.8	3.2	6.3	9.5	2.6	5.8	8.92
2	1.2	8.5	5.8	3.1	6.2	9.3	2.5	5.6	8.67
3	1.1	8.5	5.8	3.1	6.1	9.2	2.3	5.3	8.41
4	1.1	8.4	5.7	3.0	6.1	9.1	2.1	5.1	8.16
5	1.1	8.4	5.7	3.0	6.0	9.0	1.9	4.9	7.91
6	191.1	218.4	245.6	272.9	545.9	818.8	1091.8	1364.7	1637.65
7	1.0	8.3	5.6	2.9	5.8	8.7	1.6	4.5	7.40
8	1.0	8.3	5.6	2.9	5.7	8.6	1.4	4.3	7.15
9	1.0	8.3	5.5	2.8	5.6	8.5	1.3	4.1	6.90
10	0.9	8.2	5.5	2.8	5.5	8.3	1.1	3.9	6.64
11	190.9	218.2	245.5	272.7	545.5	818.2	1090.9	1363.7	1636.39
12	0.9	8.2	5.4	2.7	5.4	8.1	0.8	3.4	6.13
13	0.9	8.1	5.4	2.6	5.3	7.9	0.6	3.2	5.88
14	0.8	8.1	5.3	2.6	5.2	7.8	0.4	3.0	5.63
15	0.8	8.0	5.3	2.6	5.1	7.7	0.2	2.8	5.37
16	190.8	218.0	245.3	272.5	545.0	817.6	1090.1	1362.6	1635.12
17	0.7	8.0	5.2	2.5	5.0	7.4	89.9	2.4	4.86
18	0.7	7.9	5.2	2.4	4.9	7.3	9.7	2.2	4.61
19	0.7	7.9	5.2	2.4	4.8	7.2	9.6	2.0	4.35
20	0.6	7.9	5.1	2.3	4.7	7.0	9.4	1.7	4.10
21	190.6	217.8	245.1	272.3	544.6	816.9	1089.2	1361.5	1633.84
22	0.6	7.8	5.0	2.3	4.5	6.8	9.1	1.3	3.59
23	0.6	7.8	5.0	2.2	4.4	6.7	8.9	1.1	3.33
24	0.5	7.7	5.0	2.2	4.4	6.6	8.7	0.9	3.08
25	0.5	7.7	4.9	2.1	4.3	6.4	8.6	0.7	2.82
26	190.5	217.7	244.9	272.1	544.2	816.3	1088.4	1360.5	1632.57
27	0.4	7.6	4.8	2.0	4.1	6.2	8.2	0.3	2.31
28	0.4	7.6	4.8	2.0	4.0	6.0	8.0	0.0	2.06
29	0.4	7.6	4.8	2.0	3.9	5.9	7.9	1359.8	1.80
30	0.3	7.5	4.7	1.9	3.8	5.8	7.7	9.6	1.54

Meridional arcs.	
1″	30.8
2	61.6
3	92.3
4	123.1
5	153.9
6	184.7
7	215.5
8	246.2
9	277.0
10	307.8
20	615.6
30	923.4
40	1231.2
50	1539.0
1′ 00	1846.8
2	3693.6
3	5540.4
4	7387.2
5	9234.0
6	11080.8
7	12927.6
8	14774.4
9	16621.2
10	18468.0
11	20314.8
12	22161.6

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.4
3	.0	1.0
4	.0	1.8
5	.0	2.8
6	.0	4.0
7	.0	5.5
8	.0	7.2
9	.0	9.1
10	.0	11.2
15	.0	25.2
20	.0	44.8
25	.1	70.0
30	.1	100.7
35	.2	137.1
40	.2	179.1
45	.3	226.6
50	.5	279.8
55	.6	338.6
1° 00	.8	402.9
1 10	1.3	548.4
1 20	2.0	716.3
1 30	2.8	906.6
1 40	3.8	1119.3
1 50	5.1	1354.3
2 00	6.6	1611.7

16*

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 28° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	190.3	217.5	244.7	271.9	543.8	815.8	1087.7	1359.6	1631.54
31	0.3	7.5	4.7	1.9	3.8	5.6	7.5	9.4	1.29
32	0.3	7.5	4.7	1.8	3.7	5.5	7.4	9.2	1.03
33	0.3	7.4	4.6	1.8	3.6	5.4	7.2	9.0	0.77
34	0.2	7.4	4.6	1.7	3.5	5.3	7.0	8.8	0.52
35	0.2	7.4	4.5	1.7	3.4	5.1	6.8	8.6	0.26
36	190.2	217.3	244.5	271.7	543.3	815.0	1086.7	1358.3	1630.00
37	0.1	7.3	4.5	1.6	3.3	4.9	6.5	8.1	29.75
38	0.1	7.3	4.4	1.6	3.2	4.7	6.3	7.9	9.49
39	0.1	7.2	4.4	1.5	3.1	4.6	6.2	7.7	9.23
40	0.0	7.2	4.4	1.5	3.0	4.5	6.0	7.5	8.97
41	190.0	217.2	244.3	271.5	542.9	814.4	1085.8	1357.3	1628.71
42	0.0	7.1	4.3	1.4	2.8	4.2	5.6	7.0	8.46
43	0.0	7.1	4.2	1.4	2.7	4.1	5.5	6.8	8.20
44	189.9	7.1	4.2	1.3	2.6	4.0	5.3	6.6	7.94
45	9.9	7.0	4.2	1.3	2.6	3.8	5.1	6.4	7.68
46	189.9	217.0	244.1	271.2	542.5	813.7	1085.0	1356.2	1627.42
47	9.8	7.0	4.1	1.2	2.4	3.6	4.8	6.0	7.16
48	9.8	6.9	4.0	1.1	2.3	3.5	4.6	5.8	6.91
49	9.8	6.9	4.0	1.1	2.2	3.3	4.4	5.5	6.65
50	9.7	6.9	4.0	1.1	2.1	3.2	4.3	5.3	6.39
51	189.7	216.8	243.9	271.0	542.0	813.1	1084.1	1355.1	1626.13
52	9.7	6.8	3.9	1.0	2.0	2.9	3.9	4.9	5.87
53	9.7	6.7	3.8	0.9	1.9	2.8	3.8	4.7	5.61
54	9.6	6.7	3.8	0.9	1.8	2.7	3.6	4.5	5.35
55	9.6	6.7	3.8	0.8	1.7	2.5	3.4	4.2	5.09
56	189.6	216.6	243.7	270.8	541.6	812.4	1083.2	1354.0	1624.83
57	9.5	6.6	3.7	0.8	1.5	2.3	3.0	3.8	4.57
58	9.5	6.6	3.6	0.7	1.4	2.2	2.9	3.6	4.31
59	9.5	6.5	3.6	0.7	1.4	2.0	2.7	3.4	4.05
60	9.4	6.5	3.6	0.6	1.3	1.9	2.5	3.1	3.79

Meridional arcs.	
1″	30.8
2	61.6
3	92.3
4	123.1
5	153.9
6	184.7
7	215.5
8	246.3
9	277.0
10	307.8
20	615.6
30	923.5
40	1231.3
50	1539.1
1′ 00	1846.9
2	3693.9
3	5540.8
4	7387.7
5	9234.7
6	11081.6
7	12928.6
8	14775.5
9	16622.4
10	18469.4
11	20316.3
12	22163.2

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.0
4	.0	1.8
5	.0	2.8
6	.0	4.1
7	.0	5.5
8	.0	7.2
9	.0	9.2
10	.0	11.3
15	.0	25.5
20	.0	45.3
25	.1	70.8
30	.1	101.9
35	.2	138.7
40	.3	181.2
45	.4	229.3
50	.5	283.1
55	.7	342.5
1° 00	.8	407.6
1 10	1.3	554.8
1 20	2.0	724.7
1 30	2.9	917.1
1 40	3.9	1132.3
1 50	5.2	1370.0
2 00	6.8	1630.5

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 29° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″	Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
0′	189.4	216.5	243.6	270.6	541.3	811.9	1082.5	1353.1	1623.79	1″	30.8	1′	—.0	.1
1	9.4	6.5	3.5	0.6	1.2	1.8	2.4	2.9	3.53	2	61.6	2	.0	.5
2	9.4	6.4	3.5	0.5	1.1	1.6	2.2	2.7	3.27	3	92.4	3	.0	1.0
3	9.4	6.4	3.5	0.5	1.0	1.5	2.0	2.5	3.01	4	123.1	4	.0	1.8
4	9.3	6.4	3.4	0.5	0.9	1.4	1.8	2.3	2.75					
5	9.3	6.3	3.4	0.4	0.8	1.2	1.7	2.1	2.48	5	153.9	5	.0	2.9
										6	184.7	6	.0	4.1
6	189.3	216.3	243.3	270.4	540.7	811.1	1081.5	1351.9	1622.22	7	215.5	7	.0	5.6
7	9.2	6.3	3.3	0.3	0.7	1.0	1.3	1.6	1.96	8	246.3	8	.0	7.3
8	9.2	6.2	3.3	0.3	0.6	0.8	1.1	1.4	1.70	9	277.1	9	.0	9.3
9	9.2	6.2	3.2	0.2	0.5	0.7	1.0	1.2	1.44					
10	9.1	6.2	3.2	0.2	0.4	0.6	0.8	1.0	1.18	10	307.8	10	.0	11.4
										20	615.7	15	.0	25.8
11	189.1	216.1	243.1	270.2	540.3	810.5	1080.6	1350.8	1620.92	30	923.5	20	.0	45.8
12	9.1	6.1	3.1	0.1	0.2	0.3	0.4	0.5	0.65	40	1231.4	25	.1	71.6
13	9.0	6.1	3.1	0.1	0.1	0.2	0.3	0.3	0.39	50	1539.2	30	.1	103.0
14	9.0	6.0	3.0	0.0	0.0	0.1	0.1	0.1	0.13					
15	9.0	6.0	3.0	0.0	0 0	809.9	1079.9	49.9	1619.87	1′ 00	1847.1	35	.2	140.3
										2	3694.1	40	.3	183.2
16	189.0	215.9	242.9	269.9	539.9	809.8	1079.7	1349.7	1619.60	3	5541.2	45	.4	231.9
17	8.9	5.9	2.9	9.9	9.8	9.7	9.6	9.4	9.34	4	7388.3	50	.5	286.2
18	8.9	5.9	2.9	9.8	9.7	9.5	9.4	9.2	9.08	5	9235.3	55	.7	346.4
19	8.9	5.8	2.8	9.8	9.6	9.4	9.2	9.0	8.82	6	11082.4			
20	8.8	5.8	2.8	9.8	9.5	9.3	9.1	8.8	8.55			1° 00	.9	412.2
										7	12929.5	1 10	1.4	561.0
21	188.8	215.8	242.7	269.7	539.4	809.1	1078.9	1348.6	1618.29	8	14776.6	1 20	2.1	732.8
22	8.8	5.7	2.7	9.7	9.3	9.0	8.7	8.4	8.03	9	16623.7	1 30	2.9	927.4
23	8.7	5.7	2.7	9.6	9.3	8.9	8.5	8.1	7.76	10	18470.7	1 40	4.0	1145.0
24	8.7	5.7	2.6	9.6	9.2	8.7	8.3	7.9	7.50	11	20317.8	1 50	5.4	1385.4
25	8.7	5.6	2.6	9.5	9.1	8.6	8.2	7.7	7.23	12	22164.9	2 00	7.0	1648.8
26	188.6	215.6	242.5	269.5	539.0	808.5	1078.0	1347.5	1616.97					
27	8.6	5.6	2.5	9.5	8.9	8.4	7.8	7.3	6.71					
28	8.6	5.5	2.5	9.4	8.8	8.2	7.6	7.0	6.44					
29	8.6	5.5	2.4	9.4	8.7	8.1	7.5	6.8	6.18					
30	8.5	5.5	2.4	9.3	8.6	8.0	7.3	6.6	5.91					

TABLE VI.—*Projection Tables*—Continued.

Latitude 29° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	188.5	215.5	242.4	269.3	538.6	808.0	1077.3	1346.6	1615.91
31	8.5	5.4	2.3	9.3	8.6	7.8	7.1	6.4	5.65
32	8.5	5.4	2.3	9.2	8.5	7.7	6.9	6.1	5.38
33	8.4	5.3	2.3	9.2	8.4	7.6	6.8	5.9	5.12
34	8.4	5.3	2.2	9.1	8.3	7.4	6.6	5.7	4.85
35	8.4	5.3	2.2	9.1	8.2	7.3	6.4	5.5	4.59
36	188.3	215.2	242.1	269.1	538.1	807.2	1076.2	1345.3	1614.32
37	8.3	5.2	2.1	9.0	8.0	7.0	6.0	5.0	4.06
38	8.3	5.2	2.1	9.0	7.9	6.9	5.9	4.8	3.79
39	8.2	5.1	2.0	8.9	7.8	6.8	5.7	4.6	3.53
40	8.2	5.1	2.0	8.9	7.8	6.6	5.5	4.4	3.26
41	188.2	215.1	241.9	268.8	537.7	806.5	1075.3	1344.2	1612.99
42	8.2	5.0	1.9	8.8	7.6	6.4	5.2	3.9	2.72
43	8.1	5.0	1.9	8.7	7.5	6.2	5.0	3.7	2.46
44	8.1	5.0	1.8	8.7	7.4	6.1	4.8	3.5	2.19
45	8.1	4.9	1.8	8.7	7.3	6.0	4.6	3.3	1.93
46	188.0	214.9	241.7	268.6	537.2	805.8	1074.4	1343.1	1611.66
47	8.0	4.9	1.7	8.6	7.1	5.7	4.3	2.8	1.39
48	8.0	4.8	1.7	8.5	7.0	5.6	4.1	2.6	1.12
49	7.9	4.8	1.6	8.5	7.0	5.4	3.9	2.4	0.86
50	7.9	4.7	1.6	8.4	6.9	5.3	3.7	2.2	0.59
51	187.9	214.7	241.5	268.4	536.8	805.2	1073.5	1341.9	1610.32
52	7.8	4.7	1.5	8.3	6.7	5.0	3.4	1.7	10.06
53	7.8	4.6	1.5	8.3	6.6	4.9	3.2	1.5	09.79
54	7.8	4.6	1.4	8.3	6.5	4.8	3.0	1.3	09.52
55	7.7	4.6	1.4	8.2	6.4	4.6	2.8	1.1	09.26
56	187.7	214.5	241.3	268.2	536.3	804.5	1072.7	1340.8	1608.99
57	7.7	4.5	1.3	8.1	6.2	4.4	2.5	0.6	8.72
58	7.7	4.5	1.3	8.1	6.1	4.2	2.3	0.4	8.45
59	7.6	4.4	1.2	8.0	6.1	4.1	2.1	0.1	8.18
60	7.6	4.4	1.2	8.0	6.0	4.0	1.9	1339.9	1607.91

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	153.9
6	184.7
7	215.5
8	246.3
9	277.1
10	307.9
20	615.7
30	923.6
40	1231.5
50	1539.3
1′ 00	1847.2
2	3694.4
3	5541.6
4	7388.8
5	9236.0
6	11083.3
7	12930.5
8	14777.7
9	16624.9
10	18472.1
11	20319.3
12	22166.5

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.0
4	.0	1.9
5	.0	2.9
6	.0	4.2
7	.0	5.7
8	.0	7.4
9	.0	9.4
10	.0	11.6
15	.0	26.0
20	.0	46.3
25	.1	72.3
30	.1	104.1
35	.2	141.8
40	.3	185.2
45	.4	234.4
50	.5	289.3
55	.7	350.1
1° 00	.9	416.6
1 10	1.4	567.1
1 20	2.1	740.7
1 30	3.0	937.4
1 40	4.1	1157.8
1 50	5.5	1400.3
2 00	7.2	1666.4

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 30° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	187.6	214.4	241.2	268.0	536.0	804.0	1071.9	1339.9	1607.91
1	7.6	4.4	1.1	7.9	5.9	3.8	1.8	9.7	7.65
2	7.5	4.3	1.1	7.9	5.8	3.7	1.6	9.5	7.38
3	7.5	4.3	1.1	7.9	5.7	3.6	1.4	9.3	7.11
4	7.5	4.2	1.0	7.8	5.6	3.4	1.2	9.0	6.84
5	7.4	4.2	1.0	7.8	5.5	3.3	1.0	8.8	6.57
6	187.4	214.2	240.9	267.7	535.4	803.1	1070.9	1338.6	1606.30
7	7.4	4.1	0.9	7.7	5.3	3.0	0.7	8.4	6.03
8	7.3	4.1	0.9	7.6	5.3	2.9	0.5	8.1	5.76
9	7.3	4.1	0.8	7.6	5.2	2.7	0.3	7.9	5.49
10	7.3	4.0	0.8	7.5	5.1	2.6	0.1	7.7	5.22
11	187.2	214.0	240.7	267.5	535.0	802.5	1070.0	1337.5	1604.95
12	7.2	4.0	0.7	7.4	4.9	2.3	1069.8	7.2	4.68
13	7.2	3.9	0.7	7.4	4.8	2.2	9.6	7.0	4.41
14	7.1	3.9	0.6	7.4	4.7	2.1	9.4	6.8	4.14
15	7.1	3.8	0.6	7.3	4.6	1.9	9.2	6.6	3.87
16	187.1	213.8	240.5	267.3	534.5	801.8	1069.1	1336.3	1603.60
17	7.1	3.8	0.5	7.2	4.4	1.7	8.9	6.1	3.32
18	7.0	3.7	0.5	7.2	4.4	1.6	8.7	5.9	3.05
19	7.0	3.7	0.4	7.1	4.3	1.4	8.5	5.6	2.78
20	7.0	3.7	0.4	7.1	4.2	1.3	8.3	5.4	2.51
21	186.9	213.6	240.3	267.0	534.1	801.1	1068.2	1335.2	1602.24
22	6.9	3.6	0.3	7.0	4.0	1.0	8.0	5.0	1.97
23	6.9	3.6	0.3	7.0	3.9	0.8	7.8	4.7	1.70
24	6.8	3.5	0.2	6.9	3.8	0.7	7.6	4.5	1.43
25	6.8	3.5	0.2	6.9	3.7	0.6	7.4	4.3	1.15
26	186.8	213.5	240.1	266.8	533.6	800.4	1067.3	1334.1	1600.88
27	6.7	3.4	0.1	6.8	3.5	0.3	7.1	3.8	0.61
28	6.7	3.4	0.1	6.7	3.4	0.2	6.9	3.6	0.34
29	6.7	3.3	0.0	6.7	3.4	0.0	6.7	3.4	0.06
30	6.6	3.3	0.0	6.6	3.3	799.9	6.5	3.2	1599.79

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	153.9
6	184.7
7	215.5
8	246.3
9	277.1
10	307.9
20	615.8
30	923.7
40	1231.5
50	1539.4
1′ 00	1847.3
2	3694.7
3	5542.0
4	7389.4
5	9236.7
6	11084.1
7	12931.5
8	14778.8
9	16626.2
10	18473.5
11	20320.8
12	22168.2

Co-ordinates of curvature..		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	1.9
5	.0	2.9
6	.0	4.2
7	.0	5.7
8	.0	7.5
9	.0	9.5
10	.0	11.7
15	.0	26.3
20	.0	46.8
25	.1	73.1
30	.1	105.2
35	.2	143.2
40	.3	187.1
45	.4	236.8
50	.5	292.3
55	.7	353.7
1° 00	.9	421.0
1 10	1.5	573.0
1 20	2.2	748.4
1 30	3.1	947.1
1 40	4.2	1169.3
1 50	5.6	1414.8
2 00	7.3	1683.8

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 30° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	186.6	213.3	240.0	266.6	533.3	799.9	1066.5	1333.2	1599.79
31	6.6	3.3	239.9	6.6	3.2	9.8	6.3	2.9	9.52
32	6.6	3.2	9.9	6.5	3.1	9.6	6.2	2.7	9.25
33	6.5	3.2	9.8	6.5	3.0	9.5	6.0	2.5	8.97
34	6.5	3.2	9.8	6.5	2.9	9.4	5.8	2.3	8.70
35	6.5	3.1	9.8	6.4	2.8	9.2	5.6	2.1	8.43
36	186.4	213.1	239.7	266.4	532.7	799.1	1065.4	1331.8	1598.15
37	6.4	3.1	9.7	6.3	2.6	8.9	5.3	1.6	7.88
38	6.4	3.0	9.6	6.3	2.5	8.8	5.1	1.3	7.61
39	6.4	3.0	9.6	6.2	2.4	8.7	4.9	1.1	7.33
40	6.3	2.9	9.6	6.2	2.4	8.5	4.7	0.9	7.06
41	186.3	212.9	239.5	266.1	532.3	738.4	1064.5	1330.6	1596.78
42	6.3	2.9	9.5	6.1	2.2	8.3	4.3	0.4	6.51
43	6.2	2.8	9.4	6.0	2.1	8.1	4.1	0.2	6.24
44	6.2	2.8	9.4	6.0	2.0	8.0	4.0	0.0	5.96
45	6.2	2.8	9.4	5.9	1.9	7.8	3.8	29.7	5.69
46	186.1	212.7	239.3	265.9	531.8	797.7	1063.6	1329.5	1595.41
47	6.1	2.7	9.3	5.9	1.7	7.6	3.4	9.3	5.14
48	6.1	2.6	9.2	5.8	1.6	7.4	3.2	9.0	4.86
49	6.0	2.6	9.2	5.8	1.5	7.3	3.1	8.8	4.59
50	6.0	2.6	9.1	5.7	1.4	7.2	2.9	8.6	4.31
51	186.0	212.5	239.1	265.7	531.3	797.0	1062.7	1328.4	1594.04
52	5.9	2.5	9.1	5.6	1.3	6.9	2.5	8.1	3.76
53	5.9	2.5	9.0	5.6	1.2	6.7	2.3	7.9	3.48
54	5.9	2.4	9.0	5.5	1.1	6.6	2.1	7.7	3.21
55	5.8	2.4	8.9	5.5	1.0	6.5	2.0	7.4	2.93
56	185.8	212.4	238.9	265.4	530.9	796.3	1061.8	1327.2	1592.66
57	5.8	2.3	8.8	5.4	0.8	6.2	1.6	7.0	2.38
58	5.7	2.3	8.8	5.4	0.7	6.0	1.4	6.8	2.10
59	5.7	2.3	8.8	5.3	0.6	5.9	1.2	6.5	1.83
60	5.7	2.2	8.7	5.3	0.5	5.8	1.0	6.3	1.55

Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1″	30.8	1′	—.0	.1
2	61.6	2	.0	.5
3	92.4	3	.0	1.1
4	123.2	4	.0	1.9
5	154.0	5	.0	3.0
6	184.7	6	.0	4.3
7	215.5	7	.0	5.8
8	246.3	8	.0	7.6
9	277.1	9	.0	9.6
10	307.9	10	.0	11.8
20	615.8	15	.0	26.6
30	923.7	20	.0	47.2
40	1231.7	25	.1	73.8
50	1539.6	30	.1	106.3
1′ 00	1847.5	35	.2	144.7
2	3695.0	40	.3	189.0
3	5542.5	45	.4	239.1
4	7390.0	50	.5	295.2
5	9237.4	55	.7	357.2
6	11084.9	1° 00	.9	425.1
7	12932.4	1 10	1.5	578.7
8	14779.9	1 20	2.2	755.8
9	16627.4	1 30	3.2	956.5
10	18474.9	1 40	4.4	1180.9
11	20322.4	1 50	5.8	1428.9
12	22169.9	2 00	7.5	1700.6

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 31° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	185.7	212.2	238.7	265.3	530.5	795.8	1061.0	1326.3	1591.55
1	5.6	2.2	8.7	5.2	0.4	5.6	0.8	6.1	1.27
2	5.6	2.1	8.6	5.2	0.3	5.5	0.7	5.8	1.00
3	5.6	2.1	8.6	5.1	0.2	5.4	0.5	5.6	0.72
4	5.6	2.1	8.6	5.1	0.1	5.2	0.3	5.4	0.44
5	5.5	2.0	8.5	5.0	0.1	5.1	1060.1	5.1	1590.16
6	185.5	212.0	238.5	265.0	530.0	794.9	1059.9	1324.9	1589.89
7	5.5	1.9	8.4	4.9	529.9	4.8	9.7	4.7	9.61
8	5.4	1.9	8.4	4.9	9.8	4.7	9.6	4.4	9.33
9	5.4	1.9	8.4	4.8	9.7	4.5	9.4	4.2	9.05
10	5.4	1.8	8.3	4.8	9.6	4.4	9.2	4.0	8.78
11	185.3	211.8	238.3	264.7	529.5	794.2	1059.0	1323.7	1588.50
12	5.3	1.8	8.2	4.7	9.4	4.1	8.8	3.5	8.22
13	5.3	1.7	8.2	4.7	9.3	4.0	8.6	3.3	7.94
14	5.2	1.7	8.1	4.6	9.2	3.8	8.4	3.0	7.66
15	5.2	1.7	8.1	4.6	9.1	3.7	8.2	2.8	7.38
16	185.2	211.6	238.1	264.5	529.0	793.5	1058.1	1322.6	1587.10
17	5.1	1.6	8.0	4.5	8.9	3.4	7.9	2.4	6.82
18	5.1	1.5	8.0	4.4	8.8	3.3	7.7	2.1	6.54
19	5.1	1.5	7.9	4.4	8.8	3.1	7.5	1.9	6.27
20	5.0	1.5	7.9	4.3	8.7	3.0	7.3	1.7	5.99
21	185.0	211.4	237.9	264.3	528.6	792.9	1057.1	1321.4	1585.71
22	5.0	1.4	7.8	4.2	8.5	2.7	7.0	1.2	5.43
23	4.9	1.4	7.8	4.2	8.4	2.6	6.8	1.0	5.15
24	4.9	1.3	7.7	4.1	8.3	2.4	6.6	0.7	4.87
25	4.9	1.3	7.7	4.1	8.2	2.3	6.4	0.5	4.58
26	184.8	211.2	237.6	264.0	528.1	792.1	1056.2	1320.3	1584.30
27	4.8	1.2	7.6	4.0	8.0	2.0	6.0	0.0	4.02
28	4.8	1.2	7.6	4.0	7.9	1.9	5.8	1319.8	3.74
29	4.7	1.1	7.5	3.9	7.8	1.7	5.6	9.6	3.46
30	4.7	1.1	7.5	3.9	7.7	1.6	5.5	9.3	3.18

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.0
6	184.8
7	215.5
8	246.3
9	277.1
10	307.9
20	615.9
30	923.8
40	1231.7
50	1539.7
1′ 00	1847.6
2	3695.3
3	5542.9
4	7390.5
5	9238.1
6	11085.8
7	12933.4
8	14781.1
9	16628.7
10	18476.3
11	20324.0
12	22171.6

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	1.9
5	.0	3.0
6	.0	4.3
7	.0	5.8
8	.0	7.6
9	.0	9.7
10	.0	11.9
15	.0	26.8
20	.0	47.7
25	.1	74.5
30	.1	107.3
35	.2	146.0
40	.3	190.8
45	.4	241.4
50	.6	298.0
55	.7	360.6
1° 00	1.0	429.2
1 10	1.5	584.2
1 20	2.3	763.0
1 30	3.3	965.7
1 40	4.5	1192.2
1 50	5.9	1442.5
2 00	7.7	1716.7

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 31° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	184.7	211.1	237.5	263.9	527.7	791.6	1055.5	1319.3	1583.18
31	4.7	1.1	7.4	3.8	7.6	1.5	5.3	9.1	2.90
32	4.6	1.0	7.4	3.8	7.5	1.3	5.1	8.9	2.62
33	4.6	1.0	7.4	3.7	7.4	1.2	4.9	8.6	2.34
34	4.6	0.9	7.3	3.7	7.4	1.0	4.7	8.4	2.06
35	4.5	0.9	7.3	3.6	7.3	0.9	4.5	8.1	1.78
36	184.5	210.9	237.2	263.6	527.2	790.7	1054.3	1317.9	1581.50
37	4.5	0.8	7.2	3.5	7.1	0.6	4.1	7.7	1.21
38	4.4	0.8	7.1	3.5	7.0	0.5	4.0	7.4	0.93
39	4.4	0.8 *	7.1	3.4	6.9	0.3	3.8	7.2	0.65
40	4.4	0.7	7.1	3.4	6.8	0.2	3.6	7.0	0.37
41	184.3	210.7	237.0	263.3	526.7	790.0	1053.4	1316.7	1580.09
42	4.3	0.6	7.0	3.3	6.6	789.9	3.2	6.5	79.80
43	4.3	0.6	6.9	3.2	6.5	9.8	3.0	6.3	9.52
44	4.2	0.6	6.9	3.2	6.4	9.6	2.8	6.0	9.24
45	4.2	0.5	6.8	3.2	6.3	9.5	2.6	5.8	8.96
46	184.2	210.5	236.8	263.1	526.2	789.3	1052.5	1315.6	1578.67
47	4.1	0.5	6.8	3.1	6.1	9.2	2.3	5.3	8.39
48	4.1	0.4	6.7	3.0	6.0	9.1	2.1	5.1	8.11
49	4.1	0.4	6.7	3.0	5.9	8.9	1.9	4.9	7.82
50	4.0	0.3	6.6	2.9	5.8	8.8	1.7	4.6	7.54
51	184.0	210.3	236.6	262.9	525.8	788.6	1051.5	1314.4	1577.26
52	4.0	0.3	6.5	2.8	5.7	8.5	1.3	4.1	6.97
53	3.9	0.2	6.5	2.8	5.6	8.3	1.1	3.9	6.69
54	3.9	0.2	6.5	2.7	5.5	8.2	0.9	3.7	6.41
55	3.9	0.1	6.4	2.7	5.4	8.1	0.8	3.4	6.12
56	183.8	210.1	236.4	262.6	525.3	787.9	1050.6	1313.2	1575.84
57	3.8	0.1	6.3	2.6	5.2	7.8	0.4	3.0	5.55
58	3.8	0.0	6.3	2.5	5.1	7.6	0.2	2.7	5.27
59	3.7	0.0	6.2	2.5	5.0	7.5	0.0	2.5	4.98
60	3.7	0.0	6.2	2.4	4.9	7.3	1049.8	2.2	4.70

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.0
6	184.8
7	215.6
8	246.4
9	277.2
10	308.0
20	615.9
30	923.9
40	1231.8
50	1539.8
1′ 00	1847.8
2	3695.5
3	5543.3
4	7391.1
5	9238.9
6	11086.7
7	12934.4
8	14782.2
9	16630.0
10	18477.8
11	20325.5
12	22173.3

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	1.9
5	.0	3.0
6	.0	4.3
7	.0	5.9
8	.0	7.7
9	.0	9.7
10	.0	12.0
15	.0	27.1
20	.0	48.1
25	.1	75.2
30	.1	108.4
35	.2	147.4
40	.3	192.5
45	.4	243.6
50	.6	300.8
55	.8	364.0
1° 00	1.0	433.1
1 10	1.6	589.5
1 20	2.3	770.0
1 30	3.3	974.5
1 40	4.6	1203.1
1 50	6.1	1455.8
2 00	7.9	1732.5

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 32° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	183.7	210.0	236.2	262.4	524.9	787.3	1049.8	1312.2	1574.70
1	3.7	209.9	6.2	2.4	4.8	7.2	9.6	2.0	4.41
2	3.6	9.9	6.1	2.3	4.7	7.1	9.4	1.8	4.13
3	3.6	9.8	6.1	2.3	4.6	6.9	9.2	1.5	3.84
4	3.6	9.8	6.0	2.3	4.5	6.8	9.0	1.3	3.56
5	3.5	9.8	6.0	2.2	4.4	6.6	8.9	1.1	3.27
6	183.5	209.7	235.9	262.2	524.3	786.5	1048.7	1310.8	1572.98
7	3.5	9.7	5.9	2.1	4.2	6.3	8.5	0.6	2.70
8	3.4	9.7	5.9	2.1	4.1	6.2	8.3	0.3	2.41
9	3.4	9.6	5.8	2.0	4.0	6.1	8.1	0.1	2.13
10	3.4	9.6	5.8	2.0	3.9	5.9	7.9	1309.9	1.84
11	183.3	209.5	235.7	261.9	523.9	785.8	1047.7	1309.6	1571.55
12	3.3	9.5	5.7	1.9	3.8	5.6	7.5	9.4	1.27
13	3.3	9.5	5.6	1.8	3.7	5.5	7.3	9.1	0.98
14	3.2	9.4	5.6	1.8	3.6	5.3	7.1	8.9	0.70
15	3.2	9.4	5.6	1.7	3.5	5.2	6.9	8.7	0.41
16	183.2	209.3	235.5	261.7	523.4	785.1	1046.7	1308.4	1570.12
17	3.1	9.3	5.5	1.6	3.3	4.9	6.5	8.2	69.83
18	3.1	9.3	5.4	1.6	3.2	4.8	6.4	8.0	9.55
19	3.1	9.2	5.4	1.5	3.1	4.6	6.2	7.7	9.26
20	3.0	9.2	5.4	1.5	3.0	4.5	6.0	7.5	8.97
21	183.0	209.2	235.3	261.4	522.9	784.3	1045.8	1307.2	1568.68
22	3.0	9.1	5.3	1.4	2.8	4.2	5.6	7.0	8.40
23	2.9	9.1	5.2	1.4	2.7	4.1	5.4	6.8	8.11
24	2.9	9.0	5.2	1.3	2.6	3.9	5.2	6.5	7.83
25	2.9	9.0	5.1	1.3	2.5	3.8	5.0	6.3	7.54
26	182.8	209.0	235.1	261.2	522.4	783.6	1044.8	1306.0	1567.25
27	2.8	8.9	5.0	1.2	2.3	3.5	4.6	5.8	6.96
28	2.8	8.9	5.0	1.1	2.2	3.3	4.4	5.6	6.67
29	2.7	8.8	5.0	1.1	2.1	3.2	4.3	5.3	6.38
30	2.7	8.8	4.9	1.0	2.0	3.0	4.1	5.1	6.09

Meridional arc.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.0
6	184.8
7	215.6
8	246.4
9	277.2
10	308.0
20	616.0
30	924.0
40	1231.9
50	1539.9
1′ 00	1847.9
2	3695.8
3	5543.8
4	7391.7
5	9239.6
6	11087.5
7	12935.4
8	14783.4
9	16631.3
10	18479.2
11	20327.1
12	22175.0

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	1.9
5	.0	3.0
6	.0	4.3
7	.0	5.9
8	.0	7.8
9	.0	9.8
10	.0	12.1
15	.0	27.3
20	.0	48.5
25	.1	75.9
30	.1	109.2
35	.2	148.7
40	.3	194.2
45	.4	245.8
50	.6	303.4
55	.8	367.1
1° 00	1.0	436.9
1 10	1.6	594.7
1 20	2.4	776.7
1 30	3.4	983.0
1 40	4.7	1213.7
1 50	6.2	1468.5
2 00	8.1	1747.6

TABLE VI.—*Projection Tables*—Continued.

Latitude 32° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	182.7	208.8	234.9	261.0	522.0	783.0	1044.1	1305.1	1566.09
31	2.7	8.8	4.9	1.0	1.9	2.9	3.9	4.8	5.80
32	2.6	8.7	4.8	0.9	1.8	2.8	3.7	4.6	5.51
33	2.6	8.7	4.8	0.9	1.7	2.6	3.5	4.4	5.23
34	2.6	8.7	4.7	0.8	1.6	2.5	3.3	4.1	4.94
35	2.5	8.6	4.7	0.8	1.5	2.3	3.1	3.9	4.65
36	182.5	208.6	234.6	260.7	521.5	782.2	1042.9	1303.6	1564.36
37	2.5	8.5	4.6	0.7	1.4	2.0	2.7	3.4	4.07
38	2.4	8.5	4.6	0.6	1.3	1.9	2.5	3.1	3.78
39	2.4	8.5	4.5	0.6	1.2	1.7	2.3	2.9	3.49
40	2.4	8.4	4.5	0.5	1.1	1.6	2.1	2.7	3.20
41	182.3	208.4	234.4	260.5	521.0	781.5	1041.9	1302.4	1562.91
42	2.3	8.4	4.4	0.4	0.9	1.3	1.8	2.2	2.62
43	2.3	8.3	4.3	0.4	0.8	1.2	1.6	1.9	2.33
44	2.2	8.3	4.3	0.3	0.7	1.0	1.4	1.7	2.04
45	2.2	8.2	4.3	0.3	0.6	0.9	1.2	1.5	1.75
46	182.2	208.2	234.2	260.2	520.5	780.7	1041.0	1301.2	1561.46
47	2.1	8.2	4.2	0.2	0.4	0.6	0.8	1.0	1.17
48	2.1	8.1	4.1	0.1	0.3	0.4	0.6	0.7	0.87
49	2.1	8.1	4.1	0.1	0.2	0.3	0.4	0.5	0.58
50	2.0	8.0	4.0	0.0	0.1	0.2	0.2	0.3	0.29
51	182.0	208.0	234.0	260.0	520.0	780.0	1040.0	1300.0	1560.00
52	2.0	8.0	4.0	0.0	519.9	779.9	39.8	1299.8	59.71
53	1.9	7.9	3.9	259.9	9.8	9.7	9.6	9.5	9.41
54	1.9	7.9	3.9	9.9	9.7	9.6	9.4	9.3	9.12
55	1.9	7.8	3.8	9.8	9.6	9.4	9.2	9.0	8.83
56	181.8	207.8	233.8	259.8	519.5	779.3	1039.0	1298.8	1558.54
57	1.8	7.8	3.7	9.7	9.4	9.1	8.8	8.5	8.25
58	1.8	7.7	3.7	9.7	9.3	9.0	8.6	8.3	7.95
59	1.7	7.7	3.6	9.6	9.2	8.8	8.4	8.0	7.66
60	1.7	7.6	3.6	9.6	9.1	8.7	8.3	7.8	7.37

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.0
6	184.8
7	215.6
8	246.4
9	277.2
10	308.0
20	616.0
30	924.0
40	1232.1
50	1540.1
1′ 00	1848.1
2	3696.1
3	5544.2
4	7392.3
5	9240.3
6	11088.4
7	12936.5
8	14784.5
9	16632.6
10	18480.7
11	20328.7
12	22176.8

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	2.0
5	.0	3.1
6	.0	4.4
7	.0	6.0
8	.0	7.8
9	.0	9.9
10	.0	12.2
15	.0	27.5
20	.0	49.0
25	.1	76.5
30	.1	110.1
35	.2	149.9
40	.3	195.8
45	.4	247.8
50	.6	306.0
55	.8	370.2
1° 00	1.0	440.6
1 10	1.6	599.7
1 20	2.4	783.3
1 30	3.5	991.3
1 40	4.8	1223.9
1 50	6.4	1480.9
2 00	8.3	1762.4

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 33° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	181.7	207.6	233.6	259.6	519.1	778.7	1038.3	1297.8	1557.37
1	1.7	7.6	3.6	9.5	9.0	8.5	8.1	7.6	7.08
2	1.6	7.6	3.5	9.5	8.9	8.4	7.9	7.3	6.78
3	1.6	7.5	3.5	9.4	8.8	8.2	7.7	7.1	6.49
4	1.6	7.5	3.4	9.4	8.7	8.1	7.5	6.8	6.19
5	1.5	7.5	3.4	9.3	8.6	8.0	7.3	6.6	5.90
6	181.5	207.4	233.3	259.3	518.5	777.8	1037.1	1296.3	1555.61
7	1.5	7.4	3.3	9.2	8.4	7.7	6.9	6.1	5.31
8	1.4	7.3	3.3	9.2	8.3	7.5	6.7	5.8	5.02
9	1.4	7.3	3.2	9.1	8.2	7.4	6.5	5.6	4.72
10	1.3	7.3	3.2	9.1	8.1	7.2	6.3	5.4	4.43
11	181.3	207.2	233.1	259.0	518.0	777.1	1036.1	1295.1	1554.14
12	1.3	7.2	3.1	9.0	7.9	6.9	5.9	4.9	3.84
13	1.2	7.1	3.0	8.9	7.8	6.8	5.7	4.6	3.55
14	1.2	7.1	3.0	8.9	7.7	6.6	5.5	4.4	3.25
15	1.2	7.1	2.9	8.8	7.7	6.5	5.3	4.1	2.96
16	181.1	207.0	232.9	258.8	517.6	776.3	1035.1	1293.9	1552.66
17	1.1	7.0	2.8	8.7	7.5	6.2	4.9	3.6	2.37
18	1.1	6.9	2.8	8.7	7.4	6.0	4.7	3.4	2.07
19	1.0	6.9	2.8	8.6	7.3	5.9	4.5	3.1	1.78
20	1.0	6.9	2.7	8.6	7.2	5.7	4.3	2.9	1.48
21	181.0	206.8	232.7	258.5	517.1	775.6	1034.1	1292.7	1551.19
22	0.9	6.8	2.6	8.5	7.0	5.4	3.9	2.4	0.89
23	0.9	6.7	2.6	8.4	6.9	5.3	3.7	2.2	0.60
24	0.9	6.7	2.5	8.4	6.8	5.1	3.5	1.9	0.30
25	0.8	6.7	2.5	8.3	6.7	5.0	3.3	1.7	0.01
26	0.8	206.6	232.5	258.3	516.6	774.9	1033.1	1291.4	1549.71
27	0.8	6.6	2.4	8.2	6.5	4.7	2.9	1.2	9.41
28	0.7	6.5	2.4	8.2	6.4	4.6	2.7	0.9	9.12
29	0.7	6.5	2.3	8.1	6.3	4.4	2.5	0.7	8.82
30	0.7	6.5	2.3	8.1	6.2	4.3	2.3	0.4	8.52

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.0
6	184.8
7	215.6
8	246.4
9	277.2
10	308.0
20	616.1
30	924.1
40	1232.1
50	1540.2
1′ 00	1848.2
2	3696.4
3	5544.6
4	7392.8
5	9241.0
6	11089.3
7	12937.5
8	14785.7
9	16633.9
10	18482.1
11	20330.3
12	22178.6

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	2.0
5	.0	3.1
6	.0	4.4
7	.0	6.0
8	.0	7.9
9	.0	10.0
10	.0	12.3
15	.0	27.8
20	.0	49.3
25	.1	77.1
30	.1	111.0
35	.2	151.1
40	.3	197.4
45	.4	249.8
50	.6	308.4
55	.8	373.2
1° 00	1.1	444.1
1 10	1.7	604.5
1 20	2.5	789.5
1 30	3.6	999.3
1 40	4.9	1233.7
1 50	6.5	1492.8
2 00	8.5	1776.4

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 33° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	180.7	206.5	232.3	258.1	516.2	774.3	1032.3	1290.4	1548.52
31	0.6	6.4	2.2	8.0	6.1	4.1	2.1	0.2	8.22
32	0.6	6.4	2.2	8.0	6.0	4.0	2.0	89.9	7.93
33	0.6	6.4	2.1	7.9	5.9	3.8	1.8	9.7	7.63
34	0.5	6.3	2.1	7.9	5.8	3.7	1.6	9.5	7.34
35	0.5	6.3	2.1	7.8	5.7	3.5	1.4	9.2	7.04
36	180.5	206.2	232.0	257.8	515.6	773.4	1031.2	1289.0	1546.74
37	0.4	6.2	2.0	7.7	5.5	3.2	1.0	8.7	6.44
38	0.4	6.2	1.9	7.7	5.4	3.1	0.8	8.5	6.15
39	0.3	6.1	1.9	7.6	5.3	2.9	0.6	8.2	5.85
40	0.3	6.1	1.8	7.6	5.3	2.8	0.4	8.0	5.55
41	180.3	206.0	231.8	257.5	515.1	772.6	1030.2	1287.7	1545.25
42	0.2	6.0	1.7	7.5	5.0	2.5	30.0	7.5	4.95
43	0.2	6.0	1.7	7.4	4.9	2.3	29.8	7.2	4.66
44	0.2	5.9	1.7	7.4	4.8	2.2	9.6	7.0	4.36
45	0.1	5.9	1.6	7.3	4.7	2.0	9.4	6.7	4.06
46	180.1	205.8	231.6	257.3	514.6	771.9	1029.2	1286.5	1543.76
47	0.1	5.8	1.5	7.2	4.5	1.7	9.0	6.2	3.46
48	0.0	5.8	1.5	7.2	4.4	1.6	8.8	6.0	3.16
49	0.0	5.7	1.4	7.1	4.3	1.4	8.6	5.7	2.86
50	0.0	5.7	1.4	7.1	4.2	1.3	8.4	5.5	2.56
51	179.9	205.6	231.3	257.0	514.1	771.1	1028.2	1285.2	1542.26
52	9.9	5.6	1.3	7.0	4.0	1.0	8.0	5.0	1.96
53	9.9	5.6	1.3	6.9	3.9	0.8	7.8	4.7	1.66
54	9.8	5.5	1.2	6.9	3.8	0.7	7.6	4.5	1.36
55	9.8	5.5	1.2	6.8	3.7	0.5	7.4	4.2	1.06
56	179.8	205.4	231.1	256.8	513.6	770.4	1027.2	1284.0	1540.76
57	9.7	5.4	1.1	6.7	3.5	0.2	7.0	3.7	0.46
58	9.7	5.4	1.0	6.7	3.4	0.1	6.8	3.5	0.16
59	9.6	5.3	1.0	6.6	3.3	769.9	6.6	3.2	39.86
60	9.6	5.3	0.9	6.6	3.2	9.8	6.4	3.0	1539.56

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.0
6	184.8
7	215.6
8	246.4
9	277.3
10	308.1
20	616.1
30	924.2
40	1232.2
50	1540.3
1′ 00	1848.4
2	3696.7
3	5545.1
4	7393.5
5	9241.8
6	11090.2
7	12938.5
8	14786.9
9	16635.3
10	18483.6
11	20332.0
12	22180.4

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	2.0
5	.0	3.1
6	.0	4.5
7	.0	6.1
8	.0	8.0
9	.0	10.1
10	.0	12.4
15	.0	28.0
20	.0	49.7
25	.1	77.7
30	.1	111.9
35	.2	152.3
40	.3	198.9
45	.5	251.5
50	.6	310.7
55	.8	376.0
1° 00	1.1	447.5
1 10	1.7	609.1
1 20	2.6	795.6
1 30	3.6	1006.9
1 40	5.0	1243.1
1 50	6.6	1504.1
2 00	8.6	1790.0

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 34° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	179.6	205.3	230.9	256.6	513.2	769.8	1026.4	1283.0	1539.56
1	9.6	5.2	0.9	6.5	3.1	9.6	6.2	2.7	9.26
2	9.5	5.2	0.8	6.5	3.0	9.5	6.0	2.5	8.96
3	9.5	5.2	0.8	6.4	2.9	9.3	5.8	2.2	8.66
4	9.5	5.1	0.8	6.4	2.8	9.2	5.6	2.0	8.36
5	9.4	5.1	0.7	6.3	2.7	9.0	5.4	1.7	8.06
6	179.4	205.0	230.7	256.3	512.6	768.9	1025.2	1281.5	1537.76
7	9.4	5.0	0.6	6.2	2.5	8.7	5.0	1.2	7.45
8	9.3	5.0	0.6	6.2	2.4	8.6	4.8	1.0	7.15
9	9.3	4.9	0.5	6.1	2.3	8.4	4.6	0.7	6.85
10	9.3	4.9	0.5	6.1	2.2	8.3	4.4	0.5	6.55
11	179.2	204.8	230.4	256.0	512.1	768.1	1024.2	1280.2	1536.25
12	9.2	4.8	0.4	6.0	2.0	8.0	4.0	0.0	5.95
13	9.2	4.8	0.4	5.9	1.9	7.8	3.8	79.7	5.64
14	9.1	4.7	0.3	5.9	1.8	7.7	3.6	9.5	5.34
15	9.1	4.7	0.3	5.8	1.7	7.5	3.4	9.2	5.04
16	179.1	204.6	230.2	255.8	511.6	767.4	1023.2	1279.0	1534.74
17	9.0	4.6	0.2	5.7	1.5	7.2	3.0	8.7	4.43
18	9.0	4.6	0.1	5.7	1.4	7.1	2.8	8.4	4.13
19	8.9	4.5	0.1	5.6	1.3	6.9	2.6	8.2	3.83
20	8.9	4.5	0.0	5.6	1.2	6.8	2.3	7.9	3.53
21	178.9	204.4	230.0	255.5	511.1	766.6	1022.1	1277.7	1533.22
22	8.8	4.4	29.9	5.5	1.0	6.5	1.9	7.4	2.92
23	8.8	4.3	9.9	5.4	0.9	6.3	1.7	7.2	2.61
24	8.8	4.3	9.8	5.4	0.8	6.2	1.5	6.9	2.31
25	8.7	4.3	9.8	5.3	0.7	6.0	1.3	6.7	2.00
26	178.7	204.2	229.8	255.3	510.6	765.8	1021.1	1266.4	1531.70
27	8.7	4.2	9.7	5.2	0.5	5.7	0.9	6.2	1.40
28	8.6	4.1	9.7	5.2	0.4	5.5	0.7	5.9	1.09
29	8.6	4.1	9.6	5.1	0.3	5.4	0.5	5.6	0.79
30	8.6	4.1	9.6	5.1	0.2	5.2	0.3	5.4	0.48

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.0
6	184.9
7	215.7
8	246.5
9	277.3
10	308.1
20	616.2
30	924.3
40	1232.3
50	1540.4
1′ 00	1848.5
2	3697.0
3	5545.5
4	7394.0
5	9242.6
6	11091.1
7	12939.6
8	14788.1
9	16636.6
10	18485.1
11	20333.6
12	22182.1

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	2.0
5	.0	3.1
6	.0	4.5
7	.0	6.1
8	.0	8.0
9	.0	10.1
10	.0	12.5
15	.0	28.2
20	.0	50.1
25	.1	78.3
30	.1	112.7
35	.2	153.4
40	.3	200.4
45	.5	253.5
50	.6	313.0
55	.8	378.8
1° 00	1.1	450.8
1 10	1.7	613.6
1 20	2.6	801.4
1 30	3.7	1014.2
1 40	5.1	1252.2
1 50	6.8	1515.1
2 00	8.8	1803.1

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 34° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	178.6	204.1	229.6	255.1	510.2	765.2	1020.3	1275.4	1530.48
31	8.5	4.0	9.5	5.0	0.1	5.1	0.1	5.1	0.18
32	8.5	4.0	9.5	5.0	0.0	4.9	19.9	4.9	29.87
33	8.4	3.9	9.4	4.9	509.9	4.8	9.7	4.6	9.57
34	8.4	3.9	9.4	4.9	9.8	4.6	9.5	4.4	9.26
35	8.4	3.9	9.3	4.8	9.7	4.5	9.3	4.1	8.96
36	178.3	203.8	229.3	254.8	509.5	764.3	1019.1	1273.9	1528.65
37	8.3	3.8	9.3	4.7	9.4	4.2	8.9	3.6	8.35
38	8.3	3.7	9.2	4.7	9.3	4.0	8.7	3.4	8.04
39	8.2	3.7	9.2	4.6	9.2	3.9	8.5	3.1	7.74
40	8.2	3.7	9.1	4.6	9.1	3.7	8.3	2.9	7.43
41	178.2	203.6	229.1	254.5	509.0	763.6	1018.1	1272.6	1527.13
42	8.1	3.6	9.0	4.5	8.9	3.4	7.9	2.4	6.82
43	8.1	3.5	9.0	4.4	8.8	3.3	7.7	2.1	6.51
44	8.1	3.5	8.9	4.4	8.7	3.1	7.5	1.8	6.21
45	8.0	3.5	8.9	4.3	8.6	2.9	7.3	1.6	5.90
46	178.0	203.4	228.8	254.3	508.5	762.8	1017.1	1271.3	1525.59
47	8.0	3.4	8.8	4.2	8.4	2.6	6.9	1.1	5.29
48	7.9	3.3	8.7	4.2	8.3	2.5	6.7	0.8	4.98
49	7.9	3.3	8.7	4.1	8.2	2.3	6.5	0.6	4.67
50	7.8	3.3	8.7	4.1	8.1	2.2	6.3	0.3	4.37
51	177.8	203.2	228.6	254.0	508.0	762.0	1016.0	1270.0	1524.06
52	7.8	3.2	8.6	4.0	7.9	1.9	5.8	69.8	3.75
53	7.7	3.1	8.5	3.9	7.8	1.7	5.6	9.5	3.44
54	7.7	3.1	8.5	3.9	7.7	1.6	5.4	9.3	3.14
55	7.7	3.0	8.4	3.8	7.6	1.4	5.2	9.0	2.83
56	177.6	203.0	228.4	253.8	507.5	761.3	1015.0	1268.8	1522.52
57	7.6	3.0	8.3	3.7	7.4	1.1	4.8	8.5	2.21
58	7.6	2.9	8.3	3.6	7.3	0.9	4.6	8.3	1.90
59	7.5	2.9	8.2	3.6	7.2	0.8	4.4	8.0	1.60
60	7.5	2.8	8.2	3.5	7.1	0.6	4.2	7.7	1.29

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.1
6	184.9
7	215.7
8	246.5
9	277.3
10	308.1
20	616.2
30	924.3
40	1232.4
50	1540.6
1′ 00	1848.7
2	3697.3
3	5546.0
4	7394.6
5	9243.3
6	11092.0
7	12940.6
8	14789.3
9	16638.0
10	18486.6
11	20335.3
12	22183.9

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	2.0
5	.0	3.1
6	.0	4.5
7	.0	6.2
8	.0	8.1
9	.0	10.2
10	.0	12.6
15	.0	28.4
20	.0	50.4
25	.1	78.8
30	.1	113.5
35	.2	154.5
40	.3	201.7
45	.5	255.3
50	.7	315.2
55	.9	381.4
1° 00	1.1	453.9
1 10	1.8	617.8
1 20	2.7	806.9
1 30	3.8	1021.2
1 40	5.2	1260.8
1 50	6.9	1525.6
2 00	9.0	1815.5

TABLE VI.—*Projection Tables*—Continued.

Latitude 35° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	177.5	202.8	228.2	253.5	507.1	760.6	1014.2	1267.7	1521.29
1	7.4	2.8	8.1	3.5	7.0	0.5	4.0	7.5	0.98
2	7.4	2.8	8.1	3.4	6.9	0.3	3.8	7.2	0.67
3	7.4	2.7	8.1	3.4	6.8	0.2	3.6	7.0	0.36
4	7.3	2.7	8.0	3.3	6.7	0.0	3.4	6.7	0.05
5	7.3	2.6	8.0	3.3	6.6	59.9	3.2	6.4	19.74
6	177.3	202.6	227.9	253.2	506.5	759.7	1013.0	1266.2	1519.43
7	7.2	2.5	7.9	3.2	6.4	9.6	2.8	5.9	9.13
8	7.2	2.5	7.8	3.1	6.3	9.4	2.5	5.7	8.82
9	7.2	2.5	7.8	3.1	6.2	9.3	2.3	5.4	8.51
10	7.1	2.4	7.7	3.0	6.1	9.1	2.1	5.2	8.20
11	177.1	202.4	227.7	253.0	506.0	758.9	1011.9	1264.9	1517.89
12	7.1	2.3	7.6	2.9	5.9	8.8	1.7	4.6	7.58
13	7.0	2.3	7.6	2.9	5.8	8.6	1.5	4.4	7.27
14	7.0	2.3	7.5	2.8	5.6	8.5	1.3	4.1	6.96
15	6.9	2.2	7.5	2.8	5.5	8.3	1.1	3.9	6.65
16	176.9	202.2	227.5	252.7	505.4	758.2	1010.9	1263.6	1516.34
17	6.9	2.1	7.4	2.7	5.3	8.0	0.7	3.4	6.03
18	6.8	2.1	7.4	2.6	5.2	7.9	0.5	3.1	5.71
19	6.8	2.1	7.3	2.6	5.1	7.7	0.3	2.8	5.40
20	6.8	2.0	7.3	2.5	5.0	7.5	0.1	2.6	5.09
21	176.7	202.0	227.2	252.5	504.9	757.4	1009.9	1262.3	1514.78
22	6.7	1.9	7.2	2.4	4.8	7.2	9.6	2.1	4.47
23	6.7	1.9	7.1	2.4	4.7	7.1	9.4	1.8	4.16
24	6.6	1.8	7.1	2.3	4.6	6.9	9.2	1.5	3.85
25	6.6	1.8	7.0	2.3	4.5	6.8	9.0	1.3	3.54
26	176.5	201.8	227.0	252.2	504.4	756.6	1008.8	1261.0	1513.22
27	6.5	1.7	6.9	2.2	4.3	6.5	8.6	0.8	2.91
28	6.5	1.7	6.9	2.1	4.2	6.3	8.4	0.5	2.60
29	6.4	1.6	6.8	2.0	4.1	6.1	8.2	0.2	2.29
30	6.4	1.6	6.8	2.0	4.0	6.0	8.0	0.0	1.98

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.2
5	154.1
6	184.9
7	215.7
8	246.5
9	277.3
10	308.1
20	616.2
30	924.4
40	1232.5
50	1540.6
1′ 00	1848.8
2	3697.6
3	5546.4
4	7395.2
5	9244.0
6	11092.9
7	12941.7
8	14790.5
9	16639.3
10	18488.2
11	20337.0
12	22185.8

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	2.0
5	.0	3.2
6	.0	4.6
7	.0	6.2
8	.0	8.1
9	.0	10.3
10	.0	12.7
15	.0	28.6
20	.0	50.8
25	.1	79.3
30	.1	114.2
35	.2	155.5
40	.3	203.0
45	.5	257.0
50	.7	317.3
55	.9	383.9
1° 00	1.1	456.9
1 10	1.8	621.9
1 20	2.7	812.2
1 30	3.9	1028.0
1 40	5.3	1269.1
1 50	7.0	1535.6
2 00	9.1	1827.5

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 35° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	176.4	201.6	226.8	252.0	504.0	756.0	1008.0	1260.0	1511.98
31	6.4	1.6	6.7	1.9	3 9	5.8	7.8	59.7	1.66
32	6.3	1.5	6.7	1.9	3.8	5.7	7.6	9.5	1.35
33	6.3	1.5	6.7	1.8	3.7	5.5	7.4	9.2	1.04
34	6.3	1.4	6.6	1.8	3.6	5.4	7.2	8.9	0.73
35	6.2	1.4	6.6	1.7	3.5	5.2	6.9	8.7	0.41
36	176.2	201.3	226.5	251.7	503.4	755.0	1006.7	1258.4	1510.10
37	6.1	1.3	6.5	1.6	3.3	4.9	6.5	8.2	1509.79
38	6.1	1.3	6.4	1.6	3.2	4.7	6.3	7.9	9.47
39	6.1	1.2	6.4	1.5	3.0	4.6	6.1	7.6	9.16
40	6.0	1.2	6.3	1.5	2.9	4.4	5.9	7.4	8.85
41	176.0	201.1	226.3	251.4	502.8	754.3	1005.7	1257.1	1508.53
42	6.0	1.1	6.2	1.4	2.7	4.1	5.5	6.9	8.22
43	5.9	1.1	6.2	1.3	2.6	4.0	5.3	6.6	7.91
44	5.9	1.0	6.1	1.3	2.5	3.8	5.1	6.3	7.59
45	5.8	1.0	6.1	1.2	2.4	3.6	4.8	6.1	7.28
46	175.8	200.9	226.0	251.2	502.3	753.5	1004.6	1255.8	1506.96
47	5.8	0.9	6.0	1.1	2.2	3.3	4.4	5.5	6.65
48	5.7	0.8	5.9	1.1	2.1	3.2	4.2	5.3	6.33
49	5.7	0.8	5.9	1.0	2.0	3.0	4.0	5.0	6.02
50	5.7	0.8	5.9	1.0	1.9	2.9	3.8	4.8	5.71
51	175.6	200.7	225.8	250.9	501.8	752.7	1003.6	1254.5	1505.39
52	5.6	0.7	5.8	0.8	1.7	2.5	3.4	4.2	5.08
53	5.6	0.6	5.7	0.8	1.6	2.4	3.2	4.0	4.76
54	5.5	0.6	5.7	0.7	1.5	2.2	3.0	3.7	4.44
55	5.5	0.6	5.6	0.7	1.4	2.1	2.8	3.4	4.13
56	175.4	200.5	225.6	250.6	501.3	751.9	1002.5	1253.2	1503.81
57	5.4	0.5	5.5	0.6	1.2	1.7	2.3	2.9	3.50
58	5.4	0.4	5.5	0.5	1.1	1.6	2.1	2.6	3.18
59	5.3	0.4	5.4	0.5	1.0	1.4	1.9	2.4	2.86
60	5.3	0.3	5.4	0.4	0.8	1.3	1.7	2.1	2.55

Meridional arcs.	
1″	30.8
2	61.6
3	92.4
4	123.3
5	154.1
6	184.9
7	215.7
8	246.5
9	277.3
10	308.2
20	616.3
30	924.5
40	1232.6
50	1540.8
1′ 00	1849.0
2	3697.9
3	5546.9
4	7395.9
5	9244.8
6	11093.8
7	12942.8
8	14791.7
9	16640.7
10	18489.7
11	20338.6
12	22187.6

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.1
4	.0	2.0
5	.0	3.2
6	.0	4.6
7	.0	6.3
8	.0	8.2
9	.0	10.3
10	.0	12.8
15	.0	28.7
20	.0	51.1
25	.1	79.8
30	.1	114.9
35	.2	156.4
40	.3	204.3
45	.5	258.6
50	.7	319.2
55	.9	386.3
1° 00	1.2	459.7
1 10	1.8	625.7
1 20	2.8	817.3
1 30	3.9	1034.4
1 40	5.4	1277.0
1 50	7.2	1545.2
2 00	9.3	1838.8

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 36° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	175.3	200.3	225.4	250.4	500.8	751.3	1001.7	1252.1	1502.55
1	5.3	0.3	5.3	0.4	0.7	1.1	1.5	1.9	2.23
2	5.2	0.3	5.3	0.3	0.6	1.0	1.3	1.6	1.92
3	5.2	0.2	5.2	0.3	0.5	0.8	1.1	1.3	1.60
4	5.1	0.2	5.2	0.2	0.4	0.6	0.8	1.1	1.28
5	5.1	0.1	5.1	0.2	0.3	0.5	0.6	0.8	0.97
6	175.1	200.1	225.1	250.1	500.2	750.3	1000.4	1250.5	1500.65
7	5.0	0.0	5.1	0.1	0.1	0.2	0.2	0.3	0.33
8	5.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.02
9	5.0	0.0	5.0	249.9	499.9	49.8	999.8	49.8	1499.70
10	4.9	199.9	4.9	9.9	9.8	9.7	9.6	9.5	9.38
11	174.9	199.9	224.9	249.8	499.7	749.5	999.4	1249.2	1499.06
12	4.9	9.8	4.8	9.8	9.6	9.4	9.2	9.0	8.75
13	4.8	9.8	4.8	9.7	9.5	9.2	9.0	8.7	8.43
14	4.8	9.7	4.7	9.7	9.4	9.1	8.7	8.4	8.11
15	4.7	9.7	4.7	9.6	9.3	8.9	8.5	8.1	7.79
16	174.7	199.7	224.6	249.6	499.2	748.7	998.3	1247.9	1497.47
17	4.7	9.6	4.6	9.5	9.1	8.6	8.1	7.6	7.16
18	4.6	9.6	4.5	9.5	8.9	8.4	7.9	7.4	6.84
19	4.6	9.5	4.5	9.4	8.8	8.3	7.7	7.1	6.52
20	4.6	9.5	4.4	9.4	8.7	8.1	7.5	6.9	6.20
21	174.5	199.5	224.4	249.3	498.6	747.9	997.3	1246.6	1495.88
22	4.5	9.4	4.3	9.3	8.5	7.8	7.0	6.3	5.56
23	4.4	9.4	4.3	9.2	8.4	7.6	6.8	6.0	5.24
24	4.4	9.3	4.2	9.2	8.3	7.5	6.6	5.8	4.92
25	4.4	9.3	4.2	9.1	8.2	7.3	6.4	5.5	4.61
26	174.3	199.2	224.1	249.0	498.1	747.1	996.2	1245.2	1494.29
27	4.3	9.2	4.1	9.0	8.0	7.0	6.0	5.0	3.97
28	4.3	9.2	4.0	8.9	7.9	6.8	5.8	4.7	3.65
29	4.2	9.1	4.0	8.9	7.8	6.7	5.5	4.4	3.33
30	4.2	9.1	4.0	8.8	7.7	6.5	5.3	4.2	3.01

Meridional arcs.	
1″	30.8
2	61.6
3	92.5
4	123.3
5	154.1
6	184.9
7	215.7
8	246.5
9	277.3
10	308.2
20	616.4
30	924.6
40	1232.7
50	1540.9
1′ 00	1849.1
2	3698.2
3	5547.4
4	7396.5
5	9245.6
6	11094.7
7	12943.8
8	14792.9
9	16642.0
10	18491.2
11	20340.3
12	22189.4

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.2
6	.0	4.6
7	.0	6.3
8	.0	8.2
9	.0	10.4
10	.0	12.8
15	.0	28.9
20	.0	51.4
25	.1	80.3
30	.1	115.6
35	.2	157.4
40	.4	205.5
45	.5	260.1
50	.7	321.1
55	.9	388.6
1° 00	1.2	462.4
1 10	1.9	629.4
1 20	2.8	822.1
1 30	4.0	1040.4
1 40	5.5	1284.5
1 50	7.3	1554.3
2 00	9.5	1849.7

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 36° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	174.2	199.1	224.0	248.8	497.7	746.5	995.3	1244.2	1493.01
31	4.1	9.0	3.9	8.8	7.6	6.3	5.0	3.9	2.69
32	4.1	9.0	3.9	8.7	7.5	6.2	4.9	3.6	2.37
33	4.1	8.9	3.9	8.7	7.3	6.0	4.7	3.4	2.05
34	4.0	8.9	3.8	8.6	7.2	5.9	4.5	3.1	1.73
35	4.0	8.9	3.7	8.6	7.1	5.7	4.3	2.8	1.41
36	174.0	198.8	223.7	248.5	497.0	745.5	994.1	1242.6	1491.08
37	3.9	8.8	3.6	8.5	6.9	5.4	3.8	2.3	0.76
38	3.9	8.7	3.6	8.4	6.8	5.2	3.6	2.0	0.44
39	3.9	8.7	3.5	8.4	6.7	5.1	3.4	1.8	0.12
40	3.8	8.6	3.5	8.3	6.6	4.9	3.2	1.5	89.80
41	173.8	198.6	223.4	248.2	496.5	744.7	993.0	1241.2	1489.48
42	3.7	8.6	3.4	8.2	6.4	4.6	2.8	1.0	9.16
43	3.7	8.5	3.3	8.1	6.3	4.4	2.6	0.7	8.84
44	3.7	8.5	3.3	8.1	6.2	4.3	2.3	0.4	8.51
45	3.6	8.4	3.2	8.0	6.1	4.1	2.1	0.2	8.19
46	173.6	198.4	223.2	248.0	496.0	743.9	991.9	1239.9	1487.87
47	3.6	8.3	3.1	7.9	5.8	3.8	1.7	9.6	7.55
48	3.5	8.3	3.1	7.9	5.7	3.6	1.5	9.4	7.23
49	3.5	8.3	3.0	7.8	5.6	3.5	1.3	9.1	6.90
50	3.4	8.2	3.0	7.8	5.5	3.3	1.1	8.8	6.58
51	173.4	198.2	222.9	247.7	495.4	743.1	990.8	1238.6	1486.26
52	3.4	8.1	2.9	7.7	5.3	3.0	0.6	8.3	5.94
53	3.3	8.1	2.8	7.6	5.2	2.8	0.4	8.0	5.61
54	3.3	8.0	2.8	7.5	5.1	2.6	0.2	7.7	5.29
55	3.3	8 0	2.7	7.5	5.0	2.5	0.0	7.5	4.97
56	173.2	198.0	222.7	247.4	494.9	742.3	989.8	1237.5	1484.64
57	3.2	7.9	2.6	7.4	4.8	2.2	9.5	7.0	4.32
58	3.1	7.9	2.6	7.3	4.7	2.0	9.3	6.7	4.00
59	3.1	7.9	2.6	7.3	4.6	1.8	9.1	6.4	3.67
60	3.1	7.8	2.5	7.2	4.5	1.7	8.9	6.1	3.35

Meridional arcs.	
1″	30.8
2	61.6
3	92.5
4	123.3
5	154.1
6	184.9
7	215.7
8	246.5
9	277.3
10	308.2
20	616.4
30	924.6
40	1232.9
50	1541.1
1′ 00	1849.3
2	3698.6
3	5547.9
4	7397.1
5	9246.4
6	11095.6
7	12944.9
8	14794.2
9	16643.5
10	18492.8
11	20342.0
12	22191.3

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.2
6	.0	4.6
7	.0	6.3
8	.0	8.3
9	.0	10.5
10	.0	12.9
15	.0	29.1
20	.0	51.7
25	.1	80.7
30	.2	116.2
35	.2	158.2
40	.4	206.7
45	.5	261.5
50	.7	322.9
55	.9	390.7
1° 00	1.2	465.0
1 10	1.9	632.9
1 20	2.9	826.7
1 30	4.1	1046.2
1 40	5.6	1291.6
1 50	7.5	1562.8
2 00	9.7	1860.0

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 37° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)									Meridional arcs.		Co-ordinates of curvature.		
	7″	8″	9″	10″	20″	30″	40″	50″	60″			Minutes of longitude.	X. Arc par.	Y.
0′	173.1	197.8	222.5	247.2	494.5	741.7	988.9	1236.1	1483.35	1″	30.8	1′	—.0	.1
1	3.0	7.7	2.5	7.2	4.3	1.5	8.7	5.9	3.03	2	61.6	2	.0	.5
2	3.0	7.7	2.4	7.1	4.2	1.3	8.5	5.6	2.70	3	92.5	3	.0	1.2
3	3.0	7.7	2.4	7.1	4.1	1.2	8.3	5.3	2.38	4	123.3	4	.0	2.1
4	2.9	7.6	2.3	7.0	4.0	1.0	8.0	5.0	2.05					
5	2.9	7.6	2.3	7.0	3.9	0.9	7.8	4.8	1.73	5	154.1	5	.0	3.2
										6	184.9	6	.0	4.7
6	172.8	197.5	222.2	246.9	493.8	740.7	987.6	1234.5	1481.41	7	215.7	7	.0	6.4
7	2.8	7.5	2.2	6.8	3.7	0.5	7.4	4.2	1.08	8	246.5	8	.0	8.3
8	2.8	7.4	2.1	6.8	3.6	0.4	7.2	4.0	0.76	9	277.3	9	.0	10.5
9	2.7	7.4	2.1	6.7	3.5	0.2	7.0	3.7	0.43					
10	2.7	7.3	2.0	6.7	3.4	0.1	6.7	3.4	0.11	10	308.2	10	.0	13.0
										20	616.4	15	.0	29.2
11	172.6	197.3	222.0	246.6	493.3	739.9	986.5	1233.2	1479.78	30	924.7	20	.0	51.9
12	2.6	7.3	1.9	6.6	3.2	9.7	6.3	2.9	9.46	40	1232.9	25	.1	81.1
13	2.6	7.2	1.9	6.5	3.0	9.6	6.1	2.6	9.13	50	1541.2	30	.2	116.8
14	2.5	7.2	1.8	6.5	2.9	9.4	5.9	2.3	8.81					
15	2.5	7.1	1.8	6.4	2.8	9.2	5.7	2.1	8.48	1′ 00	1849.4	35	.2	159.1
										2	3698.8	40	.4	207.7
16	172.5	197.1	221.7	246.4	492.7	739.1	985.4	1231.8	1478.15	3	5548.2	45	.5	262.9
17	2.4	7.0	1.7	6.3	2.6	8.9	5.2	1.5	7.83	4	7397.6	50	.7	324.6
18	2.4	7.0	1.6	6.2	2.5	8.7	5.0	1.2	7.50	5	9247.1	55	.9	392.8
19	2.3	6.9	1.6	6.2	2.4	8.6	4.8	1.0	7.18	6	11096.6			
20	2.3	6.9	1.5	6.1	2.3	8.4	4.6	0.7	6.85			1° 00	1.2	467.4
										7	12946.0	1 10	1.9	636.2
21	172.3	196.9	221.5	246.1	492.2	738.3	984.4	1230.4	1476.52	8	14795.4	1 20	2.9	831.0
22	2.2	6.8	1.4	6.0	2.1	8.1	4.1	0.2	6.20	9	16644.8	1 30	4.1	1051.8
23	2.2	6.8	1.4	6.0	2.0	7.9	3.9	29.9	5.87	10	18494.3	1 40	5.7	1298.4
24	2.1	6.7	1.3	5.9	1.8	7.8	3.7	9.6	5.54	11	20343.7	1 50	7.6	1571.0
25	2.1	6.7	1.3	5.9	1.7	7.6	3.5	9.4	5.22	12	22193.2	2 00	9.8	1869.7
26	172.1	196.7	221.2	245.8	491.6	737.4	983.3	1229.1	1474.89					
27	2.0	6.6	1.2	5.8	1.5	7.3	3.0	8.8	4.56					
28	2.0	6.6	1.1	5.7	1.4	7.1	2.8	8.5	4.24					
29	2.0	6.5	1.1	5.7	1.3	7.0	2.6	8.3	3.91					
30	171.9	6.5	1.0	5.6	1.2	6.8	2.4	8.0	3.58					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 37° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	171.9	196.5	221.0	245.6	491.2	736.8	982.4	1228.0	1473.58
31	1.9	6.4	1.0	5.5	1.1	6.6	2.2	7.7	3.25
32	1.8	6.4	0.9	5.5	1.0	6.5	2.0	7.4	2.93
33	1.8	6.3	0.9	5.4	0.9	6.3	1.7	7.2	2.60
34	1.8	6.3	0.8	5.4	0.8	6.1	1.5	6.9	2.27
35	1.7	6.3	0.8	5.3	0.6	6.0	1.3	6.6	1.94
36	171.7	196.2	220.7	245.3	490.5	735.8	981.1	1226.3	1471.61
37	1.6	6.2	0.7	5.2	0.4	5.6	0.9	6.1	1.29
38	1.6	6.1	0.6	5.2	0.3	5.5	0.6	5.8	0.96
39	1.6	6.1	0.6	5.1	0.2	5.3	0.4	5.5	0.63
40	1.5	6.0	0.5	5.0	0.1	5.1	0.2	5.3	0.30
41	171.5	196.0	220.5	245.0	490.0	735.0	980.0	1225.0	1469.97
42	1.5	6.0	0.4	4.9	89.9	4.8	79.8	4.7	9.64
43	1.4	5.9	0.4	4.9	9.8	4.6	9.5	4.4	9.31
44	1.4	5.9	0.3	4.8	9.7	4.5	9.3	4.2	8.98
45	1.3	5.8	0.3	4.8	9.5	4.3	9.1	3.9	8.65
46	171.3	195.8	220.2	244.7	489.4	734.2	978.9	1223.6	1468.32
47	1.3	5.7	0.2	4.7	9.3	4.0	8.7	3.3	8.00
48	1.2	5.7	0.1	4.6	9.2	3.8	8.4	3.1	7.67
49	1.2	5.6	0.1	4.6	9.1	3.7	8.2	2.8	7.34
50	1.2	5.6	0.1	4.5	9.0	3.5	8.0	2.5	7.01
51	171.1	195.6	220.0	244.4	488.9	733.3	977.8	1222.2	1466.68
52	1.1	5.5	0.0	4.4	8.8	3.2	7.6	2.0	6.34
53	1.0	5.5	219.9	4.3	8.7	3.0	7.3	1.7	6.01
54	1.0	5.4	9.9	4.3	8.6	2.8	7.1	1.4	5.68
55	1.0	5.4	9.8	4.2	8.5	2.7	6.9	1.1	5.35
56	170.9	195.3	219.8	244.2	488.3	732.5	976.7	1220.9	1465.02
57	0.9	5.3	9.7	4.1	8.2	2.3	6.5	0.6	4.69
58	0.8	5.2	9.7	4.1	8.1	2.2	6.2	0.3	4.36
59	0.8	5.2	9.6	4.0	8.0	2.0	6.0	0.0	4.03
60	0.8	5.2	9.6	4.0	7.9	1.8	5.8	1219.7	3.70

Meridional arcs.	
1″	30.8
2	61.7
3	92.5
4	123.3
5	154.1
6	185.0
7	215.8
8	246.6
9	277.4
10	308.3
20	616.5
30	924.8
40	1233.1
50	1541.3
1′ 00	1849.6
2	3699.2
3	5548.8
4	7398.4
5	9247.9
6	11097.5
7	12947.1
8	14796.7
9	16646.3
10	18495.9
11	20345.5
12	22195.0

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.3
6	.0	4.7
7	.0	6.4
8	.0	8.4
9	.0	10.6
10	.0	13.0
15	.0	29.4
20	.0	52.2
25	.1	81.5
30	.2	117.4
35	.2	159.8
40	.4	208.8
45	.5	264.2
50	.7	326.2
55	1.0	394.7
1° 00	1.2	469.8
1 10	2.0	639.3
1 20	3.0	835.0
1 30	4.2	1057.2
1 40	5.8	1304.7
1 50	7.7	1578.7
2 00	10.0	1878.8

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 38° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	170.8	195.2	219.6	244.0	487.9	731.8	975.8	1219.7	1463.70
1	0.7	5.1	9.5	3.9	7.8	1.7	5.6	9.5	3.37
2	0.7	5.1	9.5	3.8	7.7	1.5	5.4	9.2	3.04
3	0.7	5.0	9.4	3.8	7.6	1.3	5.1	8.9	2.70
4	0.6	5.0	9.4	3.7	7.5	1.2	4.9	8.6	2.37
5	0.6	4.9	9.3	3.7	7.3	1.0	4.7	8.4	2.04
6	170.5	194.9	219.3	243.6	487.2	730.9	974.5	1218.1	1461.71
7	0.5	4.8	9.2	3.6	7.1	0.7	4.3	7.8	1.38
8	0.5	4.8	9.2	3.5	7.0	0.5	4.0	7.5	1.04
9	0.4	4.8	9.1	3.5	6.9	0.4	3.8	7.3	0.71
10	0.4	4.7	9.1	3.4	6.8	0.2	3.6	7.0	0.38
11	170.3	194.7	219.0	243.3	486.7	730.0	973.4	1216.7	1460.05
12	0.3	4.6	9.0	3.3	6.6	29.9	3.1	6.4	59.71
13	0.3	4.6	8.9	3.2	6.5	9.7	2.9	6.2	9.38
14	0.2	4.5	8.9	3.2	6.3	9.5	2.7	5.9	9.05
15	0.2	4.5	8.8	3.1	6.2	9.4	2.5	5.6	8.72
16	170.1	194.5	218.8	243.1	486.1	729.2	972.3	1215.3	1458.38
17	0.1	4.4	8.7	3.0	6.0	9.0	2.0	5.0	8.05
18	0.1	4.4	8.7	3.0	5.9	8.9	1.8	4.8	7.72
19	0.0	4.3	8.6	2.9	5.8	8.7	1.6	4.5	7.38
20	0.0	4.3	8.6	2.8	5.7	8.5	1.4	4.2	7.05
21	170.0	194.2	218.5	242.8	485.6	728.4	971.1	1213.9	1456.71
22	169.9	4.2	8.5	2.7	5.5	8.2	0.9	3.6	6.38
23	9.9	4.1	8.4	2.7	5.4	8.0	0.7	3.4	6.05
24	9.8	4.1	8.4	2.6	5.2	7.9	0.5	3.1	5.71
25	9.8	4.1	8.3	2.6	5.1	7.7	0.2	2.8	5.38
26	169.8	194.0	218.3	242.5	485.0	727.5	970.0	1212.5	1455.04
27	9.7	4.0	8.2	2.5	4.9	7.4	69.8	2.3	4.71
28	9.7	3.9	8.2	2.4	4.8	7.2	9.6	2.0	4.37
29	9.6	3.9	8.1	2.3	4.7	7.0	9.4	1.7	4.04
30	9.6	3.8	8.1	2.3	4.6	6.9	9.1	1.4	3.71

Meridional arcs.	
1′	30.8
2	61.7
3	92.5
4	123.3
5	154.2
6	185.0
7	215.8
8	246.6
9	277.4
10	308.3
20	616.6
30	924.9
40	1233.2
50	1541.4
1′ 00	1849.7
2	3699.5
3	5549.2
4	7399.0
5	9248.7
6	11098.5
7	12948.2
8	14797.9
9	16647.6
10	18497.4
11	20347.2
12	22196.9

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.3
6	.0	4.7
7	.0	6.4
8	.0	8.4
9	.0	10.6
10	.0	13.1
15	.0	29.5
20	.0	52.4
25	.1	81.9
30	.2	118.0
35	.3	160.6
40	.4	209.7
45	.5	265.4
50	.7	327.7
55	1.0	396.5
1° 00	1.3	471.8
1 10	2.0	642.2
1 20	3.0	838.8
1 30	4.3	1061.6
1 40	5.9	1310.7
1 50	7.8	1585.9
2 00	10.1	1887.4

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 38° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	169.6	193.8	218.1	242.3	484.6	726.9	969.1	1211.4	1453.71
31	9.6	3.8	8.0	2.2	4.5	6.7	8.9	1.1	3.37
32	9.5	3.7	8.0	2.2	4.3	6.5	8.7	0.9	3.03
33	9.5	3.7	7.9	2.1	4.2	6.3	8.5	0.6	2.70
34	9.4	3.6	7.9	2.1	4.1	6.2	8.2	0.3	2.36
35	9.4	3.6	7.8	2.0	4.0	6.0	8.0	0.0	2.03
36	169.4	193.6	217.8	241.9	483.9	725.8	967.8	1209.7	1451.69
37	9.3	3.5	7.7	1.9	3.8	5.7	7.6	9.5	1.36
38	9.3	3.5	7.7	1.8	3.7	5.5	7.3	9.2	1.02
39	9.2	3.4	7.6	1.8	3.6	5.3	7.1	8.9	0.68
40	9.2	3.4	7.6	1.7	3.5	5.2	6.9	8.6	0.35
41	169.2	193.3	217.5	241.7	483.3	725.0	966.7	1208.3	1450.01
42	9.1	3.3	7.5	1.6	3.2	4.8	6.5	8.1	49.68
43	9.1	3.2	7.4	1.6	3.1	4.7	6.2	7.8	9.34
44	9.1	3.2	7.4	1.5	3.0	4.5	6.0	7.5	9.00
45	9.0	3.2	7.3	1.4	2.9	4.3	5.8	7.2	8.67
46	169.0	193.1	217.2	241.4	482.8	724.2	965.6	1206.9	1448.33
47	8.9	3.1	7.2	1.3	2.7	4.0	5.3	6.7	7.99
48	8.9	3.0	7.1	1.3	2.5	3.8	5.1	6.4	7.66
49	8.8	3.0	7.1	1.2	2.4	3.7	4.9	6.1	7.32
50	8.8	2.9	7.0	1.2	2.3	3.5	4.6	5.8	6.98
51	168.8	192.9	217.0	241.1	482.2	723.3	964.4	1205.5	1446.64
52	8.7	2.8	6.9	1.1	2.1	3.2	4.2	5.3	6.31
53	8.7	2.8	6.9	1.0	2.0	3.0	4.0	5.0	5.97
54	8.7	2.8	6.8	0.9	1.9	2.8	3.8	4.7	5.63
55	8.6	2.7	6.8	0.9	1.8	2.6	3.5	4.4	5.29
56	168.6	192.7	216.7	240.8	481.7	722.5	963.3	1204.1	1444.95
57	8.5	2.6	6.7	0.8	1.5	2.3	3.1	3.8	4.62
58	8.5	2.6	6.6	0.7	1.4	2.1	2.9	3.6	4.28
59	8.5	2.5	6.6	0.7	1.3	2.0	2.6	3.3	3.94
60	8.4	2.5	6.5	0.6	1.2	1.8	2.4	3.0	3.60

Meridional arcs.	
1″	30.8
2	61.7
3	92.5
4	123.3
5	154.2
6	185.0
7	215.8
8	246.6
9	277.4
10	308.3
20	616.6
30	924.9
40	1233.2
50	1541.5
1′ 00	1849.9
2	3699.8
3	5549.7
4	7399.6
5	9249.5
6	11099.4
7	12949.3
8	14799.2
9	16649.1
10	18499.0
11	20348.9
12	22198.8

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.3
6	.0	4.7
7	.0	6.4
8	.0	8.4
9	.0	10.7
10	.0	13.2
15	.0	29.6
20	.0	52.8
25	.1	82.3
30	.2	118.5
35	.3	161.2
40	.4	210.6
45	.5	266.5
50	.7	329.0
55	1.0	398.1
1° 00	1.3	473.8
1 10	2.0	644.9
1 20	3.0	842.4
1 30	4.3	1066.1
1 40	6.0	1316.2
1 50	7.9	1592.6
2 00	10.3	1895.3

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 39° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)									Meridional arcs.		Co-ordinates of curvature.		
	7″	8″	9″	10″	20″	30″	40″	50″	60″			Minutes of longitude.	X. Arc par.	Y.
0′	168.4	192.5	216.5	240.6	481.2	721.8	962.4	1203.0	1443.60	1″	30.8	1′	—.0	.1
1	8.4	2.4	6.5	0.5	1.1	1.6	2.2	2.7	3.26	2	61.7	2	.0	.5
2	8.3	2.4	6.4	0.5	1.0	1.5	2.0	2.4	2.92	3	92.5	3	.0	1.2
3	8.3	2.3	6.4	0.4	0.9	1.3	1.7	2.1	2.58	4	123.3	4	.0	2.1
4	8.3	2.3	6.3	0.4	0.7	1.1	1.5	1.9	2.24					
5	8.2	2.3	6.3	0.3	0.6	1.0	1.3	1.6	1.91	5	154.2	5	.0	3.3
										6	185.0	6	.0	4.8
6	168.2	192.2	216.2	240.3	480.5	720.8	961.1	1201.3	1441.57	7	215.8	7	.0	6.5
7	8.1	2.2	6.2	0.2	0.4	0.6	0.8	1.0	1.23	8	246.7	8	.0	8.5
8	8.1	2.1	6.1	0.1	0.3	0.4	0.6	0.7	0.89	9	277.5	9	.0	10.7
9	8.1	2.1	6.1	0.1	0.2	0.3	0.4	0.5	0.55					
10	8.0	2.0	6.0	0.0	0.1	0.1	0.1	0.2	0.21	10	308.3	10	.0	13.2
										20	616.7	15	.0	29.7
11	168.0	192.0	216.0	240.0	480.0	719.9	959.9	1199.9	1439.87	30	925.0	20	.0	52.9
12	7.9	1.9	5.9	239.9	479.8	9.8	9.7	9.6	9.53	40	1233.4	25	.1	82.6
13	7.9	1.9	5.9	9.9	9.7	9.6	9.5	9.3	9.19	50	1541.7	30	.2	118.9
14	7.9	1.8	5.8	9.8	9.6	9.4	9.2	9.0	8.85					
15	7.8	1.8	5.8	9.8	9.5	9.3	9.0	8.8	8.51	1′ 00	1850.1	35	.3	161.9
										2	3700.1	40	.4	211.4
16	167.8	191.8	215.7	239.7	479.4	719.1	958.8	1198.5	1438.17	3	5550.2	45	.6	267.6
17	7.7	1.7	5.7	9.6	9.3	8.9	8.5	8.2	7.82	4	7400.2	50	.8	330.3
18	7.7	1.7	5.6	9.6	9.2	8.7	8.3	7.9	7.48	5	9250.3	55	1.0	399.7
19	7.7	1.6	5.6	9.5	9.0	8.6	8.1	7.6	7.14	6	11100.4			
20	7.6	1.6	5.5	9.5	8.9	8.4	7.9	7.3	6.80			1° 00	1.3	475.7
										7	12950.4	1 10	2.1	647.5
21	167.6	191.5	215.5	239.4	478.8	718.2	957.6	1197.0	1436.46	8	14800.5	1 20	3.1	845.6
22	7.5	1.5	5.4	9.3	8.7	8.1	7.4	6.8	6.12	9	16650.5	1 30	4.4	1070.3
23	7.5	1.4	5.4	9.3	8.6	7.9	7.2	6.5	5.78	10	18500.6	1 40	6.1	1321.3
24	7.5	1.4	5.3	9.2	8.5	7.7	7.0	6.2	5.44	11	20350.7	1 50	8.1	1598.9
25	7.4	1.3	5.3	9.2	8.4	7.5	6.7	5.9	5.10	12	22200.7	2 00	10.4	1902.7
26	167.4	191.3	215.2	239.1	478.2	717.4	956.5	1195.6	1434 75					
27	7.3	1.3	5.2	9.1	8.1	7.2	6.3	5.3	4.41					
28	7.3	1.2	5.1	9.0	8.0	7.0	6.1	5.1	4.07					
29	7.3	1.2	5.1	9.0	7.9	6.9	5.8	4.8	3.73					
30	7.2	1.1	5.0	8.9	7.8	6.7	5.6	4.5	3.38					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 39° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)									Meridional arcs.		Co-ordinates of curvature.		
	7″	8″	9″	10″	20″	30″	40″	50″	60″			Minutes of longitude.	X. Arc par.	Y.
30′	167.2	191.1	215.0	238.9	477.8	716.7	955.6	1194.5	1433.38	1″	30.8	1′	—.0	.1
31	7.2	1.1	5.0	8.9	7.7	6.5	5.4	4.2	3.04	2	61.7	2	.0	.5
32	7.1	1.0	4.9	8.8	7.6	6.3	5.1	3.9	2.70	3	92.5	3	.0	1.2
33	7.1	1.0	4.9	8.7	7.5	6.2	4.9	3.6	2.36	4	123.3	4	.0	2.1
34	7.1	0.9	4.8	8.7	7.3	6.0	4.7	3.3	2.00					
35	7.0	0.9	4.8	8.6	7.2	5.8	4.4	3.1	1.67	5	154.2	5	.0	3.3
										6	185.0	6	.0	4.8
36	167.0	190.8	214.7	238.6	477.1	715.7	954.2	1192.8	1431.33	7	215.9	7	.0	6.5
37	6.9	0.8	4.6	8.5	7.0	5.5	4.0	2.5	0.99	8	246.7	8	.0	8.5
38	6.9	0.8	4.6	8.4	6.9	5.3	3.8	2.2	0.64	9	277.5	9	.0	10.7
39	6.9	0.7	4.5	8.4	6.8	5.1	3.5	1.9	0.30					
40	6.8	0.7	4.5	8.3	6.6	5.0	3.3	1.6	29.96	10	308.4	10*	.0	13.3
										20	616.7	15	.0	29.8
41	166.8	190.6	214.4	238.3	476.5	714.8	953.1	1191.3	1429.61	30	925.1	20	.0	53.0
42	6.7	0.6	4.4	8.2	6.4	4.6	2.9	1.1	9.27	40	1233.5	25	.1	82.9
43	6.7	0.5	4.3	8.2	6.3	4.5	2.6	0.8	8.92	50	1541.8	30	.2	119.3
44	6.7	0.5	4.3	8.1	6.2	4.3	2.4	0.5	8.58					
45	6.6	0.4	4.2	8.0	6.1	4.1	2.2	0.2	8.24	1′ 00	1850.2	35	.3	162.4
										2	3700.4	40	.4	212.2
46	166.6	190.4	214.2	238.0	476.0	713.9	951.9	1189.9	1427.89	3	5550.7	45	.6	268.5
47	6.5	0.3	4.1	7.9	5.8	3.8	1.7	9.6	7.55	4	7400.9	50	.8	331.5
48	6.5	0.3	4.1	7.9	5.7	3.6	1.5	9.3	7.20	5	9251.1	55	1.0	401.1
49	6.5	0.2	4.0	7.8	5.6	3.4	1.2	9.0	6.86	6	11101.3			
50	6.4	0.2	4.0	7.8	5.5	3.3	1.0	8.8	6.51			1° 00	1.3	477.4
										7	12951.5	1 10	2.1	649.8
51	166.4	190.2	213.9	237.7	475.4	713.1	950.8	1188.5	1426.17	8	14801.7	1 20	3.1	848.7
52	6.3	0.1	3.9	7.6	5.3	2.9	0.6	8.2	5.82	9	16652.0	1 30	4.5	1074.2
53	6.3	0.1	3.8	7.6	5.2	2.7	0.3	7.9	5.48	10	18502.2	1 40	6.1	1326.1
54	6.3	0.0	3.8	7.5	5.0	2.6	0.1	7.6	5.13	11	20352.4	1 50	8.2	1604.6
55	6.2	0.0	3.7	7.5	4.9	2.4	949.9	7.3	4.79	12	22202.6	2 00	10.6	1909.6
56	166.2	189.9	213.7	237.4	474.8	712.2	949.6	1187.0	1424.44					
57	6.1	9.9	3.6	7.4	4.7	2.0	9.4	6.7	4.10					
58	6.1	9.8	3.6	7.3	4.6	1.9	9.2	6.5	3.75					
59	6.1	9.8	3.5	7.2	4.5	1.7	8.9	6.2	3.41					
60	6.0	9.7	3.5	7.2	4.4	1.5	8.7	5.9	3.06					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 40° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	166.0	189.7	213.5	237.2	474.4	711.5	948.7	1185.9	1423.06
1	6.0	9.7	3.4	7.1	4.2	1.4	8.5	5.6	2.71
2	5.9	9.6	3.4	7.1	4.1	1.2	8.3	5.3	2.37
3	5.9	9.6	3.3	7.0	4.0	1.0	8.0	5.0	2.02
4	5.9	9.6	3.3	6.9	3.9	0.8	7.8	4.7	1.68
5	5.8	9.5	3.2	6.9	3.8	0.7	7.6	4.4	1.33
6	165.8	189.5	213.1	236.8	473.7	710.5	947.3	1184.1	1420.98
7	5.7	9.4	3.1	6.8	3.5	0.3	7.1	3.9	0.64
8	5.7	9.4	3.0	6.7	3.4	0.1	6.9	3.6	0.29
9	5.7	9.3	3.0	6.7	3.3	0.0	6.6	3.3	19.94
10	5.6	9.3	2.9	6.6	3.2	709.8	6.4	3.0	19.60
11	165.6	189.2	212.9	236.5	473.1	709.6	946.2	1182.7	1419.25
12	5.5	9.2	2.8	6.5	3.0	9.4	5.9	2.4	8.90
13	5.5	9.1	2.8	6.4	2.8	9.3	5.7	2.1	8.55
14	5.5	9.1	2.7	6.4	2.7	9.1	5.5	1.8	8.20
15	5.4	9.0	2.7	6.3	2.6	8.9	5.2	1.5	7.86
16	165.4	189.0	212.6	236.2	472.5	708.8	945.0	1181.3	1417.51
17	5.3	9.0	2.6	6.2	2.4	8.6	4.8	1.0	7.16
18	5.3	8.9	2.5	6.1	2.3	8.4	4.5	0.7	6.81
19	5.3	8.9	2.5	6.1	2.2	8.2	4.3	0.4	6.46
20	5.2	8.8	2.4	6.0	2.0	8.1	4.1	0.1	6.12
21	165.2	188.8	212.4	236.0	471.9	707.9	943.8	1179.8	1415.77
22	5.1	8.7	2.3	5.9	1.8	7.7	3.6	9.5	5.42
23	5.1	8.7	2.3	5.8	1.7	7.5	3.4	9.2	5.07
24	5.1	8.6	2.2	5.8	1.6	7.4	3.2	8.9	4.72
25	5.0	8.6	2.2	5.7	1.5	7.2	2.9	8.6	4.37
26	165.0	188.5	212.1	235.7	471.3	707.0	942.7	1178.4	1414.02
27	4.9	8.5	2.1	5.6	1.2	6.8	2.4	8.1	3.67
28	4.9	8.4	2.0	5.6	1.1	6.7	2.2	7.8	3.32
29	4.8	8.4	1.9	5.5	1.0	6.5	2.0	7.5	2.98
30	4.8	8.3	1.9	5.4	0.8	6.3	1.8	7.2	2.63

Meridional arcs.	
1″	30.8
2	61.7
3	92.5
4	123.4
5	154.2
6	185.0
7	215.9
8	246.7
9	277.6
10	308.4
20	616.8
30	925.2
40	1233.6
50	1542.0
1′.00	1850.4
2	3700.8
3	5551.1
4	7401.5
5	9251.9
6	11102.3
7	12952.6
8	14803.0
9	16653.4
10	18503.8
11	20354.1
12	22204.5

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.3
6	.0	4.8
7	.0	6.5
8	.0	8.5
9	.0	10.8
10	.0	13.3
15	.0	29.9
20	.0	53.2
25	.1	83.2
30	.2	119.7
35	.3	163.0
40	.4	212.9
45	.6	269.4
50	.8	332.6
55	1.0	402.5
1° 00	1.3	479.0
1 10	2.1	651.9
1 20	3.2	851.5
1 30	4.5	1077.7
1 40	6.2	1330.5
1 50	8.3	1609.8
2 00	10.7	1915.9

TABLE VI.—*Projection Tables*—Continued.

Latitude 40° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″	Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
30′	164.8	188.3	211.9	235.4	470.8	706.3	941.8	1177.2	1412.63	1″	30.8	1′	—.0	.1
31	4.8	8.3	1.8	5.4	0.7	6.1	1.5	6.9	12.28	2	61.7	2	.0	.5
32	4.7	8.3	1.8	5.3	0.6	6.0	1.3	6.6	11.93	3	92.5	3	.0	1.2
33	4.7	8.2	1.7	5.3	0.5	5.8	1.1	6.3	11.58	4	123.4	4	.0	2.1
34	4.6	8.2	1.7	5.2	0.4	5.6	0.8	6.0	11.23					
35	4.6	8.1	1.6	5.1	0.3	5.4	0.6	5.7	10.88	5	154.2	5	.0	3.3
										6	185.1	6	.0	4.8
36	164.6	188.1	211.6	235.1	470.2	705.3	940.4	1175.4	1410.53	7	215.9	7	.0	6.5
37	4.5	8.0	1.5	5.0	0.1	5.1	0.1	5.1	10.18	8	246.7	8	.0	8.5
38	4.5	8.0	1.5	5.0	469.9	4.9	39.9	4.9	09.83	9	277.6	9	.0	10.8
39	4.4	7.9	1.4	4.9	9.8	4.7	9.7	4.6	09.48					
40	4.4	7.9	1.4	4.8	9.7	4.6	9.4	4.3	09.12	10	308.4	10	.0	13.3
										20	616.8	15	.0	30.0
41	164.4	187.8	211.3	234.8	469.6	704.4	939.2	1174.0	1408.77	30	925.3	20	.0	53.4
42	4.3	7.8	1.3	4.7	9.5	4.2	8.9	3.7	8.42	40	1233.7	25	.1	83.4
43	4.3	7.7	1.2	4.7	9.4	4.0	8.7	3.4	8.07	50	1542.1	30	.2	120.1
44	4.2	7.7	1.2	4.6	9.2	3.9	8.5	3.1	7.72					
45	4.2	7.6	1.1	4.6	9.1	3.7	8.2	2.8	7.37	1′ 00	1850.5	35	.3	163.5
										2	3701.1	40	.4	213.5
46	164.2	187.6	211.1	234.5	469.0	703.5	938.0	1172.5	1407.02	3	5551.6	45	.6	270.2
47	4.1	7.6	1.0	4.4	8.9	3.3	7.8	2.2	6.67	4	7402.1	50	.8	333.6
48	4.1	7.5	0.9	4.4	8.8	3.2	7.5	1.9	6.31	5	9252.7	55	1.0	403.6
49	4.0	7.5	0.9	4.3	8.7	3.0	7.3	1.6	5.96	6	11103.2			
50	4.0	7.4	0.8	4.3	8.5	2.8	7.1	1.3	5.61					
										7	12953.8	1° 00	1.3	480.4
51	163.9	187.4	210.8	234.2	468.4	702.6	936.8	1171.0	1405.26	8	14804.3	1 10	2.1	653.8
52	3.9	7.3	0.7	4.2	8.3	2.5	6.6	0.8	4.91	9	16654.8	1 20	3.2	854.0
53	3.9	7.3	0.7	4.1	8.2	2.3	6.4	0.5	4.55	10	18505.4	1 30	4.6	1080.8
54	3.8	7.2	0.6	4.0	8.1	2.1	6.1	0.2	4.20	11	20355.9	1 40	6.3	1334.3
55	3.8	7.2	0.6	4.0	8.0	1.9	5.9	69.9	3.85	12	22206.4	1 50	8.3	1614.6
												2 00	10.8	1921.5
56	163.7	187.1	210.5	233.9	467.8	701.7	935.7	1169.6	1403.50					
57	3.7	7.1	0.5	3.8	7.7	1.6	5.4	9.3	3.14					
58	3.7	7.0	0.4	3.8	7.6	1.4	5.2	9.0	2.79					
59	3.6	7.0	0.4	3.7	7.5	1.2	5.0	8.7	2.44					
60	3.6	6.9	0.3	3.7	7.4	1.0	4.7	8.4	2.08					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 41° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	163.6	186.9	210.3	233.7	467.4	701.0	934.7	1168.4	1402.08
1	3.5	6.9	0.3	3.6	7.2	0.9	4.5	8.1	1.73
2	3.5	6.9	0.2	3.6	7.1	0.7	4.3	7.8	1.38
3	3.5	6.8	0.2	3.5	7.0	0.5	4.0	7.5	1.02
4	3.4	6.8	0.1	3.4	6.9	0.3	3.8	7.2	0.67
5	3.4	6.7	0.0	3.4	6.8	0.2	3.5	6.9	0.32
6	163.3	186.7	210.0	233.3	466.7	700.0	933.3	1166.6	1399.96
7	3.3	6.6	209.9	3.3	6.5	699.8	3.1	6.3	9.61
8	3.2	6.6	9.9	3.2	6.4	9.6	2.8	6.0	9.25
9	3.2	6.5	9.8	3.1	6.3	9.4	2.6	5.8	8.90
10	3.2	6.5	9.8	3.1	6.2	9.3	2.4	5.5	8.55
11	163.1	186.4	209.7	233.0	466.1	699.1	932.2	1165.2	1398.19
12	3.1	6.4	9.7	3.0	5.9	8.9	1.9	4.9	7.84
13	3.0	6.3	9.6	2.9	5.8	8.7	1.7	4.6	7.48
14	3.0	6.3	9.6	2.8	5.7	8.6	1.4	4.3	7.13
15	3.0	6.2	9.5	2.8	5.6	8.4	1.2	4.0	6.77
16	162.9	186.2	209.5	232.7	465.5	698.2	931.0	1163.7	1396.42
17	2.9	6.1	9.4	2.7	5.4	8.0	0.7	3.4	6.06
18	2.8	6.1	9.4	2.6	5.2	7.9	0.5	3.1	5.71
19	2.8	6.0	9.3	2.6	5.1	7.7	0.2	2.8	5.35
20	2.7	6.0	9.2	2.5	5.0	7.5	0.0	2.5	5.00
21	162.7	186.0	209.2	232.4	464.9	697.3	929.8	1162.2	1394.64
22	2.7	5.9	9.1	2.4	4.8	7.1	9.5	1.9	4.29
23	2.6	5.9	9.1	2.3	4.6	7.0	9.3	1.6	3.93
24	2.6	5.8	9.0	2.3	4.5	6.8	9.1	1.3	3.57
25	2.5	5.8	9.0	2.2	4.4	6.6	8.8	1.0	3.22
26	162.5	185.7	208.9	232.1	464.3	696.4	928.6	1160.7	1392.86
27	2.5	5.7	8.9	2.1	4.2	6.2	8.3	0.4	2.50
28	2.4	5.6	8.8	2.0	4.0	6.1	8.1	0.1	2.15
29	2.4	5.6	8.8	2.0	3.9	5.9	7.9	1159.8	1.79
30	2.3	5.5	8.7	1.9	3.8	5.7	7.6	9.5	1.43

Meridional arcs.	
1″	30.8
2	61.7
3	92.5
4	123.4
5	154.2
6	185.1
7	215.9
8	246.8
9	277.6
10	308.4
20	616.9
30	925.3
40	1233.8
50	1542.2
1′ 00	1850.7
2	3701.4
3	5552.1
4	7402.8
5	9253.5
6	11104.2
7	12954.9
8	14805.6
9	16656.3
10	18507.0
11	20357.7
12	22208.4

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.3
6	.0	4.8
7	.0	6.6
8	.0	8.6
9	.0	10.8
10	.0	13.4
15	.0	30.1
20	.1	53.5
25	.1	83.6
30	.2	120.4
35	.3	163.9
40	.4	214.1
45	.6	270.9
50	.8	334.5
55	1.1	404.7
1° 00	1.4	481.6
1 10	2.2	655.5
1 20	3.3	856.2
1 30	4.7	1083.7
1 40	6.4	1337.9
1 50	8.5	1618.8
2 00	11.1	1926.5

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 41° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)									Meridional arcs.		Co-ordinates of curvature.		
′	7″	8″	9″	10″	20″	30″	40″	50″	60″			Minutes of longitude.	X. Arc par.	Y.
30′	162.3	185.5	208.7	231.9	463.8	695.7	927.6	1159.5	1391.43	1″	30.8	1′	—.0	.1
31	2.3	5.5	8.7	1.8	3.7	5.5	7.4	9.2	1.08	2	61.7	2	.0	.5
32	2.3	5.4	8.6	1.8	3.6	5.4	7.2	8.9	0.72	3	92.5	3	.0	1.2
33	2.2	5.4	8.6	1.7	3.5	5.2	6.9	8.6	0.36	4	123.4	4	.0	2.1
34	2.2	5.3	8.5	1.7	3.3	5.0	6.7	8.3	0.01					
35	2.1	5.3	8.4	1.6	3.2	4.8	6.4	8.0	89.65	5	154.2	5	.0	3.4
										6	185.1	6	.0	4.8
36	162.1	185.2	208.4	231.5	463.1	694.6	926.2	1157.7	1389.29	7	215.9	7	.0	6.6
37	2.0	5.2	8.3	1.5	3.0	4.5	6.0	7.4	8.93	8	246.8	8	.0	8.6
38	2.0	5.1	8.3	1.4	2.9	4.3	5.7	7.1	8.58	9	277.6	9	.0	10.9
39	2.0	5.1	8.2	1.4	2.7	4.1	5.5	6.8	8.22					
40	1.9	5.0	8.2	1.3	2.6	3.9	5.2	6.5	7.86	10	308.5	10	.0	13.4
										20	617.0	15	.0	30.2
41	161.9	185.0	208.1	231.2	462.5	693.7	925.0	1156.2	1387.50	30	925.4	20	.1	53.6
42	1.8	5.0	8.1	1.2	2.4	3.6	4.8	6.0	7.15	40	1232.9	25	.1	83.8
43	1.8	4.9	8.0	1.1	2.3	3.4	4.5	5.7	6.79	50	1542.4	30	.2	120.7
44	1.8	4.9	8.0	1.1	2.1	3.2	4.3	5.4	6.43					
45	1.7	4.8	7.9	1.0	2.0	3.0	4.0	5.1	6.07	1′ 00	1850.9	35	.3	164.3
										2	3701.7	40	.4	214.5
46	161.7	184.8	207.9	231.0	461.9	692.9	923.8	1154.8	1385.71	3	5552.6	45	.6	271.5
47	1.6	4.7	7.8	230.9	1.8	2.7	3.6	4.5	5.35	4	7403.4	50	.8	335.2
48	1.6	4.7	7.7	0.8	1.7	2.5	3.3	4.2	4.99	5	9254.3	55	1.1	405.7
49	1.5	4.6	7.7	0.8	1.5	2.3	3.1	3.9	4.64	6	11105.1			
50	1.5	4.6	7.6	0.7	1.4	2.1	2.9	3.6	4.28			1° 00	1.4	482.8
										7	12956.0	1 10	2.2	657.1
51	161.4	184.5	207.6	230.6	461.3	692.0	922.6	1153.3	1383.92	8	14806.9	1 20	3.3	858.2
52	1.4	4.5	7.5	0.6	1.2	1.8	2.4	3.0	3.56	9	16657.7	1 30	4.7	1086.2
53	1.4	4.4	7.5	0.5	1.1	1.6	2.1	2.7	3.20	10	18508.6	1 40	6.5	1341.0
54	1.3	4.4	7.4	0.5	0.9	1.4	1.9	2.4	2.84	11	20359.4	1 50	8.6	1622.6
55	1.3	4.3	7.4	0.4	0.8	1.2	1.7	2.1	2.48	12	22210.3	2 00	11.2	1931.1
56	161.2	184.3	207.3	230.3	460.7	691.1	921.4	1151.8	1382.12					
57	1.2	4.2	7.3	0.3	0.6	0.9	1.1	1.5	1.76					
58	1.2	4.2	7.2	0.2	0.5	0.7	0.9	1.2	1.40					
59	1.1	4.1	7.2	0.2	0.3	0.5	0.7	0.9	1.04					
60	1.1	4.1	7.1	0.1	0.2	0.3	0.4	0.6	0.68					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 42° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	161.1	184.1	207.1	230.1	460.2	690.3	920.4	1150.6	1380.68
1	1.0	4.0	7.0	0.1	0.1	0.2	0.2	0.3	0.32
2	1.0	4.0	7.0	0.0	0.0	0.0	0.0	0.0	79.96
3	1.0	3.9	6.9	29.9	59.9	689.8	919.7	49.7	9.60
4	0.9	3.9	6.9	9.9	9.7	9.6	9.5	9.4	9.24
5	0.9	3.9	6.8	9.8	9.6	9.4	9.2	9.1	8.88
6	160.8	183.8	206.8	229.7	459.5	689.3	919.0	1148.8	1378.52
7	0.8	3.8	6.7	9.7	9.4	9.1	8.8	8.5	8.15
8	0.7	3.7	6.7	9.6	9.3	8.9	8.5	8.2	7.79
9	0.7	3.7	6.6	9.6	9.1	8.7	8.3	7.9	7.43
10	0.7	3.6	6.6	9.5	9.0	8.5	8.0	7.6	7.07
11	160.6	183.6	206.5	229.5	458.9	688.4	917.8	1147.3	1376.71
12	0.6	3.5	6.5	9.4	8.8	8.2	7.6	7.0	6.35
13	0.5	3.5	6.4	9.3	8.7	8.0	7.3	6.7	5.99
14	0.5	3.4	6.3	9.3	8.5	7.8	7.1	6.3	5.62
15	0.4	3.4	6.3	9.2	8.4	7.6	6.8	6.0	5.26
16	160.4	183.3	206.2	229.1	458.3	687.4	916.6	1145.7	1374.90
17	0.4	3.3	6.2	9.1	8.2	7.3	6.4	5.4	4.54
18	0.3	3.2	6.1	9.0	8.1	7.1	6.1	5.1	4.17
19	0.3	3.2	6.1	9.0	7.9	6.9	5.9	4.8	3.81
20	0.2	3.1	6.0	8.9	7.8	6.7	5.6	4.5	3.45
21	160.2	183.1	206.0	228.9	457.7	686.5	915.4	1144.2	1373.09
22	0.2	3.0	5.9	8.8	7.6	6.4	5.1	3.9	2.72
23	0.1	3.0	5.9	8.7	7.5	6.2	4.9	3.6	2.36
24	0.1	2.9	5.8	8.7	7.3	6.0	4.7	3.3	2.00
25	0.0	2.9	5.7	8.6	7.2	5.8	4.4	3.0	1.64
26	160.0	182.8	205.7	228.5	457.1	685.6	914.2	1142.7	1371.27
27	159.9	2.8	5.6	8.5	7.0	5.5	3.9	2.4	0.91
28	9.9	2.7	5.6	8.4	6.8	5.3	3.7	2.1	0.55
29	9.9	2.7	5.5	8.4	6.7	5.1	3.5	1.8	0.18
30	9.8	2.6	5.5	8.3	6.6	4.9	3.2	1.5	1369.82

Meridional arcs.	
1″	30.9
2	61.7
3	92.6
4	123.4
5	154.3
6	185.1
7	216.0
8	246.8
9	277.7
10	308.5
20	617.0
30	925.5
40	1234.0
50	1542.5
1′ 00	1851.0
2	3702.0
3	5553.1
4	7404.1
5	9255.1
6	11106.1
7	12957.1
8	14808.2
9	16659.2
10	18510.2
11	20361.2
12	22212.2

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.4
6	.0	4.8
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.4
15	.0	30.4
20	.1	53.7
25	.1	84.0
30	.2	120.9
35	.3	164.6
40	.4	215.0
45	.6	272.1
50	.8	335.9
55	1.1	406.4
1° 00	1.4	483.7
1 10	2.2	658.4
1 20	3.3	860.0
1 30	4.8	1088.3
1 40	6.5	1343.7
1 50	8.7	1625.8
2 00	11.3	1934.9

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 42° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″	Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
30′	159.8	182.6	205.5	228.3	456.6	684.9	913.2	1141.5	1369.82	1″	30.9	1′	—.0	.1
31	9.8	2.6	5.4	8.2	6.5	4.7	3.0	1.2	9.45	2	61.7	2	.0	.5
32	9.7	2.5	5.4	8.2	6.4	4.5	2.7	0.9	9.09	3	92.6	3	.0	1.2
33	9.7	2.5	5.3	8.1	6.2	4.4	2.5	0.6	8.73	4	123.4	4	.0	2.2
34	9.6	2.4	5.3	8.1	6.1	4.2	2.2	0.3	8.36					
35	9.6	2.4	5.2	8.0	6.0	4.0	2.0	0.0	8.00	5	154.3	5	.0	3.4
										6	185.1	6	.0	4.8
36	159.6	182.4	205.2	227.9	455.9	683.8	911.8	1139.7	1367.63	7	216.0	7	.0	6.6
37	9.5	2.3	5.1	7.9	5.8	3.6	1.5	9.4	7.27	8	246.8	8	.0	8.6
38	9.5	2.3	5.0	7.8	5.6	3.5	1.3	9.1	6.90	9	277.7	9	.0	10.9
39	9.4	2.2	5.0	7.8	5.5	3.3	1.0	8.8	6.54					
40	9.4	2.2	4.9	7.7	5.4	3.1	0.8	8.5	6.17	10	308.5	10	.0	13.5
										20	617.1	15	.0	30.4
41	159.3	182.1	204.9	227.6	455.3	682.9	910.5	1138.2	1365.81	30	925.6	20	.1	53.8
42	9.3	2.1	4.8	7.6	5.1	2.7	0.3	7.9	5.44	40	1234.1	25	.1	84.1
43	9.3	2.0	4.8	7.5	5.0	2.5	0.0	7.6	5.08	50	1542.7	30	.2	121.1
44	9.2	2.0	4.7	7.5	4.9	2.4	909.8	7.3	4.71					
45	9.2	1.9	4.7	7.4	4.8	2.2	9.6	7.0	4.35	1′ 00	1851.2	35	.3	164.9
										2	3702.4	40	.4	215.4
46	159.1	181.9	204.6	227.3	454.7	682.0	909.3	1136.6	1363.98	3	5553.5	45	.6	272.5
47	9.1	1.8	4.5	7.3	4.5	1.8	9.1	6.3	3.62	4	7404.7	50	.8	336.5
48	9.0	1.8	4.5	7.2	4.4	1.6	8.8	6.0	3.25	5	9255.9	55	1.1	407.1
49	9.0	1.7	4.4	7.1	4.3	1.4	8.6	5.7	2.88	6	11107.1			
50	9.0	1.7	4.4	7.1	4.2	1.3	8.3	5.4	2.52			1° 00	1.4	484.6
										7	12958.3	1 10	2.3	659.5
51	158.9	181.6	204.3	227.0	454.0	681.1	908.1	1135.1	1362.15	8	14809.4	1 20	3.4	861.4
52	8.9	1.6	4.3	7.0	3.9	0.9	7.9	4.8	1.79	9	16660.6	1 30	4.8	1090.2
53	8.8	1.5	4.2	6.9	3.8	0.7	7.6	4.5	1.42	10	18511.8	1 40	6.6	1346.0
54	8.8	1.5	4.2	6.8	3.7	0.5	7.4	4.2	1.05	11	20363.0	1 50	8.8	1628.6
55	8.7	1.4	4.1	6.8	3.6	0.3	7.1	3.9	0.69	12	22214.2	2 00	11.4	1938.2
56	158.7	181.4	204.0	226.7	453.4	680.2	906.9	1133.6	1360.32					
57	8.7	1.3	4.0	6.7	3.3	0.0	6.6	3.3	59.95					
58	8.6	1.3	3.9	6.6	3.2	79.8	6.4	3.0	9.59					
59	8.6	1.2	3.9	6.5	3.1	9.6	6.1	2.7	9.22					
60	8.5	1.2	3.8	6.5	3.0	9.4	5.9	2.4	8.85					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 43° 00′.

Length in metres of arcs of the parallel, (arc par.)

Min.	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	158.5	181.2	203.8	226.5	453.0	679.4	905.9	1132.4	1358.85
1	8.5	1.1	3.8	6.4	2.8	9.2	5.7	2.1	8.48
2	8.4	1.1	3.7	6.3	2.7	9.1	5.4	1.8	8.12
3	8.4	1.0	3.7	6.3	2.6	8.9	5.2	1.5	7.75
4	8.4	1.0	3.6	6.2	2.5	8.7	4.9	1.2	7.38
5	8.3	0.9	3.6	6.2	2.3	8.5	4.7	0.8	7.02
6	158.3	180.9	203.5	226.1	452.2	678.3	904.4	1130.5	1356.65
7	8.2	0.8	3.4	6.0	2.1	8.1	4.2	0.2	6.28
8	8.2	0.8	3.4	6.0	2.0	8.0	3.9	29.9	5.91
9	8.1	0.7	3.3	5.9	1.8	7.8	3.7	9.6	5.54
10	8.1	0.7	3.3	5.9	1.7	7.6	3.4	9.3	5.17
11	158.1	180.6	203.2	225.8	451.6	677.4	903.2	1129.0	1354.81
12	8.0	0.6	3.2	5.7	1.5	7.2	3.0	8.7	4.44
13	8.0	0.5	3.1	5.7	1.4	7.0	2.7	8.4	4.07
14	7.9	0.5	3.1	5.6	1.2	6.8	2.5	8.1	3.70
15	7.9	0.4	3.0	5.6	1.1	6.7	2.2	7.8	3.33
16	157.8	180.4	302.9	225.5	451.0	676.5	902.0	1127.5	1352.96
17	7.8	0.3	2.9	5.4	0.9	6.3	1.7	7.2	2.59
18	7.8	0.3	2.8	5.4	0.7	6.1	1.5	6.9	2.22
19	7.7	0.2	2.8	5.3	0.6	5.9	1.2	6.5	1.85
20	7.7	0.2	2.7	5.2	0.5	5.7	1.0	6.2	1.48
21	157.6	180.1	202.7	225.2	450.4	675.6	900.7	1125.9	1351.11
22	7.6	0.1	2.6	5.1	0.2	5.4	0.5	5.6	0.74
23	7.5	0.0	2.6	5.1	0.1	5.2	0.2	5.3	0.37
24	7.5	0.0	2.5	5.0	0.0	5.0	0.0	5.0	0.00
25	7.5	0.0	2.4	4.9	449.9	4.8	899.8	4.7	49.63
26	157.4	179.9	202.4	224.9	449.8	674.6	899.5	1124.4	1349.26
27	7.4	9.9	2.3	4.8	9.6	4.4	9.3	4.1	8.89
28	7.3	9.8	2.3	4.8	9.5	4.3	9.0	3.8	8.52
29	7.3	9.8	2.2	4.7	9.4	4.1	8.8	3.5	8.15
30	7.2	9.7	2.2	4.6	9.3	3.9	8.5	3.1	7.78

Meridional arcs.

1″	30.9
2	61.7
3	92.6
4	123.4
5	154.3
6	185.1
7	216.0
8	246.8
9	277.7
10	308.6
20	617.1
30	925.7
40	1234.2
50	1542.8
1′ 00	1851.3
2	3702.7
3	5554.0
4	7405.4
5	9256.7
6	11108.1
7	12959.4
8	14810.7
9	16662.1
10	18513.4
11	20364.8
12	22216.1

Co-ordinates of curvature.

Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.9
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.5
15	.0	30.4
20	.1	53.9
25	.1	84.2
30	.2	121.3
35	.3	165.1
40	.4	215.6
45	.6	273.0
50	.8	337.0
55	1.1	407.8
1° 00	1.4	485.2
1 10	2.3	660.5
1 20	3.4	862.6
1 30	4.9	1091.8
1 40	6.7	1347.9
1 50	8.9	1630.9
2 00	11.6	1940.9

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 43° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″	Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
30′	157.2	179.7	202.2	224 6	449.3	673.9	898.5	1123.1	1347.78	1″	30.9	1′	—.0	.1
31	7.2	9.7	2.1	4.6	9.1	3.7	8.3	2.8	7.41	2	61.7	2	.0	.5
32	7.2	9.6	2.1	4.5	9.0	3.5	8.0	2.5	7.04	3	92.6	3	.0	1.2
33	7.1	9.6	2.0	4.4	8.9	3.3	7.8	2.2	6.67	4	123.4	4	.0	2.2
34	7.1	9.5	1.9	4.4	8.8	3.1	7.5	1.9	6.30					
35	7.0	9.5	1.9	4.3	8.6	3.0	7.3	1.6	5.93	5	154.3	5	.0	3.4
										6	185.2	6	.0	4.9
36	157.0	179.4	201.8	224.3	448.5	672.8	897.0	1121.3	1345.56	7	216.0	7	.0	6.6
37	6.9	9.4	1.8	4.2	8.4	2.6	6.8	1.0	5.18	8	246.9	8	.0	8.6
38	6.9	9.3	1.7	4.1	8.3	2.4	6.5	0.7	4.81	9	277.7	9	.0	10.9
39	6.9	9.3	1.7	4.1	8.1	2.2	6.3	0.4	4.44					
40	6.8	9.2	1.6	4.0	8.0	2.0	6.0	0.1	4.07	10	308.6	10	.0	13.5
										20	617.2	15	.0	30.4
41	156.8	179.2	201.6	224.0	447.9	671.8	895.8	1119.7	1343.70	30	925.8	20	.1	54.0
42	6.7	9.1	1.5	3.9	7.8	1.7	5.5	9.4	3.32	40	1234.3	25	.1	84.3
43	6.7	9.1	1.4	3.9	7.7	1.5	5.3	9.1	2.95	50	1542.9	30	.2	121.4
44	6.6	9.0	1.4	3.8	7.5	1.3	5.1	8.8	2.58					
45	6.6	9.0	1.3	3.7	7.4	1.1	4.8	8.5	2.21	1′ 00	1851.5	35	.3	165.3
										2	3703.0	40	.4	215.9
46	156.5	178.9	201.3	223.6	447.3	670.9	894.6	1118.2	1341.84	3	5554.5	45	.6	273.3
47	6.5	8.9	1.2	3.6	7.2	0.7	4.3	7.9	1.46	4	7406.0	50	.8	337.3
48	6.5	8.8	1.2	3.5	7.0	0.5	4.1	7.6	1.09	5	9257.5	55	1.1	408.2
49	6.4	8.8	1.1	3.5	6.9	0.4	3.8	7.3	0.72	6	11109.0			
50	6.4	8.7	1.1	3.4	6.8	0.2	3.6	7.0	0.34			1° 00	1.5	485.8
										7	12960.5	1 10	2.3	661.2
51	156.3	178.7	201.0	223.3	446.6	670.0	893.3	1116.6	1339.97	8	14812.0	1 20	3.5	863.6
52	6.3	8.6	0.9	3.3	6.5	69.8	3.1	6.3	9.60	9	16663.5	1 30	4.9	1093.0
53	6.2	8.6	0.9	3.2	6.4	9.6	2.8	6.0	9.22	10	18515.0	1 40	6.8	1349.4
54	6.2	8.5	0.8	3.1	6.3	9.4	2.6	5.7	8.85	11	20366.5	1 50	9.0	1632.8
55	6.2	8.5	0.8	3.1	6.2	9.2	2.3	5.4	8.48	12	22218.0	2 00	11.7	1943.1
56	156.1	178.4	200.7	223.0	446.0	669.0	892.1	1115.1	1338.10					
57	6.1	8.4	0.7	2.9	5.9	8.9	1.8	4.8	7.73					
58	6.0	8.3	0.6	2.9	5.8	8.7	1.6	4.5	7.36					
59	6.0	8.3	0.5	2.8	5.7	8.5	1.3	4.1	6.98					
60	5.9	8.2	0.5	2.8	5.5	8.3	1.1	3.8	6.61					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 44° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	155.9	178.2	200.5	222.8	445.5	668.3	891.1	1113.8	1336.61
1	5.9	8.2	0.4	2.7	5.4	8.1	0.8	3.5	6.23
2	5.8	8.1	0.4	2.6	5.3	7.9	0.6	3.2	5.86
3	5.8	8.1	0.3	2.6	5.2	7.7	0.3	2.9	5.48
4	5.8	8.0	0.3	2.5	5.0	7.6	0.1	2.6	5.11
5	5.7	8.0	0.2	2.5	4.9	7.4	889.8	2.3	4.74
6	155.7	177.9	200.2	222.4	444.8	667.2	889.6	1112.0	1334.36
7	5.6	7.9	0.1	2.3	4.7	7.0	9.3	1.7	3.99
8	5.6	7.8	0.0	2.3	4.5	6.8	9.1	1.3	3.61
9	5.5	7.8	0.0	2.2	4.4	6.6	8.8	1.0	3.24
10	5.5	7.7	199.9	2.1	4.3	6.4	8.6	0.7	2.86
11	155.5	177.7	199.9	222.1	444.2	666.2	888.3	1110.4	1332.49
12	5.4	7.6	9.8	2.0	4.0	6.1	8.1	0.1	2.11
13	5.4	7.6	9.8	2.0	3.9	5.9	7.8	1109.8	1.73
14	5.3	7.5	9.7	1.9	3.8	5.7	7.6	9.5	1.36
15	5.3	7.5	9.6	1.8	3.7	5.5	7.3	9.2	0.98
16	155.2	177.4	199.6	221.8	443.5	665.3	887.1	1108.8	1330.61
17	5.2	7.4	9.5	1.7	3.4	5.1	6.8	8.5	0.23
18	5.1	7.3	9.5	1.6	3.3	4.9	6.6	8.2	29.85
19	5.1	7.3	9.4	1.6	3.2	4.7	6.3	7.9	9.48
20	5.1	7.2	9.4	1.5	3.0	4.5	6.1	7.6	9.10
21	155.0	177.2	199.3	221.5	442.9	664.4	885.8	1107.3	1328.73
22	5.0	7.1	9.3	1.4	2.8	4.2	5.6	7.0	8.35
23	4.9	7.1	9.2	1.3	2.7	4.0	5.3	6.6	7.97
24	4.9	7.0	9.1	1.3	2.5	3.8	5.1	6.3	7.60
25	4.8	7.0	9.1	1.2	2.4	3.6	4.8	6.0	7.22
26	154.8	176.9	199.0	221.1	442.3	663.4	884.6	1105.7	1326.84
27	4.8	6.9	9.0	1.1	2.2	3.2	4.3	5.4	6.46
28	4.7	6.8	8.9	1.0	2.0	3.0	4.1	5.1	6.09
29	4.7	6.8	8.9	1.0	1.9	2.9	3.9	4.8	5.71
30	4.6	6.7	8.8	220.9	1.8	2.7	3.6	4.4	5.33

Meridional arcs.	
1″	30.9
2	61.7
3	92.6
4	123.4
5	154.3
6	185.2
7	216.0
8	246.9
9	277.8
10	308.6
20	617.2
30	925.8
40	1234.4
50	1543.1
1′ 00	1851.7
2	3703.3
3	5555.0
4	7406.7
5	9258.3
6	11110.0
7	12961.7
8	14813.3
9	16665.0
10	18516.7
11	20368.3
12	22220.0

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.9
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.5
15	.0	30.4
20	.1	54.0
25	.1	84.4
30	.2	121.5
35	.3	165.4
40	.4	216.1
45	.6	273.5
50	.9	337.6
55	1.1	408.5
1° 00	1.5	486.1
1 10	2.3	661.7
1 20	3.5	864.3
1 30	4.9	1093.9
1 40	6.8	1350.4
1 50	9.1	1634.0
2 00	11.8	1944.6

TABLE VI.—*Projection Tables*—Continued.

Latitude 44° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	154.6	176.7	198.8	220.9	441.8	662.7	883.6	1104.4	1325.33
31	4.6	6.7	8.7	0.8	1.6	2.5	3.3	4.1	4.95
32	4.5	6.6	8.7	0.8	1.5	2.3	3.1	3.8	4.58
33	4.5	6.6	8.6	0.7	1.4	2.1	2.8	3.5	4.20
34	4.4	6.5	8.6	0.6	1.3	1.9	2.5	3.2	3.82
35	4.4	6.5	8.5	0.6	1.1	1.7	2.3	2.9	3.44
36	154.4	176.4	198.5	220.5	441.0	661.5	882.0	1102.5	1323.06
37	4.3	6.4	8.4	0.4	0.9	1.3	1.8	2.2	2.69
38	4.3	6.3	8.3	0.4	0.8	1.2	1.5	1.9	2.31
39	4.2	6.3	8.3	0.3	0.6	1.0	1.3	1.6	1.93
40	4.2	6.2	8.2	0.3	0.5	0.8	1.0	1.3	1.55
41	154.1	176.2	198.2	220.2	410.4	660.6	880.8	1101.0	1321.17
42	4.1	6.1	8.1	0.1	0.3	0.4	0.5	0.7	0.79
43	4.0	6.1	8.1	0.1	0.1	0.2	0.3	0.3	0.41
44	4.0	6.0	8.0	0.0	0.0	0.0	0.0	0.0	0.04
45	4.0	6.0	7.9	219.9	39.9	59.8	79.8	1099.7	19.66
46	153.9	175.9	197.0	219.9	439.8	659.6	879.5	1099.4	1319.28
47	3.9	5.9	7.8	9.8	9.6	9.5	9.3	9.1	8.90
48	3.8	5.8	7.8	9.8	9.5	9.3	9.0	8.8	8.52
49	3.8	5.8	7.7	9.7	9.4	9.1	8.8	8.4	8.14
50	3.7	5.7	7.7	9.6	9.2	8.9	8.5	8.1	7.76
51	153.7	175.7	197.6	219.6	439 1	658.7	878.3	1097.8	1317.38
52	3.6	5.6	7.5	9.5	9.0	8.5	8.0	7.5	7.00
53	3.6	5.5	7.5	9.4	8.9	8.3	7.7	7.2	6.62
54	3.6	5.5	7.4	9.4	8.8	8.1	7.5	6.9	6.24
55	3.5	5.4	7.4	9.3	8.6	7.9	7.2	6.5	5.86
56	153.5	175.4	197.3	219.2	438.5	657.7	877.0	1096.2	1315.48
57	3.4	5.3	7.3	9.2	8.4	7.5	6.7	5.9	5.10
58	3.4	5.3	7.2	9.1	8.2	7.4	6.5	5.6	4.72
59	3.3	5.2	7.1	9.1	8.1	7.2	6.2	5.3	4.34
60	3.3	5.2	7.1	9.0	8.0	7.0	6.0	5.0	3.96

Meridional arcs.	
1″	30.9
2	61.7
3	92.6
4	123.5
5	154.3
6	185.2
7	216.0
8	246.9
9	277.8
10	308.6
20	617.3
30	925.9
40	1234.6
50	1543.2
1′ 00	1851.8
2	3703.7
3	5555.5
4	7407.3
5	9259.1
6	11111.0
7	12962.8
8	14814.6
9	16666.5
10	18518.3
11	20370.1
12	22222.0

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.9
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.5
15	.0	30.4
20	.1	51.0
25	.1	84.4
30	.2	121.6
35	.3	165.5
40	.4	216.2
45	.6	273.6
50	.9	337.8
55	1.1	408.7
1° 00	1.5	486.4
1 10	2.4	662.0
1 20	3.5	864.7
1 30	5.1	1094.4
1 40	6.9	1351.1
1 50	9.2	1631.8
2 00	11.9	1945.6

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 45° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	153.3	175.2	197.1	219.0	438.0	657.0	876.0	1095.0	1313.96
1	3.2	5.1	7.0	8.9	7.9	6.8	5.7	4.6	3.57
2	3.2	5.1	7.0	8.9	7.7	6.6	5.5	4.3	3.19
3	3.2	5.0	6.9	8.8	7.6	6.4	5.2	4.0	2.81
4	3.1	5.0	6.9	8.7	7.5	6.2	5.0	3.7	2.43
5	3.1	4.9	6.8	8.7	7.3	6.0	4.7	3.4	2.05
6	153.0	174.9	196.8	218.6	437.2	655.8	874.4	1093.1	1311.67
7	3.0	4.8	6.7	8.5	7.1	5.6	4.2	2.7	1.29
8	2.9	4.8	6.6	8.5	7.0	5.4	3.9	2.4	0.90
9	2.9	4.7	6.6	8.4	6.8	5.3	3.7	2.1	0.52
10	2.9	4.7	6.5	8.4	6.7	5.1	3.4	1.8	0.14
11	152.8	174.6	196.5	218.3	436.6	654.9	873.2	1091.5	1309.76
12	2.8	4.6	6.4	8.2	6.5	4.7	2.9	1.1	9.38
13	2.7	4.5	6.3	8.2	6.3	4.5	2.7	0.8	8.99
14	2.7	4.5	6.3	8.1	6.2	4.3	2.4	0.5	8.61
15	2.6	4.4	6.2	8.0	6.1	4.1	2.2	0.2	8.23
16	152.6	174.4	196.2	218.0	436.0	653.9	871.9	1089.9	1307.85
17	2.5	4.3	6.1	7.9	5.8	3.7	1.6	9.5	7.46
18	2.5	4.3	6.1	7.8	5.7	3.5	1.4	9.2	7.08
19	2.4	4.2	6.0	7.8	5.6	3.3	1.1	8.9	6.70
20	2.4	4.2	5.9	7.7	5.4	3.2	0.9	8.6	6.31
21	152.4	174.1	195.9	217.6	435.3	653.0	870.6	1088.3	1305.93
22	2.3	4.1	5.8	7.6	5.2	2.8	0.4	8.0	5.54
23	2.3	4.0	5.8	7.5	5.1	2.6	0.1	7.6	5.16
24	2.2	4.0	5.7	7.5	4.9	2.4	869.9	7.3	4.78
25	2.2	3.9	5.7	7.4	4.8	2.2	9.6	7.0	4.40
26	152.1	173.9	195.6	217.3	434.7	652.0	869.3	1086.7	1304.01
27	2.1	3.8	5.5	7.3	4.5	1.8	9.1	6.4	3.63
28	2.0	3.8	5.5	7.2	4.4	1.6	8.8	6.0	3.25
29	2.0	3.7	5.4	7.1	4.3	1.4	8.6	5.7	2.86
30	2.0	3.7	5.4	7.1	4.2	1.2	8.3	5.4	2.48

Meridional arcs.	
1″	30.9
2	61.7
3	92.6
4	123.5
5	154.3
6	185.2
7	216.1
8	246.9
9	277.8
10	308.7
20	617.3
30	926.0
40	1234.7
50	1543.3
1′ 00	1852.0
2	3704.0
3	5556.0
4	7408.0
5	9260.0
6	11111.9
7	12963.9
8	14815.9
9	16667.9
10	18519.9
11	20371.9
12	22223.9

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.9
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.5
15	.0	30.4
20	.1	54.0
25	.1	84.5
30	.2	121.6
35	.3	165.5
40	.4	216.2
45	.6	273.7
50	.9	337.8
55	1.2	408.8
1° 00	1.5	486.4
1 10	2.4	662.2
1 20	3.6	864.8
1 30	5.1	1094.6
1 40	6.9	1351.3
1 50	9.3	1635.1
2 00	11.9	1945.9

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 45° 30′.

Length in metres of arcs of the parallel, (arc par.)

Min.	7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	152.0	173.7	195.4	217.1	434.2	651.2	868.3	1085.4	1302.48
31	1.9	3.6	5.3	7.0	4.0	1.0	8.1	5.1	2.09
32	1.9	3.6	5.3	7.0	3.9	0.9	7.8	4.8	1.71
33	1.8	3.5	5.2	6.9	3.8	0.7	7.5	4.4	1.32
34	1.8	3.5	5.1	6.8	3.6	0.5	7.3	4.1	0.94
35	1.7	3.4	5.1	6.8	3.5	0.3	7.0	3.8	0.55
36	151.7	173.4	195.0	216.7	433.4	650.1	866.8	1083.5	1300.17
37	1.6	3.3	5.0	6.6	3.3	49.9	6.5	3.1	1299.78
38	1.6	3.3	4.9	6.6	3.1	9.7	6.3	2.8	9.39
39	1.6	3.2	4.9	6.5	3.0	9.5	6.0	2.5	9.01
40	1.5	3.2	4.8	6.4	2.9	9.3	5.8	2.2	8.63
41	151.5	173.1	194.7	216.4	432.7	649.1	865.5	1081.9	1298.24
42	1.4	3.0	4.7	6.3	2.6	8.9	5.2	1.6	7.86
43	1.4	3.0	4.6	6.2	2.5	8.7	5.0	1.2	7.47
44	1.3	2.9	4.6	6.2	2.4	8.5	4.7	0.9	7.09
45	1.3	2.9	4.5	6.1	2.2	8.2	4.5	0.6	6.70
46	151.2	172.8	194.4	216.1	432.1	648.2	864.2	1080.2	1296.31
47	1.2	2.8	4.4	6.0	2.0	8.0	4.0	1079.9	5.93
48	1.1	2.7	4.3	5.9	1.8	7.8	3.7	9.6	5.54
49	1.1	2.7	4.3	5.9	1.7	7.6	3.4	9.3	5.16
50	1.1	2.6	4.2	5.8	1.6	7.4	3.2	9.0	4.77
51	151.0	172.6	194.2	215.7	431.5	647.2	862.9	1078.7	1294.38
52	1.0	2.5	4.1	5.7	1.3	7.0	2.7	8.3	4.00
53	0.9	2.5	4.0	5.6	1.2	6.8	2.4	8.0	3.61
54	0.9	2.4	4.0	5.5	1.1	6.6	2.1	7.7	3.22
55	0.8	2.4	3.9	5.5	0.9	6.4	1.9	7.3	2.83
56	150.8	172.3	193.9	215.4	430.8	646.2	864.6	1077.0	1292.45
57	0.7	2.3	3.8	5.3	0.7	6.0	1.4	6.7	2.06
58	0.7	2.2	3.8	5.3	0.6	5.8	1.1	6.4	1.67
59	0.6	2.2	3.7	5.2	0.4	5.6	0.9	6.1	1.29
60	0.6	2.1	3.6	5.1	0.3	5.5	0.6	5.8	0.90

Meridional arcs.

1″	30.9
2	61.7
3	92.6
4	123.5
5	154.3
6	185.2
7	216.1
8	247.0
9	277.8
10	308.7
20	617.4
30	926.1
40	1234.8
50	1543.5
1′ 00	1852.2
2	3704.3
3	5556.5
4	7408.6
5	9260.8
6	11113.0
7	12965.1
8	14817.3
9	16669.4
10	18521.5
11	20373.7
12	22225.8

Co-ordinates of curvature.

Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.9
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.5
15	.0	30.4
20	.1	54.0
25	.1	84.4
30	.2	121.6
35	.3	165.5
40	.4	216.2
45	.6	273.6
50	.9	337.8
55	1.2	408.7
1° 00	1.5	486.4
1 10	2.4	662.1
1 20	3.6	864.7
1 30	5.1	1094.5
1 40	7.1	1351.1
1 50	9.3	1635.0
2 00	12.1	1945.7

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 46° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	150.6	172.1	193.6	215.1	430.3	645.5	860.6	1075.8	1290.90
1	0.5	2.1	3.6	5.1	0.2	5.3	0.3	5.4	0.51
2	0.5	2.0	3.5	5.0	0.0	5.1	0.1	5.1	0.12
3	0.5	2.0	3.5	5.0	29.9	4.9	859.8	4.8	89.73
4	0.4	1.9	3.4	4.9	9.8	4.7	9.6	4.5	9.35
5	0.4	1.9	3.3	4.8	9.7	4.5	9.3	4.1	8.96
6	150.3	171.8	193.3	214.8	429.5	644.3	859.0	1073.8	1288.57
7	0.3	1.8	3.2	4.7	9.4	4.1	8.8	3.5	8.18
8	0.2	1.7	3.2	4.6	9.3	3.9	8.5	3.2	7.79
9	0.2	1.7	3.1	4.6	9.1	3.7	8.3	2.8	7.41
10	0.2	1.6	3.1	4.5	9.0	3.5	8.0	2.5	7.02
11	150.1	171.6	193.0	214.4	428.9	643.3	857.8	1072.2	1286.63
12	0.1	1.5	2.9	4.4	8.7	3.1	7.5	1.9	6.24
13	0.0	1.4	2.9	4.3	8.6	2.9	7.2	1.5	5.85
14	0.0	1.4	2.8	4.2	8.5	2.7	7.0	1.2	5.46
15	149.9	1.3	2.8	4.2	8.4	2.5	6.7	0.9	5.07
16	149.9	171.3	192.7	214.1	428.2	642.3	856.5	1070.6	1284.68
17	9.8	1.2	2.6	4.0	8.1	2.1	6.2	0.2	4.29
18	9.8	1.2	2.6	4.0	8.0	1.9	5.9	69.9	3.90
19	9.7	1.1	2.5	3.9	7.8	1.8	5.7	9.6	3.51
20	9.7	1.1	2.5	3.9	7.7	1.6	5.4	9.3	3.12
21	149.7	171.0	192.4	213.8	427.6	641.4	855.2	1068.9	1282.73
22	9.6	1.0	2.4	3.7	7.4	1.2	4.9	8.6	2.34
23	9.6	0.9	2.3	3.7	7.3	1.0	4.6	8.3	1.95
24	9.5	0.9	2.2	3.6	7.2	0.8	4.4	8.0	1.56
25	9.5	0.8	2.2	3.5	7.1	0.6	4.1	7.7	1.17
26	149.4	170.8	192.1	213.5	426.9	640.4	853.9	1067.3	1280.78
27	9.4	0.7	2.1	3.4	6.8	0.2	3.6	7.0	0.39
28	9.3	0.7	2.0	3.3	6.7	0.0	3.3	6.7	0.00
29	9.3	0.6	1.9	3.3	6.5	39.8	3.1	6.3	79.61
30	9.2	0.6	1.9	3.2	6.4	9.6	2.8	6.0	1279.22

Meridional arcs.	
1″	30.9
2	61.7
3	92.6
4	123.5
5	154.4
6	185.2
7	216.1
8	247.0
9	277.8
10	308.7
20	617.4
30	926.2
40	1234.9
50	1543.6
1′ 00	1852.3
2	3704.6
3	5556.9
4	7409.3
5	9261.6
6	11113.9
7	12966.2
8	14818.5
9	16670.8
10	18523.1
11	20375.5
12	22227.8

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.9
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.5
15	.0	30.4
20	.1	54.0
25	.1	84.4
30	.2	121.6
35	.3	165.4
40	.5	216.1
45	.6	273.5
50	.9	337.6
55	1.2	408.5
1° 00	1.5	486.2
1 10	2.4	661.8
1 20	3.6	864.4
1 30	5.2	1094.0
1 40	7.1	1350.6
1 50	9.4	1634.2
2 00	12.2	1944.9

TABLE VI.—*Projection Tables*—Continued.

Latitude 46° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)									Meridional arcs.		Co-ordinates of curvature.		
	7″	8″	9″	10″	20″	30″	40″	50″	60″			Minutes of longitude.	X. Arc par.	Y.
30′	149.2	170.6	191.9	213.2	426.4	639.6	852.8	1066.0	1279.22	1″	30.9	1′	—.0	.1
31	9.2	0.5	1.8	3.1	6.3	9.4	2.6	5.7	8.83	2	61.7	2	.9	.5
32	9.2	0.5	1.8	3.1	6.1	9.2	2.3	5.4	8.84	3	92.6	3	.0	1.2
33	9.1	0.4	1.7	3.0	6.0	9.0	2.0	5.0	8.05	4	123.5	4	.0	2.2
34	9.1	0.4	1.6	2.9	5.9	8.8	1.8	4.7	7.66					
35	9.0	9.3	1.6	2.9	5.8	8.6	1.5	4.4	7.27	5	154.4	5	.0	3.4
										6	185.2	6	.0	4.9
36	149.0	170.2	191.5	212.8	425.6	638.4	851.2	1064.1	1276.87	7	216.1	7	.0	6.6
37	8.9	0.2	1.5	2.7	5.5	8.2	1.0	3.7	6.48	8	247.0	8	.0	8.6
38	8.9	0.1	1.4	2.7	5.4	8.0	0.7	3.4	6.09	9	277.9	9	.0	10.9
39	8.8	0.1	1.4	2.6	5.2	7.8	0.5	3.1	5.70					
40	8.8	0.0	1.3	2.6	5.1	7.7	0.2	2.8	5.31	10	308.7	10	.0	13.5
										20	617.5	15	.0	30.4
41	148.7	170.0	191.2	212.5	425.0	637.5	850.0	1062.4	1274.91	30	926.2	20	.1	54.0
42	8.7	69.9	1.2	2.4	4.8	7.3	49.7	2.1	4.52	40	1235.0	25	.1	84.3
43	8.6	9.9	1.1	2.4	4.7	7.1	9.4	1.8	4.13	50	1543.7	30	.2	121.5
44	8.6	9.8	1.1	2.3	4.6	6.9	9.2	1.5	3.74					
45	8.6	9.8	1.0	2.2	4.4	6.7	8.9	1.1	3.35	1′ 00	1852.5	35	.3	165.3
										2	3705.0	40	.5	215.9
46	148.5	169.7	190.9	212.2	424.3	636.5	848.6	1060.8	1272.95	3	5557.4	45	.6	273.3
47	8.5	9.7	0.9	2.1	4.2	6.3	8.4	0.5	2.56	4	7409.9	50	.9	337.4
48	8.4	9.6	0.8	2.0	4.1	6.1	8.1	0.1	2.17	5	9262.4	55	1.2	408.3
49	8.4	9.6	0.8	2.0	3.9	5.9	7.9	1059.8	1.77	6	11114.9			
50	8.3	9.5	0.7	1.9	3.8	5.7	7.6	9.5	1.38			1° 00	1.5	485.9
										7	12967.4	1 10	2.4	661.3
51	148.3	169.5	190.6	211.8	423.7	635.5	847.3	1059.2	1270.99	8	14819.8	1 20	3.6	863.7
52	8.2	9.4	0.6	1.8	3.5	5.3	7.1	8.8	0.60	9	16672.3	1 30	5.2	1093.2
53	8.2	9.4	0.5	1.7	3.4	5.1	6.8	8.5	0.20	10	18524.8	1 40	7.1	1349.6
54	8.1	9.3	0.5	1.6	3.3	4.9	6.5	8.2	69.81	11	20377.3	1 50	9.5	1633.1
55	8.1	9.3	0.4	1.6	3.1	4.7	6.3	7.9	9.42	12	22229.7	2 00	12.3	1943.4
56	148.1	169.2	190.4	211.5	423.0	634.5	846.0	1057.5	1269.02					
57	8.0	9.2	0.3	1.4	2.9	4.3	5.7	7.2	8.63					
58	8.0	9.1	0.2	1.4	2.8	4.1	5.5	6.9	8.23					
59	7.9	9.1	0.2	1.3	2.6	3.9	5.2	6.5	7.84					
60	7.9	9.0	0.1	1.2	2.5	3.7	5.0	6.2	7.45					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 47° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″	Meridional arcs.		Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
0′	147.9	169.0	190.1	211.2	422.5	633.7	845.0	1056.2	1267.45	1″	30.9	1′	—.0	.1
1	7.8	9.0	0.0	1.2	2.3	3.5	4.7	5.9	7.05	2	61.8	2	.0	.5
2	7.8	8.9	0.0	1.1	2.2	3.3	4.4	5.5	6.66	3	92.6	3	.0	1.2
3	7.7	8.8	189.9	1.0	2.1	3.1	4.2	5.2	6.26	4	123.5	4	.0	2.2
4	7.7	8.8	9.9	1.0	2.0	2.9	3.9	4.9	5.87					
5	7.6	8.7	9.8	0.9	1.8	2.7	3.7	4.6	5.47	5	154.4	5	.0	3.4
										6	185.3	6	.0	4.9
6	147.6	168.7	189.8	210.8	421.7	632.5	843.4	1054.2	1265.08	7	216.1	7	.0	6.6
7	7.5	8.6	9.7	0.8	1.6	2.3	3.1	3.9	4.68	8	247.0	8	.0	8.6
8	7.5	8.6	9.6	0.7	1.4	2.1	2.9	3.6*	4.29	9	277.9	9	.0	10.9
9	7.5	8.5	9.6	0.6	1.3	1.9	2.6	3.2	3.89					
10	7.4	8.5	9.5	0.6	1.2	1.7	2.3	2.9	3.50	10	308.8	10	.0	13.5
										20	617.5	15	.0	30.3
11	147.4	168.4	189.5	210.5	421.0	631.5	842.1	1052.6	1263.10	30	926.3	20	.1	53.9
12	7.3	8.4	9.4	0.4	0.9	1.4	1.8	2.3	2.71	40	1235.1	25	.1	84.3
13	7.3	8.3	9.3	0.4	0.8	1.2	1.5	1.9	2.31	50	1543.9	30	.2	121.3
14	7.2	8.3	9.3	0.3	0.6	1.0	1.3	1.6	1.92					
15	7.2	8.2	9.2	0.3	0.5	0.8	1.0	1.3	1.52	1′ 00	1852.6	35	.3	165.2
										2	3705.3	40	.5	215.7
16	147.1	168.2	189.2	210.2	420.4	630.6	840.8	1050.9	1261.13	3	5557.9	45	.7	273.0
17	7.1	8.1	9.1	0.1	0.2	0.4	0.5	0.6	0.73	4	7410.6	50	.9	337.0
18	7.0	8.0	9.0	0.1	0.1	0.2	0.2	0.3	0.33	5	9263.2	55	1.2	407.8
19	7.0	8.0	9.0	0.0	0.0	0.0	0.0	49.9	59.94	6	11115.9			
20	6.9	7.9	8.9	209.9	419.9	29.8	39.7	9.6	9.54			1° 00	1.5	485.3
										7	12968.5	1 10	2.5	660.6
21	146.9	167.9	188.9	209.9	419.7	629.6	839.4	1049.3	1259.15	8	14821.1	1 20	3.7	862.8
22	6.9	7.8	8.8	9.8	9.6	9.4	9.2	9.0	8.75	9	16673.8	1 30	5.2	1092.0
23	6.8	7.8	8.8	9.7	9.4	9.2	8.9	8.7	8.35	10	18526.4	1 40	7.2	1348.2
24	6.8	7.7	8.7	9.7	9.3	9.0	8.6	8.3	7.96	11	20379.0	1 50	9.5	1631.4
25	6.7	7.7	8.6	9.6	9.2	8.8	8.4	8.0	7.56	12	22231.7	2 00	12.4	1941.4
26	146.7	167.6	188.6	209.5	419.1	628.6	838.1	1047.6	1257.16					
27	6.6	7.6	8.5	9.5	8.9	8.4	7.8	7.3	6.77					
28	6.6	7.5	8.5	9.4	8.8	8.2	7.6	7.0	6.37					
29	6.5	7.5	8.4	9.3	8.7	8.0	7.3	6.7	5.97					
30	6.5	7.4	8.3	9.3	8.5	7.8	7.0	6.3	5.57					

TABLE VI.—*Projection Tables*—Continued.

Latitude 47° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10	20″	30″	40″	50″	60″
30′	146.5	167.4	188.3	209.3	418.5	627.8	837.0	1046.3	1255.57
31	6.4	7.4	8.3	9.2	8.4	7.6	6.8	6.0	5.18
32	6.4	7.3	8.2	9.1	8.3	7.4	6.5	5.6	4.78
33	6.3	7.3	8.2	9.1	8.1	7.2	6.3	5.3	4.38
34	6.3	7.2	8.1	9.0	8.0	7.0	6.0	5.0	3.98
35	6.3	7.1	8.0	8.9	7.9	6.8	5.7	4.7	3.59
36	146.2	167.1	188.0	208.9	417.7	626.6	835.5	1044.3	1253.19
37	6.2	7.0	7.9	8.8	7.6	6.4	5.2	4.0	2.79
38	6.1	7.0	7.9	8.7	7.5	6.2	4.9	3.7	2.39
39	6.1	6.9	7.8	8.7	7.3	6.0	4.7	3.4	1.99
40	6.0	6.9	7.7	8.6	7.2	5.8	4.4	3.0	1.59
41	146.0	166.8	187.7	208.5	417.1	625.6	834.1	1042.7	1251.20
42	5.9	6.8	7.6	8.5	6.9	5.4	3.9	2.3	0.80
43	5.9	6.7	7.6	8.4	6.8	5.2	3.6	2.0	0.40
44	5.8	6.7	7.5	8.3	6.7	5.0	3.3	1.7	0.00
45	5.8	6.6	7.4	8.3	6.5	4.8	3.1	1.3	49.60
46	145.7	166.6	187.4	208.2	416.4	624.6	832.8	1041.0	1249.20
47	5.7	6.5	7.3	8.1	6.3	4.4	2.5	0.7	8.80
48	5.6	6.5	7.3	8.1	6.1	4.2	2.3	0.3	8.40
49	5.6	6.4	7.2	8.0	6.0	4.0	2.0	0.0	8.00
50	5.6	6.3	7.1	7.9	5.9	3.8	1.7	39.7	7.60
51	145.5	166.3	187.1	207.9	415.7	623.6	831.5	1039.4	1247.21
52	5.5	6.2	7.0	7.8	5.6	3.4	1.2	9.0	6.81
53	5.4	6.2	7.0	7.7	5.5	3.2	0.9	8.7	6.41
54	5.4	6.1	6.9	7.7	5.3	3.0	0.7	8.3	6.01
55	5.3	6.1	6.8	7.6	5.2	2.8	0.4	8.0	5.61
56	145.3	166.0	186.8	207.5	415.1	622.6	830.1	1037.7	1245.21
57	5.2	6.0	6.7	7.5	4.9	2.4	29.9	7.4	4.81
58	5.2	5.9	6.7	7.4	4.8	2.2	9.6	7.0	4.41
59	5.1	5.9	6.6	7.3	4.7	2.0	9.3	6.7	4.01
60	5.1	5.8	6.5	7.3	4.5	1.8	9.1	6.3	3.60

Meridional arcs.	
1″	30.9
2	61.8
3	92.6
4	123.5
5	154.4
6	185.3
7	216.2
8	247.0
9	277.9
10	308.8
20	617.6
30	926.4
40	1235.2
50	1544.0
1′ 00	1852.8
2	3705.6
3	5558.4
4	7411.2
5	9264.0
6	11116.8
7	12969.6
8	14822.4
9	16675.2
10	18528.0
11	20380.8
12	22233.6

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.8
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.5
15	.0	30.3
20	.1	53.9
25	.1	84.2
30	.2	121.2
35	.3	164.9
40	.5	215.4
45	.7	272.6
50	.9	336.6
55	1.2	407.3
1° 00	1.6	484.7
1 10	2.5	659.7
1 20	3.7	861.7
1 30	5.3	1090.5
1 40	7.2	1346.4
1 50	9.6	1629.2
2 00	12.5	1938.7

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 48° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.)								
	7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	145.1	165.8	186.5	207.3	414.5	621.8	829.1	1036.3	1243.60
1	5.0	5.8	6.5	7.2	4.4	1.6	8.8	6.0	3.20
2	5.0	5.7	6.4	7.1	4.3	1.4	8.5	5.7	2.80
3	4.9	5.7	6.4	7.1	4.1	1.2	8.3	5.3	2.40
4	4.9	5.6	6.3	7.0	4.0	1.0	8.0	5.0	2.00
5	4.9	5.5	6.2	6.9	3.9	0.8	7.7	4.7	1.60
6	144.8	165.5	186.2	206.9	413.7	620.6	827.5	1034.3	1211.20
7	4.8	5.4	6.1	6.8	3.6	0.4	7.2	4.0	0.80
8	4.7	5.4	6.1	6.7	3.5	0.2	6.9	3.7	0.40
9	4.7	5.3	6.0	6.7	3.3	0.0	6.7	3.3	0.00
10	4.6	5.3	5.9	6.6	3.2	19.8	6.4	3.0	39.59
11	144.6	165.2	185.9	206.5	413.1	619.6	826.1	1032.7	1239.19
12	4.5	5.2	5.8	6.5	2.9	9.4	5.9	2.3	8.79
13	4.5	5.1	5.8	6.4	2.8	9.2	5.6	2.0	8.39
14	4.4	5.1	5.7	6.3	2.7	9.0	5.3	1.7	7.99
15	4.4	5.0	5.6	6.3	2.5	8.8	5.1	1.3	7.59
16	144.3	165.0	185.6	206.2	412.4	618.6	824.8	1031.0	1237.18
17	4.3	4.9	5.5	6.1	2.3	8.4	4.6	0.6	6.78
18	4.2	4.9	5.5	6.1	2.1	8.2	4.3	0.3	6.38
19	4.2	4.8	5.4	6.0	2.0	8.0	4.0	0.0	5.97
20	4.2	4.7	5.3	5.9	1.9	7.8	3.7	29.6	5.57
21	144.1	164.7	185.3	205.9	411.7	617.6	823.4	1029.3	1235.17
22	4.1	4.6	5.2	5.8	1.6	7.4	3.2	9.0	4.77
23	4.0	4.6	5.2	5.7	1.5	7.2	2.9	8.6	4.36
24	4.0	4.5	5.1	5.7	1.3	7.0	2.6	8.3	3.96
25	3.9	4.5	5.0	5.6	1.2	6.8	2.4	8.0	3.56
26	143.9	164.4	185.0	205.5	411.0	616.6	822.1	1027.6	1233.15
27	3.8	4.4	4.9	5.5	0.9	6.4	1.8	7.3	2.75
28	3.8	4.3	4.9	5.4	0.8	6.2	1.6	7.0	2.35
29	3.7	4.3	4.8	5.3	0.6	6.0	1.3	6.6	1.94
30	3.7	4.2	4.7	5.3	0.5	5.8	1.0	6.3	1.54

Meridional arcs.	
1″	30.9
2	61.8
3	92.6
4	123.5
5	154.4
6	185.3
7	216.2
8	247.1
9	277.9
10	308.8
20	617.7
30	926.5
40	1235.3
50	1544.1
1′ 00	1853.0
2	3705.9
3	5558.9
4	7411.9
5	9264.8
6	11117.8
7	12970.7
8	14823.7
9	16676.7
10	18529.6
11	20382.6
12	22235.6

Co-ordinates of curvature.		
Minutes of longitude.	X. Arc. par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.2
5	.0	3.4
6	.0	4.8
7	.0	6.6
8	.0	8.6
9	.0	10.9
10	.0	13.4
15	.0	30.2
20	.1	53.8
25	.1	84.0
30	.2	121.0
35	.3	164.7
40	.5	215.1
45	.7	272.2
50	.9	336.0
55	1.2	406.6
1° 00	1.6	483.9
1 10	2.5	658.6
1 20	3.7	860.3
1 30	5.3	1088.7
1 40	7.3	1344.2
1 50	9.7	1626.4
2 00	12.6	1935.5

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 48° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.)									Meridional arcs.		Co-ordinates of curvature.		
	7″	8″	9″	10″	20″	30″	40″	50″	60″			Minutes of longitude.	X. Arc par.	Y.
30′	143.7	164.2	184.7	205.3	410.5	615.8	821.0	1026.3	1231.54	1″	30.9	1″	—.0	.1
31	3.6	4.2	4.7	5.2	0.4	5.6	0.8	5.9	1.14	2	61.8	2	.0	.5
32	3.6	4.1	4.6	5.1	0.2	5.4	0.5	5.6	0.73	3	92.7	3	.0	1.2
33	3.5	4.0	4.5	5.1	0.1	5.2	0.2	5.2	0.33	4	123.5	4	.0	2.1
34	3.5	4.0	4.5	5.0	0.0	5.0	0.0	4.9	29.93					
35	3.4	3.9	4.4	4.9	409.8	4.8	819.7	4.6	9.52	5	154.4	5	.0	3.4
										6	185.3	6	.0	4.8
36	143.4	163.9	184.4	204.9	409.7	614.6	819.4	1024.3	1229.12	7	216.2	7	.0	6.6
37	3.4	3.8	4.3	4.8	9.6	4.4	9.1	3.9	8.71	8	247.1	8	.0	8.6
38	3.3	3.8	4.2	4.7	9.4	4.2	8.9	3.6	8.31	9	278.0	9	.0	10.9
39	3.3	3.7	4.2	4.6	9.3	4.0	8.6	3.3	7.90					
40	3.2	3.7	4.1	4.6	9.2	3.7	8.3	2.9	7.50	10	308.9	10	.0	13.4
										20	617.7	15	.0	30.2
41	143.2	163.6	184.1	204.5	409.0	613.5	818.1	1022.6	1227.09	30	926.6	20	.1	53.7
42	3.1	3.6	4.0	4.4	8.9	3.3	7.8	2.2	6.69	40	1235.4	25	.1	83.8
43	3.1	3.5	3.9	4.4	8.8	3.1	7.5	1.9	6.28	50	1544.3	30	.2	120.7
44	3.0	3.5	3.9	4.3	8.6	2.9	7.3	1.6	5.88					
45	3.0	3.4	3.8	4.2	8.5	2.7	7.0	1.2	5.47	1′ 00	1853.1	35	.3	164.3
										2	3706.2	40	.5	214.6
46	142.9	163.3	183.8	204.2	408.4	612.5	816.7	1020.9	1225.07	3	5559.4	45	.7	271.7
47	2.9	3.3	3.7	4.1	8.2	2.3	6.4	0.6	4.66	4	7412.5	50	.9	335.4
48	2.8	3.2	3.6	4.0	8.1	2.1	6.2	0.2	4.26	5	9265.6	55	1.2	405.8
49	2.8	3.2	3.6	4.0	8.0	1.9	5.9	19.9	3.85	6	11118.7			
50	2.7	3.1	3.5	3.9	7.8	1.7	5.6	9.5	3.45			1° 00	1.6	483.0
										7	12971.9	1 10	2.5	657.4
51	142.7	163.1	183.5	203.8	407.7	611.5	815.4	1019.2	1223.04	8	14825.0	1 20	3.8	858.6
52	2.6	3.0	3.4	3.8	7.5	1.3	5.1	8.9	2.63	9	16678.1	1 30	5.3	1086.6
53	2.6	3.0	3.3	3.7	7.4	1.1	4.8	8.5	2.23	10	18531.2	1 40	7.3	1341.5
54	2.5	2.9	3.3	3.6	7.3	0.9	4.5	8.2	1.82	11	20384.4	1 50	9.8	1623.2
55	2.5	2.9	3.2	3.6	7.1	0.7	4.3	7.8	1.42	12	22237.5	2 00	12.6	1931.8
56	142.5	162.8	183.2	203.5	407.0	610.5	814.0	1017.5	1221.01					
57	2.4	2.7	3.1	3.4	6.9	0.3	3.7	7.2	20.60					
58	2.4	2.7	3.0	3.4	6.7	0.1	3.5	6.8	20.19					
59	2.3	2.6	3.0	3.3	6.6	609.9	3.2	6.5	19.79					
60	2.3	2.6	2.9	3.2	6.5	9.7	2.9	6.1	19.38					

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 49° 00′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
0′	142.3	162.6	182.9	203.2	406.5	609.7	812.9	1016.1	1219.38
1	2.2	2.5	2.8	3.2	6.3	9.5	2.6	5.8	8.97
2	2.2	2.5	2.8	3.1	6.2	9.3	2.4	5.5	8.57
3	2.1	2.4	2.7	3.0	6.1	9.1	2.1	5.1	8.16
4	2.1	2.4	2.7	3.0	5.9	8.9	1.8	4.8	7.75
5	2.0	2.3	2.6	2.9	5.8	8.7	1.6	4.5	7.35
6	142.0	162.3	182.5	202.8	405.6	608.5	811.3	1014.1	1216.94
7	1.9	2.2	2.5	2.8	5.5	8.3	1.0	3.8	6.53
8	1.9	2.1	2.4	2.7	5.4	8.1	0.7	3.4	6.12
9	1.8	2.1	2.4	2.6	5.2	7.9	0.5	3.1	5.72
10	1.8	2.0	2.3	2.6	5.1	7.7	0.2	2.8	5.31
11	141.7	162.0	182.2	202.5	405.0	607.5	809.9	1012.4	1214.90
12	1.7	1.9	2.2	2.4	4.8	7.2	9.7	2.1	4.49
13	1.6	1.9	2.1	2.3	4.7	7.0	9.4	1.7	4.08
14	1.6	1.8	2.1	2.3	4.6	6.8	9.1	1.4	3.68
15	1.5	1.8	2.0	2.2	4.4	6.6	8.8	1.1	3.27
16	141.5	161.7	181.9	202.1	404.3	606.4	808.6	1010.7	1212.86
17	1.5	1.7	1.9	2.1	4.1	6.2	8.3	0.4	2.45
18	1.4	1.6	1.8	2.0	4.0	6.0	8.0	0.0	2.04
19	1.4	1.6	1.7	1.9	3.9	5.8	7.8	1009.7	1.63
20	1.3	1.5	1.7	1.9	3.7	5.6	7.5	9.4	1.22
21	141.3	161.4	181.6	201.8	403.6	605.4	807.2	1009.0	1210.81
22	1.2	1.4	1.6	1.7	3.5	5.2	6.9	8.7	0.40
23	1.2	1.3	1.5	1.7	3.3	5.0	6.7	8.3	0.00
24	1.1	1.3	1.4	1.6	3.2	4.8	6.4	8.0	1209.59
25	1.1	1.2	1.4	1.5	3.1	4.6	6.1	7.7	9.18
26	141.0	161.2	181.3	201.5	402.9	604.4	805.8	1007.3	1208.77
27	1.0	1.1	1.3	1.4	2.8	4.2	5.6	7.0	8.36
28	0.9	1.1	1.2	1.3	2.7	4.0	5.3	6.6	7.95
29	0.9	1.0	1.1	1.3	2.5	3.8	5.0	6.3	7.54
30	0.8	1.0	1.1	1.2	2.4	3.6	4.8	5.9	7.13

Meridional arcs.	
1″	30.9
2	61.8
3	92.7
4	123.6
5	154.4
6	185.3
7	216.2
8	247.1
9	278.0
10	308.9
20	617.8
30	926.6
40	1235.5
50	1544.4
1′ 00	1853.3
2	3706.6
3	5559.9
4	7413.1
5	9266.4
6	11119.7
7	12973.0
8	14826.3
9	16679.6
10	18532.9
11	20386.1
12	22239.4

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.3
6	.0	4.8
7	.0	6.6
8	.0	8.6
9	.0	10.8
10	.0	13.4
15	.0	30.1
20	.1	53.5
25	.1	83.7
30	.2	120.5
35	.3	164.0
40	.5	214.2
45	.7	271.0
50	.9	334.6
55	1.2	404.9
1° 00	1.6	481.9
1 10	2.5	655.9
1 20	3.8	856.6
1 30	5.3	1084.1
1 40	7.3	1338.5
1 50	9.8	1619.6
2 00	12.7	1927.4

TABLE VI.—*Projection Tables*—Continued.

LATITUDE 49° 30′.

Min.	Length in metres of arcs of the parallel, (arc par.) 7″	8″	9″	10″	20″	30″	40″	50″	60″
30′	140.8	161.0	181.1	201.2	402.4	603.6	804.8	1005.9	1207.13
31	0.8	0.9	1.0	1.1	2.2	3.4	4.5	5.6	6.72
32	0.7	0.8	0.9	1.1	2.1	3.2	4.2	5.3	6.31
33	0.7	0.8	0.9	1.0	2.0	2.9	3.9	4.9	5.90
34	0.6	0.7	0.8	0.9	1.8	2.7	3.7	4.6	5.49
35	0.6	0.7	0.8	0.8	1.7	2.5	3.4	4.2	5.08
36	140.5	160.6	180.7	200.8	401.6	602.3	803.1	1003.9	1204.67
37	0.5	0.6	0.6	0.7	1.4	2.1	2.9	3.6	4.26
38	0.4	0.5	0.6	0.6	1.3	1.9	2.6	3.2	3.85
39	0.4	0.5	0.5	0.6	1.1	1.7	2.3	2.9	3.44
40	0.4	0.4	0.5	0.5	1.0	1.5	2.0	2.5	3.02
41	140.3	160.3	180.4	200.4	400.9	601.3	801.7	1002.2	1202.61
42	0.3	0.3	0.3	0.4	0.7	1.1	1.5	1.8	2.20
43	0.2	0.2	0.3	0.3	0.6	0.9	1.2	1.5	1.79
44	0.2	0.2	0.2	0.2	0.5	0.7	0.9	1.1	1.38
45	0.1	0.1	0.1	0.2	0.3	0.5	0.6	0.8	0.97
46	140.1	160.1	180.1	200.1	400.2	600.3	800.4	1000.4	1200.56
47	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.14
48	0.0	0.0	0.0	0.0	399.9	599.9	799.8	999.8	1199.73
49	139.9	159.9	179.9	199.9	9.8	9.7	9.5	9.4	9.32
50	9.9	9.9	9.8	9.8	9.6	9.5	9.3	9.1	8.91
51	139.8	159.8	179.8	199.8	399.5	599.2	799.0	998.8	1198.50
52	9.8	9.7	9.7	9.7	9.4	9.0	8.8	8.4	8.08
53	9.7	9.7	9.7	9.6	9.2	8.8	8.4	8.1	7.67
54	9.7	9.6	9.6	9.5	9.1	8.6	8.2	7.7	7.26
55	9.6	9.6	9.5	9.5	8.9	8.4	7.9	7.4	6.85
56	139.6	159.5	179.5	199.4	398.8	598.2	797.6	997.0	1196.44
57	9.5	9.5	9.4	9.3	8.7	8.0	7.3	6.7	6.02
58	9.5	9.4	9.3	9.3	8.5	7.8	7.1	6.3	5.61
59	9.4	9.4	9.3	9.2	8.4	7.6	6.8	6.0	5.20
60	9.4	9.3	9.2	9.1	8.3	7.4	6.5	5.6	4.78

Meridional arcs.	
1″	30.9
2	61.8
3	92.7
4	123.6
5	154.5
6	185.3
7	216.2
8	247.1
9	278.0
10	308.9
20	617.8
30	926.7
40	1235.6
50	1544.5
1′ 00	1853.4
2	3706.9
3	5560.3
4	7413.8
5	9267.2
6	11120.7
7	12974.1
8	14827.6
9	16681.0
10	18534.5
11	20387.9
12	22241.4

Co-ordinates of curvature. Minutes of longitude.	X. Arc par.	Y.
1′	—.0	.1
2	.0	.5
3	.0	1.2
4	.0	2.1
5	.0	3.3
6	.0	4.8
7	.0	6.5
8	.0	8.5
9	.0	10.8
10	.0	13.4
15	.0	30.0
20	.1	53.4
25	.1	83.4
30	.2	120.2
35	.3	163.6
40	.5	213.6
45	.7	270.3
50	.9	333.7
55	1.2	403.8
1° 00	1.6	480.6
1 10	2.5	654.2
1 20	3.8	854.4
1 30	5.4	1081.3
1 40	7.4	1335.0
1 50	9.8	1615.4
2 00	12.8	1922.4

APPENDIX No. 40.

Letter from Lieut. Comg. T. A. M. Craven, U. S. Navy, assistant in the Coast Survey, communicating his correspondence with Capt. Thomas E. Shaw, of the steamer William Gaston, in relation to the assistance rendered that vessel when disabled near the St. John's river, Florida, by the Coast Survey steamer Corwin.

COAST SURVEY STEAMER "CORWIN,"
Jacksonville, March 18, 1853.

DEAR SIR: On the 16th we discovered a steamer at anchor outside the bar, with signals of distress hoisted. I immediately got up steam; but it was too late in the tide to cross the bar, on which the sea was breaking heavily. Word was brought me that her ground tackle was not good, and I sent out a hawser by the pilot-boat, with the promise of assistance the next morning, at high water. I accordingly got under way at 11 a. m., went out, and succeeded in bringing in the steamer William Gaston, from Savannah. Her machinery had broken down, (fortunately, just outside of the breakers;) she was in a very critical position, and the weather threatening. By request of her captain I left the "Gaston" at Mayport Mills, and, receiving on board of this vessel the passengers and mails, proceeded up the river to Jacksonville, where I am now replenishing my fuel. The weather has been very bad. with but little intermission, since my arrival.

Very respectfully, your obedient servant,

T. AUGS. CRAVEN,
Lieut. Comg. U. S. Navy, Assistant in Coast Survey.

Prof. A. D. BACHE,
Supt. U. S. Coast Survey, Washington, D. C.

JACKSONVILLE, FLA., *March* 17, 1853.

SIR: Circumstances which compel my early return to Savannah deprives me of the opportunity of tendering to you in person my sincere thanks for your kind and efficient aid in rescuing the steamer William Gaston, her passengers, officers, and crew, from her late perilous condition at sea when disabled, near the St. John's bar. Permit me, in the name of all on board my vessel, to express to yourself our high appreciation of the kind feeling which prompted you to rescue us from imminent danger. May I ask the favor of you to communicate to your officers and crew the expression of our sincere gratitude for the timely service so promptly rendered us.

THOMAS E. SHAW,
Captain Steamer William Gaston.

Lieut. Comg. T. AUGS. CRAVEN,
U. S. Navy, Assistant in U. S. Coast Survey.

U. S. SURVEYING STEAMER "CORWIN," *March* 19, 1853.

SIR: In acknowledging your flattering communication of the 17th instant, I am constrained to say that too high an estimate is placed on the service I have rendered; but I can assure you it is a source of infinite gratification that aid to your endangered party was thus at hand, and am thankful that the duties of this vessel, in the emergency, were discharged in a successful manner.

Respectfully,

T. AUGS. CRAVEN,
Lieut. Comg. U. S. Navy, Assistant in Coast Survey.

Captain THOMAS E. SHAW,
Steamer William Gaston.

APPENDIX No. 41.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the letter of Lieut. Comg. James Alden, U. S. Navy, assistant in the Coast Survey, in regard to the wreck of the ship Aberdeen, lying in the entrance of the harbor of San Francisco, California.

U. S. COAST SURVEY OFFICE,
Washington, D. C., August 13, 1853.

SIR: I have the honor to forward, for the information of the department, though I am not aware that any present action can be taken in the case, the enclosed copies of letters from Lieutenant Commanding James Alden, assistant in the Coast Survey, and Passed Midshipman R. M. Cuyler, reporting the obstruction to navigation caused by the wreck of the ship Aberdeen, lying at the entrance of the harbor of San Francisco.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

U. S. SURVEYING STEAMER "ACTIVE,"
San Francisco, June 30, 1853.

DEAR SIR: Mr. Worster, who has been wrecking for some time past near Fort Point, at the entrance of this harbor, represented to me that the wreck of the ship Aberdeen, which lies sunk at that spot, was an obstruction to navigation; I therefore sent Mr. Cuyler to make the necessary examination. After spending two or three days there, he returned. His report upon the matter is herewith enclosed. The result, although not entirely satisfactory, shows, I think, very conclusively, that the wreck is there, and in the narrowest part of the entrance. My opinion is, therefore, that it ought to be removed with as little delay as possible.

With great respect, I am your obedient servant,

JAMES ALDEN,
Lieut. Commanding U. S. N., Assistant in Coast Survey.

Prof. A. D. BACHE,
Superintendent Coast Survey, Washington, D. C.

U. S. STEAMER "ACTIVE," *San Francisco, June* 22, 1853.

SIR: In compliance with your order of this date, I have made a hurried examination of the wreck of the ship Aberdeen, lying off Fort Point, with a view to ascertain whether she is an obstruction to navigation.

I sounded on the outer portion of the wreck in three fathoms water, but was unable to determine its exact distance from the shore in consequence of a very thick fog. I should judge its distance from the outer rocks of Fort Point to be from one hundred and eighty to two hundred yards.

The tide at this point is slack for so short a time, the sea so often rough, and the weather thick, that there are but few days in the course of a year when a thorough and satisfactory examination of the Aberdeen can be made.

Respectfully yours,

RICHARD M. CUYLER.

Lieut. Commanding JAMES ALDEN,
Assistant in United States Coast Survey.

APPENDIX No. 42.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting one from Lieutenant Commanding James Alden, U. S. N., assistant in the Coast Survey, recognising the services of Acting Lieutenant R. M. Cuyler, in transferring the passengers from the steamer Tennessee, wrecked near the entrance to San Francisco harbor.

COAST SURVEY OFFICE, *March* 18, 1853.

SIR: I have the honor to enclose to the department a copy of a letter from Lieutenant Commanding James Alden, U. S. Navy, assistant in the Coast Survey, who is in charge of the hydrographic party on the Western coast, recognising the services of Acting Lieutenant R. M. Cuyler, in transferring the passengers from the steamer Tennessee, wrecked near the mouth of the harbor of San Francisco, through the surf, to the steamer sent to their aid. As due to Mr. Cuyler, and recommended by Lieutenant Commanding Alden, I would respectfully request that this recognition of the "coolness and good management" shown by Mr. Cuyler may be communicated to the honorable Secretary of the Navy, to be placed on the files of the Navy Department.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE,
Secretary of the Treasury.

U. S. SURVEYING STEAMER "ACTIVE,"
San Francisco, California, March 13, 1853.

SIR: I have respectfully to report that so soon as the news of the disaster which occurred, near the mouth of this harbor, to the Pacific Mail Steamship Company's steamer Tennessee, reached me, I despatched two boats, well manned, under the charge of Acting Lieutenant R. M. Cuyler, to their assistance, and I am happy to say they were fortunate in being able to render them good and efficient service. Mr. Cuyler, with his boats, succeeded in transporting more than two-thirds of some six or seven hundred passengers, with their baggage, from the beach, through a heavy surf, to the steamer sent to receive them, in the short space of three hours, without the slightest injury to any one—a result entirely attributable to his coolness and good management. I would also state that Mr. Cuyler remained with the boats by the wreck nearly two days, and succeeded in saving much valuable property.

With the request that you will bring such praiseworthy conduct before the proper department,

I am, with great respect, your obedient servant,

JAMES ALDEN,
Lieut. Comg. U. S. Navy, Assistant in U. S. Coast Survey.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey.

APPENDIX No. 43.

Tribute of respect to the memory of Sears C. Walker, Esq., assistant in the Coast Survey.

COAST SURVEY OFFICE,
Washington, February, 9, 1853.

DEAR SIR: We discharge a melancholy act of friendship to your lamented brother in communicating the proceedings of a meeting of the officers and members of the Coast Survey, held at the Coast Survey office on the 2d inst., to pay a tribute of respect and feeling to his memory. The meeting was largely attended, and was characterized by an unusual solemnity of feeling. The resolutions but feebly express the sense entertained by his associates of his exalted services as a brother officer, and as a leader in American science. His death is a national loss. Private grief is absorbed in the contemplation of the larger loss which has resulted to science, and to the public at large. We knew your brother well; we sympathize most fully with your own bereavement. This letter of condolence, showing you how largely it is shared by all his associates, we hope may tend to alleviate your own sorrow. We address you as the representative of Prof. Walker's family. Please communicate to the other members, particularly to that kind sister who was so vigilant in her cares and attentions, our condolence and sympathy, and remember that his relatives and friends will have a place in our hearts.

With sentiments of respect, we remain truly your friends,

I. I. STEVENS,
Brevet Major U. S. Corps of Eng., assistant in the Coast Survey.
J. J. ALMY,
Lieutenant U. S. Navy, assistant in the Coast Survey.
L. F. POURTALES,
Assistant in the Coast Survey.

Hon. T. WALKER, *Cincinnati, Ohio.*

A meeting of the officers and members of the Coast Survey in Washington was held at the Coast Survey office on the 2d instant, and on motion of Lieutenant Commanding J. J. Almy, United States Navy, assistant in Coast Survey, Professor A. D. Bache, Superintendent of the Survey, was called to the chair.

Upon taking the chair, Professor Bache addressed the meeting as follows:

We have met to pay our tribute of respect and feeling to one of our most distinguished and valued associates, Sears C. Walker, Esq., whose failing health, for more than a year past, has kept us in anxiety and fear for the result which has now come. Mr. Walker was attacked by bilious fever some weeks since, and though his mind was clear, his physical strength was not adequate to resist the effects of the disease. He died at the residence of his brother, Judge Walker, near Cincinnati, on Sunday evening last, having the consolations of the devoted care of the members of his family residing there, and of his sister, who had been sent for to Washington.

The services which Mr. Walker has rendered to the Coast Survey are known in a general way to most of those whom I address. He had made the largest collections of American observations of moon culminations and occultations ever made in the country, and prepared to discuss them thoroughly for longitudes, and to bring them to bear, as far as applicable, by the geodetic results of the Coast Survey, upon the longitude of a central point. The magnitude of this labor would have appalled an ordinary mind. He knew that by perseverance it could be accomplished. During this discussion he reached the conclusion that the longitudes from moon culminations could not be reconciled with those from occultations, and that the theory must be re-examined for an explanation. His published reports show the successive steps of his investigation, which was not completed at the time of his decease. In the midst of it, the new, attractive, and determining differences of longitude by the telegraph was committed to him. and he threw all his zeal and knowledge into the solution of this problem, and brought it to the successful condition in which it now is. He early saw the impossibility of reaching a near result by merely repeating the transmission and reception of signals, beats of a clock or chronometer, and that the beats sent and received must be of time-keepers regulated to different times—as, for example, mean solar and siderial—and seized all the consequences flowing from this principle. The telegraphing of transits of stars was original with him. He soon became satisfied of the necessity for graphic registry of the time-results, and invited the co-operation of Mr. Saxton, of Mr. Bond, of Prof. Mitchel, and of Dr. Locke, in the solution. With him originated the application of this method of the registry of time-observations for general astronomical purposes, now developed by so many ingenious modes, and known as the "American method." His researches on galvanic wave-time, growing out of these experiments for difference of longitude, are by far the most valuable contributions yet made to this march of science. In this subject alone Mr. Walker accomplished a most remarkable five years' work. But this was only a part of what his mind found there to do; and aside from this, and labors of daily and nightly routine in computing and observing, he accomplished a work of investigation of the orbit, and computation of an ephemeris of Neptune, which of itself would have given him an undying reputation. I cannot in this place describe how the training of a life was obtained which led to these brilliant results of our work, and for American science, nor can I trust myself now in analysis of the mind and heart of this friend of many years. I have faintly pencilled his doings while closely connected with our work, shadowing merely his claims to our admiration, respect and gratitude.

On motion of Samuel Hein, Esq., Brevet Captain J. G. Foster, corps of engineers, assistant in the Coast Survey, was appointed secretary.

L. F. Pourtales, Esq., assistant, then presented the following resolutions:

In view of the great services rendered by Professor Sears C. Walker during his connexion with the Coast Survey, and especially in the complicated but essential investigations connected with the longitudes, in the method of using the telegraph for differences of longitude and in time-observations generally, of the lustre reflected upon the work by his other great researches in astronomy and electricity, and of his many excellent qualities as an associate—

Resolved, That we have learned with the deepest regret and sorrow the decease of our much respected colleague, Professor Sears C. Walker, and mourn for his loss to us as a friend and associate, to our work as one of its most distinguished, zealous, and efficient officers, and to American science as one of its most ardent, persevering, and successful cultivators.

Resolved, That we will wear the usual badge of mourning for our deceased colleague.

Resolved, That we offer to the family of Professor Walker our heartfelt sympathy in their grief, alleviated only by the consciousness of the watchful care with which they attended him in failing health and in his last illness.

Resolved, That the proceedings of this meeting be communicated to the family of Professor Walker, and be published.

In seconding the resolutions, Major I. I. Stevens, corps of engineers, assistant, paid the following tribute to the memory of the deceased:

Mr. CHAIRMAN: After the touching and complete exposition which we have just heard, it would be a work of supererogation on my part to add one single word in illustration of Professor Walker's character and services; but I should do great injustice to my own feelings did I not draw from his example a lesson to guide us in life. Professor Walker was not only emphatically a man of genius, bringing strong powers of mind, great natural ardor, and indefatigable perseverance to pursuits for which nature had given him a particular bent, but he was emphatically a far-seeing and national man who was prompted to exertion that he might advance the honor and renown of his country, and assist to give her a foremost rank in science. He has done much in placing our country in this foremost rank, as is her due, her purpose, and her duty. With our newness of circumstances, with the great problems of human destiny and progress we are called upon to solve, with the motives to exertion growing out of our admirable form of government, he felt that mere equality with former efforts was a miserable failure, deserving but rebuke and reprobation. Our duty was to take the lead, to press forward in discovery, to illumine the future and redeem the past.

We are brought together from various departments of the public service, and are associated in a great public work. Like him we should seek, each in his sphere, to advance the honor and renown of our common country. We each should make it our purpose to do something for his profession, which, while it will insure the greatest possible present efficiency, will be a preparation for those great exigencies which happen to men and nations, and which lead, if rightly understood and availed of, not only to national glory, but to world-wide usefulness and honor. It is a great mistake to suppose that the mere routine of daily labor can lead to great results. This can be done only by a far-reaching view of things, which sweetens labor and gives life and light to laborious pursuits, which fills the soul with hope and gives to intellect its greatest vigor. Such was pre-eminently the case with our departed friend. His intercourse, too, with the youthful aspirants for scientific distinction, was most admirable. I have at times been thrown into intimate personal relations with him, and frequently have I been delighted with the paternal interest which he took in all youths of promise associated with him, and his untiring perseverance and hope in doing what he could to develop their powers. It was to him an intense personal gratification, and would be the subject of frequent conversation. Ought not this example to impel us, each with the means he has at his disposal, to develop youthful promise, and thus to do our part towards rearing the structure of American greatness? It was Professor Walker's profound conviction, that wherever American hearts and hands were joined in the accomplishment of an object, a peculiar grandeur would attach to it, surpassing all previous accomplishment. Let such be our conviction. It is by single men, like us, taking this large view of duty, pursuing it with hope and fixed resolve, that new forms of greatness will become known to the world. As it was with our departed friend, so let it be with us an abiding sentiment, giving direction to our daily life, not to minister to the gratification of personal or national pride, but to enable us to exert a world-wide usefulness.

Lieutenant E. B. Hunt, corps of engineers, assistant, made the following remarks:

I should not on the present occasion think of adding anything to what has been already said, were it not for a pleasant remembrance of an incident which seems not unworthy of narration even here, as it will serve to exhibit some fine traits in Mr. Walker's character. The occasion on which I first chanced to meet our deceased associate was at the meeting of the American Association, held in Cambridge. He there first announced the discovery of Kirkwood's analogy. His connexion with this discovery is one evincing on his part great delicacy and kindness. Mr. Kirkwood was then unknown and unrecognised—a teacher in the backwoods of Pennsylvania. He wrote to Mr. Walker, to whom he was quite a stranger, announcing his discovery, and stating it in an imperfect and undeveloped way. Mr. Walker immediately perceived its value, and applied the powers of his own mind to the elaboration and development of the idea. When occasion offered, he presented, it in all its clearness and development, to the American Association. It was, indeed, worthy of all notice how he there ascribed the entire merit of the discovery to Mr. Kirkwood, claiming to himself nothing for the labor he had bestowed and the extension he had given to the imperfect conception. Yet it was clear to all present, that without his aid the discovery would have continued to slumber in obscurity. Whether the analogy proves ultimately to be an entirely correct one or not is immaterial, so far as concerns the generosity of Mr. Walker's course. He came forward and endorsed, with all the powerful aid of his established reputation, an idea which else would have lingered unrecognised for many long years. He had much to lose and little to gain in reputation by such a course; but he lacked not the kindness and courage which dare to take risks for the benefit of others, and for the promotion of knowledge. By extending a helping hand to a conception which at the outset seemed fanciful and hopeless, he did a service reflecting peculiar honor on himself as a man. How many great and important ideas have been lost to science for years, or even forever, because such friends were lacking, who, having the knowledge needful for discriminating, possess also that kindliness and courage which are indispensable to overcoming the prejudices and mental inertia of the world! There are but few such men, and we can but ill afford to lose any of them. While we may hope, indeed, that good novel ideas will not fail to find recognition among those left in our midst who have established reputations, it is not the less a reason why we should regard our present loss as positive and peculiar. He whose name is most intimately associated with the "American method" of astronomical records, with that of telegraphic longitudes, with the ephemeris of Neptune, and the ingenious discovery of Laland's observation on that planet, cannot fail to be regarded as one for whom the dawning science of this country had most especial reason to wish for long life, and to claim, what he henceforth will have, a memory honored through the progressing ages.

On motion of Lieutenant Commanding Maxwell Woodhull, U. S. Navy, assistant, the Chair appointed Major I. I. Stevens, corps of engineers, Lieutenant Commanding J. J. Almy, U. S. Navy, and L. F. Pourtales, Esq., assistant in the Coast Survey, a committee to communicate the proceedings of this meeting to the family of Professor Walker, and to publish them.

The resolutions were then unanimously adopted, and the meeting adjourned.

A. D. BACHE, *Chairman.*

JOHN G. FOSTER, *Brevet Captain Corps of Engineers U. S. A., Secretary.*

APPENDIX No. 44.

Tribute of respect to the memory of Lieutenant Joseph Swift Totten, U. S. Army, assistant in the Coast Survey.

A meeting of the officers of the United States Coast Survey was held in Washington on the 18th of May, in consequence of the death of Lieut. Joseph S. Totten, of the 2d regiment of artillery, while engaged as an assistant of the survey.

Professor A. D. Bache, the Superintendent, was called to the chair, and Lieut. A. A. Gibson, U. S. Army, appointed Secretary.

The Superintendent, upon taking the chair, addressed the meeting as follows:

Joseph Swift Totten, to whose memory we have met to pay the tribute of our unfeigned regard and respect, was first appointed on the Coast Survey in 1845, and served in the Eastern section, and with Mr. Gerdes, the pioneer of the survey on the Gulf of Mexico. The delicate health which had induced his resignation as a cadet, now seemed to improve under the outdoor services of the survey, and, from his devotion to the work, a long and useful course appeared to be before him. On the breaking out of the war with Mexico, he was appointed a lieutenant in the second regiment of artillery, and served faithfully with his company in the field. Returning at the close of the war to garrison at Charleston, his health again became impaired, and he hoped to recruit it by joining once more the Coast Survey, which had proved so congenial and beneficial a service to him.

He was detailed for that service in December, 1850, with Mr. Blunt, on the Chesapeake and Hudson; and in Florida, in the survey of the reefs and keys, sought with characteristic modesty that experience which would enable him successfully to conduct a party. Last December he was detailed to make the triangulation of the harbor of Georgetown, South Carolina, and though much weakened by an attack of illness in Charleston, insisted on proceeding to execute his instructions, and on his entire physical ability to conduct the operations without more than the ordinary assistance.

Though suffering, from time to time, excessive pain from the consequence of a disease of the heart, he still continued to work, after those around him would have persuaded him to seek medical advice and aid.

He was determined to accomplish the task allotted to him, and only after going through the fatigue of a reconnaissance, and erecting signals, and having, indeed, occupied some of the stations for observations, did his disease obtain so far the mastery as to induce him to desist from work. In less than four weeks from that time he was no more. Not all the care of the members of his family, who in their devotion attended him from Charleston, could prolong his life until he had reached his home.

A strong will, strongly exercised, enabled Lieut. Totten to triumph over physical suffering, and to set the example of a conscientious discharge of duty under circumstances when most men shrink from even ordinary effort. He had a natural aptitude for the active operations of the survey, and a method and order in the execution of his work, which insured success. His mild but steady authority was felt in his party, and his amiability endeared him to those in his employ, as well as to his associates. I cannot better describe his character than in the words of an officer of the Coast Survey who knew him well, and was warmly attached to him, (Mr. Boutelle,) who, mourning over his early death, says, "He was worthy, conscientious, and upright—a true Christian gentleman."

Resolutions were presented by Captain J. G. Foster, corps of engineers, which, after appropriate remarks by Dr. B. A. Gould, of Cambridge, and Captain H. W. Benham and Lieut. E. B. Hunt, corps of engineers, in testimony of the high character of the deceased in public and private life, were unanimously adopted, as follows:

Resolved, That we have learned with sincere regret the decease of our associate and friend, Lieut. Joseph Swift Totten, U. S. Army, whose conscientious discharge of duty was an example to us, while his urbanity of manner and kindness of heart made him most agreeable to us in all social relations.

Resolved, That we look back upon the closing part of the life of our young associate, devoted zealously to work to the last, while suffering under painful and wasting disease, as giving him the highest title to our respect and esteem, and to a place in the history of the national work in which he was engaged.

Resolved, That we offer to the family of Lieut. Totten our most sincere condolence in the loss of the dutiful son and affectionate brother thus taken, in early manhood, from the family circle.

Resolved, That we will wear the usual badge of mourning for our deceased associate, in testimony of our respect for his memory.

Resolved, That the secretary of this meeting communicate to the family of the deceased the above resolutions.

A. D. BACHE, *Chairman*.

A. A. GIBSON, *First Lieutenant 2d Artillery, Secretary*.

APPENDIX No. 45.

Tribute of respect to the memory of B. F. West, Esq., sub-assistant in the Coast Survey.

COAST SURVEY STATION, MT. BLUE, NEAR PHILLIPS, MAINE,
September 12, 1853.

DEAR SIR: Although nothing can lighten the force of the blow which you have suffered in the loss of your excellent son, except the consolation from Him who, in his Almighty wisdom, permitted its infliction, it must afford some gratification to know how unanimously he was esteemed and loved by those, his associates of the few years just past, occupying such different positions in respect to him, and of such different ages, and yet uniting in one cordial expression of deep regret for his loss. Such an expression we tender to you and to the bereaved mother of our young friend, praying that you may be sustained in this your day of bitter affliction.

With great respect, yours truly,

A. D. BACHE.

JOHN WEST, Esq., *Alexandria, Va.*

Whereas it has pleased Divine Providence to remove from us, by death, our young friend and associate, Mr. Benjamin F. West, and in view of his amiable disposition, high attainments, and strict adherence in the performance of every duty; therefore,

Resolved, That we have learned with deep regret and sorrow of the decease of our much esteemed young friend and associate, Mr. Benjamin F. West.

Resolved, That while we mourn his loss as an agreeable companion, we feel that the Coast Survey has lost an efficient and promising young officer.

Resolved, That we extend to the family and friends of the deceased our heartfelt sympathy in their deep affliction.

Resolved, That a copy of these resolutions be forwarded to the family of Assistant West, and that they be printed.

A. D. BACHE.
GEORGE W. DEAN.
P. BEVERLY HOOE.
THOMAS McDONNELL.
LEWIS S. HAYDEN.

APPENDIX No. 46.

Letter of the Secretary of the Treasury to the Superintendent of the Coast Survey, directing surveys and examinations to be made with reference to the location of authorized lights, and other aids to navigation, in conformity with the request of the Light-house Board, and with the acts of Congress approved March 3, 1851, and August 31, 1852.

TREASURY DEPARTMENT, *April* 7, 1853.

SIR: I have to request that you will cause examinations and surveys to be made, as enumerated in the enclosed copy of a communication from the Light-house Board, with the view to the location of authorized lights, and other aids to navigation, in conformity to the act of 3d March, 1851, and the 17th section of the act of 31st August, 1852.

Very respectfully, your obedient servant,
JAMES GUTHRIE,
Secretary of the Treasury.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey, Washington.

TREASURY DEPARTMENT, OFFICE LIGHT HOUSE BOARD,
April 6, 1853.

SIR: I am directed to request that the Superintendent of the Coast Survey may be instructed to make examinations and surveys of the following points, with the view to the location of authorized lights, and other aids to navigation, in conformity to the act approved 3d March, 1851, and the 17th section of the act approved 31st August, 1852, viz:

To examine "Deep Hole Rock," in Vineyard sound, Massachusetts, with a view to place a beacon upon it.

To make a topographical survey of Cuttyhunk Point, and a hydrographical survey of the rocks called "Sow and Pigs," in connection with it, for the purpose of determining the best position for a light-house.

To make examination of Connecticut river below Middletown, and selection of sites for one or more beacon-lights, and for buoys and spindles in that locality.

To make an examination, and report upon the sites for the Coast Survey signals along the Florida reefs, with a view to their being made permanent.

To make an examination and survey of Point Bonita, California, north side of San Francisco bay, with a view to the erection of a second class light-house.

Examination and selection of site for light-house in San Pedro bay, California.

To make a survey of Romer shoal, New York harbor, with a view to placing channel range-lights authorized by law.

Very respectfully, your obedient servant,
THORNTON A. JENKINS, *Secretary.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

APPENDIX No. 47.

Table showing the results of re-examinations for sites of light-houses, beacons, buoys, &c., referred to the Superintendent of the Coast Survey by the Secretary of the Treasury, in accordance with the laws of March 3, 1851, and August 31, 1852, and the recommendation of the Light-house Board.

Sect'n.	State.	No.	Special locality.	Object.	By whom examined.	Report of Superintendent.
I	Maine	1	Nubble, Cape Neddick, York harbor, Me.	Examination and survey for light-house.	Lieutenant Comg. Woodhull.	Report to be made.
	Massachusetts	2	Minot's ledge, Cohasset Rocks, Boston harbor, Mass.	Examination and survey for light-house.	Lieutenant Comg. Stellwagen.	Recommended November 21, 1853.
		3	Deep-hole Rock, Vineyard sound, Mass.	Beacon	Lieutenant Comg. Woodhull.	Spindle recommended Oct. 31, 1853.
		4	Sow and Pigs Rocks, off Cuttyhunk, Mass.	Examination and survey for light-house.	Lieutenant Comg. Woodhull.	Recommended September 3, 1853.
II	New York	5	Romer shoal, New York harbor.	Channel range-lights	Lieutenant Comg. Woodhull.	Report to be made.
VI	Florida	6	Signals on Florida reef		Lieut. Jas. Totten.	Recommended November 3, 1853.
VIII	Mississippi	7	Entrance to East Pascagoula river.	Examination and survey for light-house	Lieutenant Comg. Sands.	Recommended November 15, 1853.
	Louisiana	8	Ship shoal and Racoon Point.	Examination and survey for light-house.	Lieutenant Comg. Sands.	Recommended November 16, 1853.
IX	Texas	9	Entrance to Sabine river.	Examination and survey for light-house.	Lieut. Jno. Wilkinson.	Recommended July 12, 1853.
		10	Aransas Pass	Examination and survey for light-house.	Lieutenant Comg. Stellwagen.	Light-vessel recommended September 5, 1853.
X	California	11	Point Bonita	Examination and survey for light-house.	Assistant R. D. Cutts.	Recommended September 1, 1853.
	Do	13	San Pedro	Examination and survey for light-house.	Lieutenant Comg. J. Alden.	Under instructions for examination.
	Do	14	Santa Cruz	Examination and survey for light-house.	Lieutenant Comg. J. Alden.	Under instructions for examination.

APPENDIX No. 48.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the report of Lieut. Comg. H. S. Stellwagen, U. S. Navy, assistant in the Coast Survey, on the survey of Minot's Ledge, Cohassett Rocks, Boston Harbor, with a view to the selection of a site for a light-house there.

COAST SURVEY STATION, NEAR PHILLIPS, MAINE, *November* 21, 1853.

SIR: I have the honor to transmit, for the use of the Light-house Board, the report of Lieut. Comg. H. S. Stellwagen, U. S. Navy, assistant in the Coast Survey, on the survey of the Cohassett Rocks, Boston harbor, with a view to the selection of a site for a light-house, to replace the one swept from Minot's Ledge, and for which appropriation was made in the act of Congress approved August 31, 1852.

The hydrographic survey was made by Lieut. Comg. Stellwagen, who was aided in the selection of the site for the light-house by Captain H. W. Benham, U. S. corps of engineers, assistant in charge of the Coast Survey office.

I enclose herewith a tracing of the map, upon a scale of $\frac{1}{500}$, on which the proposed site is indicated by a circle in red ink, the dimensions and relative position of the rocks, and the depth of water, immediately upon and around them.

I concur in the selection of this position for the proposed light-house, and would respectfully request that a copy of this letter, its enclosure, and the sketch, may be forwarded to the Light-house Board, at whose request the survey and examination have been made.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

COAST SURVEY STEAMER "BIBB," *At sea, September* 28, 1853.

SIR: To make a survey of each rock that appeared well calculated by size and position to answer the purpose required, on a scale of one five-hundredth, I enclosed each separately, with buoys forming a quadrilateral figure around it at a proper distance, so as to determine accurately the boundary and area embraced, also the position of each buoy, by that means being enabled to run the lines of soundings truly, placing them parallel and straight, and crossing them in like manner at right-angles, cutting the space into numerous small squares, and showing with the greatest precision the depth of water and the nature of the bottom in all parts of the space enclosed, each sounding being marked in its exact place.

I also obtained, at very low water, the figure and dimensions, with all the elevations and depressions, as presented when bare of each rock, and representing it by a ground-plan and elevated views, the latter in several directions, on a scale of $\frac{1}{12}$.

They are called, respectively, the Inner and Outer Minot, Hogshead Rock, East Willie, and Shag Rock. The three latter present good foundations for the erection of a stone light-house, but are objectionable as lying too far inside the outermost point of danger to serve with certainty in very foggy or snowy weather, particularly for vessels coming from the direction of Scituate light. In this respect the Minots are far preferable, and Captain Benham, engineer corps U. S. Army, assuring me that a sufficiently large and firm basis could be obtained on the Inner Minot, I was convinced that it possessed the greatest advantages, and gave it the most minute examination, enclosing it three times by buoys as before explained, and also measuring its surface and sounding from it in lines varying from a central point in thirty-two different directions, and the Outer Minot in same way with nineteen radiating lines, each line determined by actual measurement as to length, and by angles taken from central point where measuring line was fastened, getting the exact direction of line by the arc subtended between it and a line of sight to an established object on shore; thus each sounding is on a correctly determined line, and at actual measured distances from central point.

The advantages presented by the proposed location on the Inner Minot, are: that it is greatly sheltered by the Outer Minot, and much protected from the force of the sea; that a stone structure, according to Capt. Benham's opinion, (whose long experience and great abilities as an engineer make him a most capable judge,) can be erected, large enough at base, with a perfectly secure foundation on the rock, by preparing the lower courses of large blocks of granite, dressed so as to key or dove-tail together, and to mutually support each other, being still further secured by bolts or clamps to the solid mass of the rock and one another; and by filling all the interstices with concrete, the tower will be almost indestructible.

The examination shows that the work can be prosecuted in very rough weather, as moorings can be placed for vessels, in sufficiently deep water, close to the S. W. side of the Inner Minot, where it and the outer ledge form an excellent breakwater, and the stone and materials can be swung by a derrick directly into place from a vessel's deck. A light-house can thus be built, in a reasonable time, that will last for centuries, and be a warning against all dangers of that group, and standing within three hundred yards of the furthest dangerous spot.

Very respectfully, your obedient servant,

H. S. STELLWAGEN,
Lieut. Comg. U. S. Navy, Assistant in Coast Survey.

Prof. A. D. BACHE,
Superintendent. U. S. Coast Survey, near Phillips, Maine.

APPENDIX No. 49.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, communicating the report of Lieut. Comg. M. Woodhull, U. S. N., assistant in the Coast Survey, upon an examination of Deep Hole Rock, in Vineyard Sound, Massachusetts, with reference to placing a beacon there.

C. S. STATION, NEAR PHILLIPS, MAINE, *October* 31, 1853.

SIR: I have the honor to transmit, herewith, the report of Lieut. Comg. M. Woodhull in relation to placing a beacon on Deep Hole Rock, in Vineyard sound, Massachusetts, the result of his examination, made under my instructions, and by direction of the department.

I would respectfully request that a copy of this letter, and accompanying report and sketch, may be transmitted to the Light-house Board, by whose request the examination was made.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

U. S. SCHOONER "GALLATIN,"
Wood's Hole, October 22, 1853.

SIR: I have the honor to inform you that I completed, yesterday, the survey of "Deep Hole Rock," at the entrance of "Deep Hole harbor," near Cotuit. This rock is about fifteen feet long and about twelve feet wide, and has on it, in the shoalest spot, three and a half feet of water at low tide. Though soundings around it are remarkably regular, being almost a dead flat, with thirteen and a half feet on it at low water, I should think a good-sized spindle would answer all the purposes of a beacon, and could be more easily erected, and be much less expensive. There is now a large red buoy near it, which I am of the opinion, if it could be properly placed and maintained in its position, would answer. However, as a spindle is more permanent, and as it could be so constructed as to show prominently, it would be the best distinguishing mark, under the circumstances, that could be devised. I send you the chart of the rock, which will, perhaps, give you a better idea of the subject than any written exposition would do. If it is determined to put a beacon on it, the apex of the rock will have to be cut off, shaped as shown in the sketch, which will increase the expense.

"Deep Hole harbor" is principally used as an anchorage in a northeast blow for coasters bound along the north shore of Nantucket sound. Further than this it is of small importance, the rock being entirely out of the way of the entrance to Cotuit, but is much complained of by those who use "Deep Hole harbor." I have not heard that it has ever been the cause of accident, which argues that its position is well known to those frequenting the locality. I presume the guide required is necessary in foggy weather and dark nights.

Yours, respectfully,

M. WOODHULL,
Lieut. Comg. U. S. N., Assistant in Coast Survey.

Professor A. D. BACHE,
Superintendent U. S. Coast Survey, Washington, D. C.

APPENDIX No. 50.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting extracts from the report of Lieut. Comg. M. Woodhull, U. S. N., assistant in the Coast Survey, upon the survey of the "Sow and Pigs" rocks, off Cuttyhunk, Massachusetts, with reference to the location of a light-house.

MOUNT BLUE, NEAR PHILLIPS, MAINE, *September* 3, 1853.

SIR: I have the honor to transmit, for the use of the Light-house Board, a report on the survey of the rocks off Cuttyhunk, Massachusetts, known as the "Sow and Pigs," where it is proposed to establish a light-house. The hydrographic surveys were made by Lieut. Comg. Maxwell Woodhull, U. S. Navy, assistant in the Coast Survey, and the topographical survey by H. L. Whiting, Esq., assistant in the Coast Survey. Captain H. W. Benham, corps of engineers, assistant in charge of Coast Survey office, also aided in the final examinations of the proposed site for the light-house. The first of the two maps herewith transmitted shows the general relation of the rocks to the island of Cuttyhunk, and the depth and character of the bottom in the vicinity. It is on a scale of $\frac{1}{5000}$, and indicates, by a circle in red, the position where Lieut. Comg. Woodhull proposes to place the light-house. The second map shows on a large scale ($\frac{1}{120}$) the relative positions of the rocks around the site, and their dimensions, and the depth of water on the proposed site, and in the immediate vicinity.

In his report to me Lieut. Comg. Woodhull says: "This shoal is formed of single rocks of various sizes and irregular forms, none of which, not even the largest, have any considerable surface. They rest on a hard bed of mixed pebbles and rocks, with the interstices here and there filled with sand and clay. They extend in a regular line from the bluff of Cuttyhunk, first W. by S. 1,463 metres, then SSW. 750 metres, then turn SW. by W. 503 metres to the place where the light-boat is moored. There is but one place on the shoal, in my judgment, suitable for the erection of a light-house. I have marked this spot on my sheet with a double red line, which seems particularly adapted to the purpose. This site is on a ridge amidst a cluster of rocks, forming almost a full circle of some fifty feet in diameter, within which there is about one to two feet water at low tide. The arrangement of the rock is such as to form an admirable breakwater, within which a foundation could be built. This locality can be easily approached, having comparatively deep water on the north side, sufficiently so during a smooth sea for scows or other vessels drawing four or five feet water. If a temporary working pier were built, resting on the rocks, and extending north fifty or one hundred feet, vessels of more considerable burden could approach safely. The Whale's Back or Middle Ledge rocks are too near in-shore for the purpose, even if their dimensions were adequate. Sow Rock stands alone, in about two fathoms water at low tide. This is the most considerable in size of the whole number that show themselves. The rock has a base of about twenty feet by fifteen, shaped as shown in sketch. The apex of the rock only is seen at ordinary low water. At very low spring tides, I am informed that one-third of the rock is exposed. While at work I approached it from several directions, but was unable to get upon it, as the sea was breaking too violently to do so.

"A light-house, placed as described, would be of incalculable value on this dangerous part of the coast, and would sufficiently mark the shoal. The soundings outside of the reef are characteristic, and would be a sufficient guide to the navigator if the light-house were furnished with a proper fog-bell, or fog-whistle. As a rule, the reef should not be approached in foggy weather nearer on the north side than where the soundings are *fourteen* fathoms, and on the west and south sides *seven* fathoms; from which depth the reef rises abruptly."

In a subsequent report, Lieut. Comg. Woodhull says: "The rocks, which form almost a circle about the proposed site, are most of them of large dimensions, resting on a bed of rocks and stones from the size of those generally used for paving, to boulders of two to three feet in diameter. I was fortunate in having a very smooth time, and I examined with great care and satisfaction the whole locality, and I have no hesitation in saying that this is the very best place that could be selected for the object proposed. The water to the northward of this site is deep enough, as you will perceive by the chart, at the distance of forty to fifty feet from the main rock (on the chart marked No. 1) to permit vessels drawing four or five feet water to approach without difficulty. At a hundred feet, vessels of a greater draught could anchor and deliver their loading with ease and safety. No. 1 rock would be a capital position for erecting a boom. The rock is by measurement fourteen feet in length, seven feet wide, and nine high. The surrounding rocks would give sufficient support for the guys, &c. Altogether, the facility for work is remarkable, considering the locality. I have been particular in my inquiries as regards the best season for smooth working weather. I find that, on an average, it is always smoother with the wind anywhere from NW. round by N. to E.; that the winds which cause the greatest amount of swell are from the southward and westward, which a wind of a few hours' duration from the northward soon overcomes. The calculation is, that from May to the end of August, about a quarter to a third of the time operations could be carried on with perfect ease, and about one-fifth of the time for the remainder of the year. I would also state that there is an abundance of rock of the requisite hardness and quality for building the foundation, &c., to be found on Cuttyhunk island, which could be purchased at a very moderate cost. I am informed, further, that the ledge is frequently entirely bare of water, if the wind is or has been prevailing from the northward for some days, with a smooth sea preceding a spring tide. I have never been so fortunate as to find it as described; but, owing to a slight swell, I have always found from one to two and a half feet water on it."

I would respectfully request that a copy of this report be transmitted, with the maps, to the Light-house Board.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

APPENDIX No. 51.

Report of Edmund Blunt, Esq., assistant in the Coast Survey, to the Superintendent, upon the selection and marking of positions for range beacons in New York harbor.

BROOKLYN, *June* 9, 1853.

SIR: I returned yesterday to the city, having finished the duty assigned me in your instructions of March 24, by marking out, on the ground, the points for the range-beacons proposed by Assistant Glück, as far as is practicable.

The position for the proposed sites on Point Comfort not being furnished me, and Mr. Glück having opened no line showing the direction of the range, I was left to select such points as would serve to bring vessels, when on the range, on a line with the point A, and in mid-channel between Sandy Hook extreme point and Flynn's Knoll; and these points, I am happy to say, when referred to Mr. Glück's survey, differ very little from his proposed line.

The place where this line touches the shore is about eight and a half statute miles from the point A, and the distance of the place where it might be advisable to build the near light from this point is about sixteen hundred and fifty yards; the land is about fifteen feet above high water, and by extending the line about eight hundred yards, an elevation of the same height might be obtained, but this I think objectionable. The land is low on the extended line, and an object fifty feet in height would be barely projected against the sky when seen from a ship's deck at A, and it will be necessary to have the control of a gore of land in front of the near light extending to the shore, so as to have an opening of about 5°. If, therefore, the near light would be brought nearer to the shore, and at the same time the front light be built on the shoal near the six-foot knoll, (B,) I think the advantage to be derived would justify the additional expense, and I am at liberty to say that Major Delafield and Lieutenant Case agree with me as to the necessity of building the front beacon out from the shore.

These beacons being of the most importance to vessels bound through the main channel between Sandy Hook and Flynn's Knoll, should be sufficiently elevated to be seen in clear weather from the point A. I would therefore suggest that, in addition to the change proposed in the sites, an increased height of twenty feet be given to each structure, over what, under other circumstances, would be considered necessary, since objects of little elevation are not seen when the ray passes over water at a higher temperature than that of the air.

The next range staked out was that for the ship channel between SW. spit and what is called the Knoll. The land near the shore is sufficiently high to allow a proper beacon to be erected, and an opening towards the bay can be obtained so as to prevent obstructions. The site for the near beacon is nearly a mile and a half from the shore, about one hundred and fifty feet above the level of the sea: and a building here would, when seen, be projected on the trees. The slope is sufficiently sudden, and the elevation such that nothing can be placed to obstruct the view from the bay.

The points marked B and C, ranges for the elm tree beacon, have been marked on the ground, and observations made to determine the position of the point C, as also the place where the beacon now stands, with reference to permanent objects on the bay, so as to provide for any change in the direction or location of said ranges, should the examination of the swash channel by Lieutenant Woodhull show it to be necessary.

The soundings taken on all the lines were very satisfactory to Major Delafield and Lieutenant Case, and so I have made observations for determining the position of the ranges. These gentlemen are desirous that I should furnish such data as would enable them to project the same.

Very respectfully, your obedient servant,

EDMUND BLUNT.

Prof. A. D. BACHE,
Superintendent U. S. Coast Survey, Washington.

APPENDIX No. 52.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the report of Lieutenant James Totten, U. S. Army, assistant in the Coast Survey, upon the result of his examinations of the Coast Survey signals along the Florida reef, with a view to make them permanent.

COAST SURVEY STATION, NEAR PHILLIPS, MAINE, *November* 3, 1853.

SIR: I have the honor to transmit, herewith, a report from Lieutenant James Totten, U. S. Army, assistant in the Coast Survey, upon his examinations of the signals erected by the Coast Survey along the Florida reef, with a view to ascertain the feasibility and means of making them permanent. This examination was made under my instructions, and by direction of the Treasury Department.

I would respectfully ask that a copy of this letter and report, and sketch accompanying, may be transmitted to the Light-house Board, at whose request the examination was made.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE,
Secretary of the Treasury.

NEW LONDON, CONNECTICUT, *October* 22, 1853.

SIR: In obedience to your instructions, I have now the honor to submit the following report, relative to the means of making permanent the signals erected by the Coast Survey, for its purposes, along the Florida reef.

These signals having already, in the limited period since they were put up, proved of decided and acknowledged utility to navigation along the hazardous coast between Cape Florida and Key West, I have on one or two former occasions strongly recommended making them more durable, and always, I believe, with your approbation.

* * * * * * * *

The most important of the signals erected by me, in obedience to your instructions, along the Florida reef, stand from four to six miles from the outside shore-line of the Florida Keys, and generally within a few hundred yards of the Gulf Stream. Where the signals stand, the depth of water at low tide does not exceed four feet in any instance, and the Gulf Stream just outside of them is of unknown depth. At certain times, owing to the state of the atmosphere, the low lands of the Keys cannot be descried, however careful the watch, by a navigator approaching the reef, until he becomes entangled amid the dangers of these coral rocks, and then, often, it is too late for the best seamanship. A careful consideration of these facts must convince any one of the very great usefulness of a system of conspicuous beacons or signals at distances of five or six miles apart, and located upon the most seaward or projecting points of the Florida reef. This being premised, to explain the object of the report, I now proceed, at once, to explain my plan for making conspicuous and lasting signals of those already fixed along the reef by the Coast Survey.

The signals as they now stand, along the Florida reef, consist each of a cast iron screw-pile fixed into the coral rocks, and having a mangrove signal-pole in it from thirty to forty feet in length. The screw-pile is nine feet in length and nine inches in diameter, and has a cylindrical cavity within it seven feet deep and seven inches in diameter. The different screw-piles along the reef are sunk into the coral rocks, &c., wherever placed, to a depth of between three and six feet, and are believed, in almost every instance, to be immovable. The mangrove signal-poles are, however, perishable, and these are the parts which must be renewed. The signals I now propose for replacing those of mangrove, and rendering them as lasting as the screw-piles themselves, are to be of cast and wrought iron, and arranged as follows:

The sketch accompanying this represents a vertical section through the axis or central vertical line of the signal in position. The lower section, *a b*, represents the screw-pile, and all above that represents the signal in three sections, *b c*, *c d*, and *d o*. The whole length from *b*, the top of the screw-pile, to *o*, the top of the signal, is intended to be thirty-six feet. The first section extends ten feet above the top of the screw-pile, and four feet below it, into the cylindrical cavity of the screw-pile. This lower section of the signal is to be cast with a shoulder upon it at a point four feet from its lower end, or ten feet from its upper; the object of this shoulder is to hold the lower section in position, by resting upon the top of the screw-pile. The second or middle section is ten feet in length from *c*, where it enters the lower or first section to *d*, its top, and passes into the hollow cavity of the first four feet. On the top of the first section, and foot of the second, are cast the respective halves of a collar, intended, by the assistance of nuts and screws, to hold the two sections firmly together. The exterior diameter of the vertical shaft of the signal, where it enters the screw-pile at *b*, is seven inches, and at the top of the second section, at *d*, it is five inches; these two sections are cast hollow, the iron being only one inch in thickness throughout the shaft, as represented in these two sections. The third or upper section of the signal is of wrought iron, and is sixteen feet in length above the top, *d*, of the second section, and passes down into the hollow cavity of the second section four feet; these two sections, the middle and upper, are arranged with a wrought iron collar to hold them firmly together when in position. On the top of the signal shaft is arranged, as represented in the figure, a cylinder of stout hoop-iron, six feet in length and two feet and a half in diameter. The different pieces of hoop iron, of which this cylinder is formed, run vertically and horizontally, and wherever they cross each other are strongly riveted together. The horizontal straps are arranged as the hoops of a barrel, and the vertical ones are bent to a horizontal direction at the ends of the cylinder, pass into the centre, and are there made fast by riveting to a collar, through which the vertical shaft of the signal passes, and to which it is firmly attached. The figure *d e f g*, which, for convenience, I will call a vane, is six feet square, made of thick sheet iron, strongly braced and riveted. This vane, as represented in the sketch, is supported in its position by two powerful hinges, one at the top and the other at the bottom of the vane. The lower hinge of the vane rests upon the upper surface of the collar, uniting the middle and upper sections of the signal shaft, which is so formed and polished as to give a smooth surface for the vane to revolve upon. The whole arrangement of the vane is so calculated as to allow it to revolve into the direction the wind may blow, under very light pressure, and thus its surface of thirty-six square feet will never be presented to the whole force of a strong wind. This vane was hung as described, and its dimensions adopted, in order that the least possible resistance might be presented to the force of the wind, and the greatest possible surface to the eye of the mariner. There is but one position in which the vane will not be seen, and that is when it chances that the mariner finds himself in the plane of the vane; but, as this will seldom occur, and can never last long, such a consideration can be no great objection.

If the vane should be hid by the position of the sailor, he will still have the signal-shaft, and hoop-iron cylinder upon the top of the shaft, to attract his attention. It is very easily seen that the whole signal, as I have described it, must prove a very conspicuous and remarkable object, standing, as each of these will, so far from land, and so near the course of all vessels bound into or out of the Gulf of Mexico by this passage. As to the cost of these signals as I have partially described them, I will now give you the result of a careful estimate made by an individual in New London who is anxious to do the work, and whom I take pleasure in recommending. I refer to Mr. Albertson, an iron founder, well known in New London, and one who has the reputation of doing his work as faithfully and as reasonably as any other in this city. He gave me, as the result of "the closest estimate he is able to make," for the cost of one signal, as described, the sum of "two hundred and eighty-five dollars." I cannot say what the cost of transportation to Key West will be, nor just what the expense of fixing the signals in their places, but think it would be safe to call the whole one hundred dollars, and I do not believe it will vary much from that sum on either hand. Call, then, the total expense of each signal four hundred dollars, and fifteen of them can be put up for six thousand dollars. If this be done, I will insure that the signals so improved will be the cause of saving fifty times their cost to the commercial world every year they stand.

* * * * * * * * * * * * * * *

I will now mention the points where I would recommend that the improved signals be placed, if their adoption should be determined upon; and, convinced myself of the decided advantages of such a system of signals to navigation along the Florida reef, I would advise the adoption in the strongest terms. I mention the points in the order in which they stand, going southward along the reef from Cape Florida.

1st. Fowey Rocks, bearing S. 35° 41′ 44″ (true) E., and distant 6.33 miles from Cape Florida, and in latitude 25° 35′ 23″ N., and longitude 80° 1′ 26″ W.

2d. Triumph Reef, bearing S. 21° 4′ 17″ (true) E., and distant 8.33 miles from Soldier Key, and in latitude 25° 28′ 36″ N., and longitude 80° 2′ 25″ W.

3d. Long Reef, bearing S. 13° 53′ 51″ (true) E., and distant 10.19 miles from Soldier Key, and in latitude 25° 26′ 45″ N., and longitude 80° 2′ 57″ W.

4th. Ajax Reef, bearing S. 26° 6′ 8″ (true) E., and distant 6.21 miles from Elliott's Key No. 1, and in latitude 25° 24′ 9″ N., and longitude 80° 3′ 35″ W.

5th. Pacific Reef, bearing S. 15° 48′ 11″ (true) E., and distant 8.16 miles from Elliott's Key No. 1, and in latitude 25° 22′ 13″ N., and longitude 80° 4′ 6″ W.

6th. Turtle Reef, bearing S. 22° 20′ 48″ (true) E., and distant 5.04 miles from Old Rhodes, and in latitude 25° 16′ 52″ N., and longitude 80° 8′ 10″ W.

7th. The Elbow, bearing S. 2° 4′ 5″ (true) E., and distant 4.35 miles from Basin Bank, and in latitude 25° 8′ 32″ N., and logitude 80° 11′ 16″ W.

8th. Grecian Shoals, bearing S. 45° 58′ 19″ (true) E., and distant 4.47 miles from Sound Point.

9th. French Reef, bearing S. 37° E., by compass, and distant 3.73 miles from lower Sound Point.

10th. Pickle's Reef, bearing about S. 18° E., by compass, and distant 6.17 miles from Point Charles.

11th. Couch Reef, bearing about S. 4° 30′ W., by compass, from Rodriguez Bank, and about S. 43° 30′ E. from Key Tavernier.

12th. Crow's Reef, bearing about S. 39° 15′ E., by compass, and distant between four and five miles from Snake Creek Point.

13th. Alligator Reef, bearing about S. 36° 30′ E., by compass, and distant near five miles from Indian Key.

14th. The American Shoals. These shoals are between fifteen and twenty miles from Key West, as you go north and eastward from that place along the reef.

All the points named are well known to pilots and other persons acquainted with the Florida reef, and have, each of them, at some time proved fatal to one or more good ships and their cargoes; and they will continue the source of such misfortunes unless some such thing as recommended be done to warn sailors of their proximity to danger in these waters. It will be perceived that after the 7th point in the order above named, the latitudes, longitudes, &c., of the localities of the signals are not given. This arises from the fact that in some of the cases the survey has not yet reached them, and in others—such as Grecian shoals, French reef, and Pickle's reef—the calculations are not yet completed. It is probable, however, that the survey may envelope the whole of the points named by the end of the next season's work. As I have before mentioned, each of the fourteen points named has a screw-pile signal fixed upon it, which, in connexion with the description given of the localities, will serve to show where they are.

The 15th signal, the locality of which as yet I have not mentioned, may be fixed in the screw-pile already located upon a dangerous point known as the "Washerwoman," bearing, by compass, SSW. from Key Vacas, or may be placed in the most advantageous of several which the Survey may find it necessary to put up between Alligator reef and the American shoals during the progress of the triangulation along that part of the Coast.

I am, very respectfully,

JAMES TOTTEN,
First Lieutenant U. S. A., and Assistant in Coast Survey.

APPENDIX No. 53.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the report of Lieut. Comg. B. F. Sands, U. S. Navy, assistant in the Coast Survey, upon the examination and survey of the eastern entrance to Pascagoula river, Mississippi, with a view to the selection of a site for a light-house to be placed there.

Coast Survey Station, near Phillips, Maine,
November 15, 1853.

Sir: I have the honor to enclose herewith the report of Lieut. Comg. B. F. Sands, U. S. Navy, assistant in the Coast Survey, upon the examination and survey of the eastern entrance to Pascagoula river, Mississippi, made with a view to the selection of a site for a light-house, for which appropriation was made by the act of Congress approved August 31, 1852.

I concur in the recommendation contained in the report of Lieut. Comg. Sands, that the light be placed upon the marsh at Spanish Point. A sketch indicating the precise position proposed for this light-house will be transmitted as soon as the reduction of the original sheet can be made.

I would respectfully request that a copy of this letter and enclosure may be transmitted to the Light-house Board, at whose request the survey has been made, under the instructions of the department.

Very respectfully, yours, &c.,
A. D. BACHE, *Superintendent.*

Hon. James Guthrie, *Secretary of the Treasury.*

Office U. S. Coast Survey, Washington City,
October 10, 1853.

Sir: Since my communication of the 4th October, 1852, upon the subject of a light-house at East Pascagoula for the entrance to Pascagoula river, I have made a thorough survey of the locality, agreeably with your instructions.

Although with but five feet water over the bar at its mouth, (which I think can be easily increased by dredging,) the river has now a large and increasing trade in lumber; and with greater facilities for navigation, it would also be sought as an outlet for the cotton so extensively raised in the neighborhood of its banks.

A small class light-house or beacon would greatly facilitate the entrance over the bar; and if placed upon the marsh at Spanish Point, (the western point of the river,) it would be a better leading-mark for the channel than if upon the *fast land* of the eastern side.

Respectfully, your obedient servant,
B. F. SANDS,
Lieut. U. S. N., Assistant in U. S. Coast Survey.

Prof. A. D. Bache, *Superintendent U. S. Coast Survey.*

APPENDIX No. 54.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the report of Lieut. Comg. B. F. Sands, U. S. Navy, assistant in the Coast Survey, upon the examination and survey of Ship shoal, Louisiana, with a view to the selection of the site for a light-house to be placed there.

COAST SURVEY STATION, NEAR PHILLIPS, MAINE, *November* 16, 1853.

SIR: I have the honor to transmit the report of Lieut. Comg. B. F. Sands, U. S. Navy, assistant in the Coast Survey, upon the examination and survey of Ship shoal, Louisiana, with a view to placing a light there, as provided for by act of Congress approved August 31, 1852.

The spot marked A, on accompanying sheet, was selected by Lieut. Comg. Sands for reasons given in his report, and in which I concur, as also in his recommendation that an iron pile light-house, for a seacoast light, be erected upon the spot selected.

I would respectfully request that a copy of this letter and enclosure may be transmitted to the Light-house Board, at whose request the examination and survey were made, under the instructions of the department.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury.*

WASHINGTON CITY, *October* 2, 1853.

SIR: In pursuance of your instructions of February 3, 1853, to make the survey of Ship shoal the first in the order of my work for the season, I proceeded, immediately after my arrival in Section VIII, to the prosecution of that work, upon which I was occupied nearly six weeks, sounding closely upon the shoal, running nine hundred and twenty-three miles of soundings, making thirty-five thousand casts of the lead, and measuring eleven hundred and twenty-two sets of angles.

The shoal within the three-fathom curve extends along the coast twenty miles in an easterly and westerly direction, and has a breadth of from one to three and a half miles. The western end is the widest, and also the shoalest part, with five feet water on it, and bears S. 41 W. from Racoon Point, the west end of Isle Dernière (Last island) distant thirteen miles. The eastern end is distant eight and a half miles south of the house of Mr. T. Maskell, which is three and three-fourths miles east of Racoon Point, and the first house to be seen on Isle Dernière.

From its position in the route of vessels sailing between New Orleans and Texas, it is very dangerous, particularly in the approach from the westward, where it shoals rapidly from three fathoms. This is also the case all along the northern side of the shoal.

The eastern and southern approach is less dangerous, as the decrease in depth is gradual. A channel of five and six fathoms—bottom blue mud—extends along the northern side, which would serve as a guide to vessels beating between the shoal and Isle Dernière, if they are careful of their lead-line, and approach the shoal in not less than four fathoms.

A light-vessel, showing two lights, is very judiciously placed, and securely moored, at the west end of the shoal, in six fathoms water, and about a mile and a quarter north of the shoalest spot, upon which the steamer Galveston was wrecked. But the lights can scarcely be seen beyond five or six miles, and are very inefficient for so dangerous a shoal.

A light-house upon Racoon Point would only serve as a guide to vessels passing on the north side of the shoal, and could not be seen sufficiently far by those of a large class from the southward. It would be of as little use in the western approach, on account of the distance of Racoon Point shoal, which extends from that point twelve miles in a W. by S. direction, and would be thirteen miles distant from the most dangerous part of Ship shoal.

A good light upon the shoal would serve for all the approaches. As a good location for this, there is a spot of four hundred and fifty square metres in area, within the six-foot curve, hard sand bottom, near the wreck of the steamer Galveston, where the force of the sea from SE., S., and SW., would be broken by the gradual shoaling for the distance of three and a half and five miles within the three-fathom curve. On the N. and NW. the Racoon Point shoal prevents a heavy sea, the sea from the westward being the worst, but not so great as I suppose would be raised by the heavy gales of the Gulf Stream, near Sand key and Carysfort reef, Florida, upon which we have screw-pile light-houses; and, as permanent lights are preferable to floating ones, when they can be placed at or near the danger, I would respectfully recommend a first-class screw-pile light-house to be erected upon this spot, (marked A upon the sketch,) where, in my opinion, it would be as secure as those upon the keys of Florida, and where it would be seen the whole extent of the shoal.

Respectfully submitted by your obedient servant,

B. F. SANDS,

Lieutenant U. S. N., Assistant in U. S. Coast Survey.

Professor A. D. BACHE, *Superintendent U. S. Coast Survey.*

APPENDIX No. 55.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, communicating the report of Lieutenant J. Wilkinson, U. S. N., assistant in the Coast Survey, upon the selection of a site for a light-house at Sabine Pass, Texas; also a letter upon the subject from Lieut. Montgomery Hunt, U. S. N., light-house inspector.

NEAR LEED'S STATION, MAINE, *July* 12, 1853.

SIR: On the 22d of March last, at the request of the Light-house Board, the Superintendent of the Coast Survey was directed by the department to cause a survey to be made and a site selected for a first-class light-house, to be erected at the entrance of Sabine river, Texas, for which appropriation was made in the act of Congress of March 3, 1853.

On the 24th of that month I issued instructions to the hydrographic party in section IX to make said survey and selection, and have now the honor to transmit the report of Lieut. John Wilkinson, U. S. Navy, on Coast Survey service, the officer in charge of the party, and who performed the duty. It will be perceived that Lieut. Wilkinson recommends the erection of the light-house at the point indicated on enclosed sketch, as well calculated to supply the wants of the general coast navigation and commerce, and not merely to subserve the local interests.

I have also the honor to transmit extracts from a letter from Lieut. M. Hunt, U. S. Navy, and light-house inspector for that district, upon this subject. Lieut. Hunt recommends that a portion of the sum of $30,000 appropriated for this light-house should be applied to the improvement of the lights in Galveston bay.

The board can decide upon the utility of the erection of this light-house, its class and site, having the report of the survey of the locality, and the views of Lieuts. Wilkinson and Hunt on the subject, before them.

Very respectfully, yours, &c., &c.,

A. D. BACHE, *Superintendent.*

Hon. James Guthrie, *Secretary of the Treasury.*

Surveying Schooner "Morris,"
Galveston, Texas, June 22, 1853.

Sir: I have the honor to report the execution of a reconnaissance and selection of a site for a light-house at Sabine Pass, of which a sketch is herewith enclosed.

The proposed site, as indicated on the sketch, answers, in my opinion, all the conditions required by the law: First, because there is a substratum of stiff clay, as ascertained by boring, twelve feet below the surface, affording a firm basis for the building. Second, because the local interests of trade will be materially benefited by its erection, as the bar may then be crossed, day or night, by a simple compass-bearing. Third, because the general wants of commerce will be subserved, as a certain means of establishing their position will then be afforded to vessels bound either to the eastward or westward, and because the bar, from its nature, may then be crossed safely at times when others on this coast would be impassable. The light should be distinctly visible from the plane of the horizon sixteen miles, as it would then be sighted by vessels while in their regular track.

Two important facts connected with the matter, I mention: First, the mud on and inside the bar is so soft, (the lead not indicating the exact depth) that a vessel of heavy draught can cross or anchor on it with absolute safety; and, second, repeated trials, by boring with an iron rod, established the fact that no spot can be found on either side of the pass, nearer to the coast, suitable for the construction of a light-house.

I am, sir, very respectfully, your obedient servant,

J. WILKINSON, *Lieutenant.*

Prof. A. D. Bache, *Superintendent Coast Survey, Washington, D. C.*

Galveston, *April* 16, 1853.

Dear Sir: I notice, by the report of the Light-house Board, that thirty thousand dollars has been appropriated by Congress for the erection of a light-house at the Sabine Pass, and that the requisite information touching the propriety of the expenditure has not been obtained. May I venture to give you my reason why so large an amount of money should not be thrown away upon such an unimportant place, and that a part of the appropriation should be devoted to the improvement of the light-house at Galveston?

There will be shipped from this port, during the current year, over seventy thousand bales of cotton, and for each succeeding year the increase will be rapid and certain.

There are some two hundred miles of coast included in Galveston bay; and the Trinity river, with its tributaries, pours its productions into this inland sea, and conveys the return cargoes to the most fertile portion of Texas. Most of the sugar, molasses, &c., from the rich bottoms of the Brazos, are brought to this place either by the inland routes or by the coasting vessels, and shipped from the wharves to all parts of the world.

Galveston is the medium through which most of the productions of Texas get to a market, and in a few years it will monopolize the entire foreign trade, for it will soon be connected with the main land by railroads, and its harbor invite the trade of large-sized ships.

To give you an idea of its commerce, I will remark, that there are three lines of sailing-vessels between Galveston and New York—one from Boston, one contemplated from Philadelphia, and another from Baltimore. A canal will be completed in January, which will unite the waters of the Brazos river with those of Galveston bay, and other means will be taken to encourage commerce and concentrate it here.

In Texas fifteen bales of cotton have been produced from the acre, while in Georgia and other southern States one bale to the acre returns a remunerative profit. With this great advantage alone, Texas must soon become the great cotton State, and that trade which attaches to this interest must ultimately make Galveston a seaport of vast importance. In short, if Texas ever became populated, Galveston must be proportionally wealthy and important. Upon this bar we have thirteen feet water; at the Sabine there is but six feet, with two feet of soft mud, making eight feet at the utmost limit. A steamer of fourteen hundred tons passes this bar almost daily, and, in connection with others of the same size, carries forward the tide of emigration into Texas. These facts are not new to you, I very well know, but I mention them by the way of reminding you of their importance, and to show the necessity for a first-class light at this place. If ten thousand dollars, out of the appropriation for the Sabine, be devoted to raising and improving this light-house, the ends of commerce will be better served than in erecting a magnificent structure at an out-of-the-way place.

You would scarcely believe it when I tell you that there is but one saw-mill and a few mean houses at the Sabine.

Five thousand dollars would build as good a light as is required there for the next twenty years; indeed, it will be an absolute waste of money to expend over eight thousand dollars for that purpose. Galveston is getting to be the seaport for the Sabine, (there are several small vessels trading between the two places,) and nothing can prevent it from swallowing up all the foreign trade west of Vermillion bay. This light is not high enough, nor has it sufficient power; it cannot be seen over twelve or fourteen miles from the bar. In conclusion, permit me to apologize for this long letter, trusting it may convey some information, and advance the interests of commerce.

With great regard and respect, your obedient servant,

MONTGOMERY HUNT, *U. S. Navy.*

Prof. A. D. Bache, *Superintendent Coast Survey.*

APPENDIX No. 56.

Letter from the Superintendent of the Coast Survey to the Secretary of the Treasury, communicating the report of Lieut. Comg. H. S. Stellwagen, U. S. N., assistant in the Coast Survey, on the re-examination of Aransas Pass, with reference to the necessity and site for a light-house there.

COAST SURVEY STATION, NEAR PHILLIPS, FRANKLIN COUNTY, ME.,
September 5, 1853.

SIR: In conformity with the instructions of the department, a resurvey was made of Aransas Pass, to determine the expediency of placing a light-boat or a light-house there. I have now the honor to submit a chart, showing the entrance as it existed in 1851, from the reconnaissance of Lieut. Comg. T. A. M. Craven, U. S. Navy, assistant in the Coast Survey, and as found recently by Lieut. Comg. H. S. Stellwagen, U. S. Navy, assistant in the Coast Survey.

I append extracts from the report of Lieut. Comg. Stellwagen, and refer to the report of Lieut. Comg. Craven which accompanied the annual report of the Superintendent of the Coast Survey for 1851. (See Doc. 3, App. No. 39, p. 507.)

The light-house recommended by Lieut. Comg. Stellwagen will probably be of service in entering the harbor after the bar is passed, especially if movable beacons be provided in connection with it. It may also benefit the extensive navigation of the coast, if raised sufficiently high, but is not in the best position for that purpose. It can afford no facilities in passing the very shifting bar at the entrance. The comparative chart shows that, while the depth on Aransas bar remains nearly the same, the channel has changed its position by nearly the whole breadth of the pass in two years. It is plainly impracticable to erect a fixed structure which would guide vessels over the bar. The light-boat proposed by Lieut. Comg. Craven appears to me to be necessary for that purpose.

The Light-house Board will judge whether the commerce using Aransas Pass is sufficient to require both these aids to navigation—the light-boat to guide navigators over the bar, and the light-house to enable them to pass up the bay. I would also submit to their better judgment the selection of the aid to navigation which they may deem most important, from the information now communicated to them, or already in their possession.

I would respectfully request that this report be transmitted to the Light-house Board.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. JAMES GUTHRIE, *Secretary of the Treasury, Washington.*

COAST SURVEY SCHOONER "MORRIS,"
Galveston, May 4, 1853.

DEAR SIR: * * * * * * * *

I find the channel has changed materially since Lieut. Comg. Craven's visit; instead of running out NE. along San Josef, it goes out SE. across what was then the south breakers, and the shifting of the whole pass to the southward and westward still progresses steadily—the end of Mustang island washing away, and San Josef forming in a corresponding ratio.

From conversations with persons best informed on the subject, I gather that this change has been going on for at least fifteen years, though Mr. William H. Jones, a gentleman of observation, is of opinion that formerly the pass was some four or five miles further down, where there is now a sort of bayou, a creek, or deep indentation of the bay, extending into Mustang island, and that it worked to NE., and is returning to its former situation, which may be its furthest limits of progress in that direction. Time only can determine this point. But, in the meanwhile, there can be no doubt that the pass, bar, channel and all, are constantly removing with a general progression to the southward and westward; and thus far my observations and opinion agree with those of Lieut. Comg. Craven.

I am of opinion that it would be practicable to erect a light-house on the small island back of the pass, so as to serve as a guide, and, with movable beacons, to make a range for the bar for some years. I tried the nature of the ground with an iron rod some ten feet long. The top soil is an alluvial deposite of mud; beneath that the same, mixed with sand. The rod penetrated rather easily for about nine feet, when it reached something pretty firm, but I suppose it was only compact sand; but at or above the depth of the channel, no doubt, would be found, as is the bottom in thirty feet water, a very tenacious, compact sort of clay; and I think common or screw-piles would easily make a very secure base for erecting a light-house. The island, though little above water-level, never changes or washes, they say, and is only about one or one and a half miles back from the bar.

The end of Mustang island is composed of loose sandy hillocks, and washes away some ten or fifteen yards in a year, and San Josef forms about the same, the point being low and bare, and frequently overflowed for one-half or three-fourths of a mile, and on either one a house would have to be placed, some distance from the point.

As regards a light-boat, she would have to be removed so often on account of sudden changes of channel, that I think that an iron house, even expecting to remove it in a few years, would be preferable. A light-house is very necessary here, and would be of great and essential aid to commerce, not only on account of the growing trade of Corpus Christi, &c., but it would be invaluable as a land-mark on a coast where there is so much sameness as to make it almost impossible to distinguish one place from another. Even old traders have been known to be beating for several days, though absolutely to windward of their port, not recognising where they were.

Very respectfully, your obedient servant,

H. S. STELLWAGEN, *Lieut. Comg.*

Prof. A. D. BACHE,
Superintendent of the Coast Survey, Washington.

APPENDIX No. 57.

Letter of the Superintendent of the Coast Survey to the Secretary of the Treasury, transmitting the report of R. D. Cutts, Esq., assistant in the Coast Survey, upon the examination and survey of Point Bonita, California, with reference to the location of a light-house.

Coast Survey Station, near Phillips, Maine,
September 1, 1853.

Sir: On the 7th of April last, at the request of the Light-house Board, the Superintendent of the Coast Survey was directed by the department to cause an examination and survey to be made of Point Bonita, California, north side of San Francisco bay, with a view to the erection of a second-class light-house, for which appropriation was made in the act of Congress of March 3, 1853.

On the 15th of that month I issued instructions to the officers in charge of the topographical and hydrographic parties in Section X, to make said examination and survey, and have now the honor to transmit a copy of the report of Assistant R. D. Cutts, the officer in charge of the party by which the topographical survey was made, with accompanying sketch of the locality.

I concur in the opinion expressed by Mr. Cutts, of the great necessity of such a light at Point Bonita to vessels desirous of making an entrance into the Bay of San Francisco, and of the advantages of the position selected over other points at the entrance into that bay.

I also concur in the recommendation of Mr. Cutts, that the light-house to be erected should be supplied with a fog-bell or whistle of the largest size, which would be a valuable auxiliary in the foggy season in warning vessels of their near approach to this bold and rocky coast.

Very respectfully, yours, &c.,

A. D. BACHE, *Superintendent.*

Hon. James Guthrie, *Secretary of the Treasury.*

Pulgas Camp, San Francisco County,
July 6, 1853.

Dear Sir: In accordance with the instructions contained in your letter of the 15th April, I have caused a particular examination to be made of Point Bonita, with a view to the erection thereon of a second-class light.

I send you herewith a sketch of the point, showing the site selected for the proposed light-house, its elevation, and its different approaches.

Of the necessity for a leading light wherewith to find the entrance into the bay of San Francisco, I believe there can be no doubt. Fort Point is too far within the heads, and consequently embraces too small an arc of the sea-horizon, to be considered or trusted as such a light. Nor has the coast in the vicinity of the entrance any such well known or remarkable landmark as could be readily and promptly distinguished during a clear night. The southwest Farallon, although a valuable auxiliary in the general navigation of the coast, is more useful as showing its own position and the surrounding dangers, than as a guide to the heads. With an entrance so broad, deep, and entirely free from hidden danger, there appears to be no reason why ships should not enter at night whenever an opportunity occurs; and yet, up to the present time, few, if any, have done so. This is partly owing to the fogs and light winds which prevail during the summer season after sunset, but more particularly to the want of a light at Point Bonita, and the leading-in lights of Fort Point and Alcatraz island. These two last are now erected. The first is even more necessary and important. It will guide and direct the vessel coming from any direction; and during a clear night in summer, and throughout the winter season, would save the delay of many days, sometimes weeks, which vessels have heretofore incurred by waiting an opportunity to enter by day.

In connexion with the light-house at Point Bonita, I would call your attention to the necessity of having placed thereon a fog-bell or whistle of the largest size. The risk of running on and along so bold a coast during the foggy season is fully illustrated by the late loss of the clipper ship "Carrier Pigeon," and of the two steamships "Tennessee" and "S. S. Lewis," as well as of the revenue brig "Lawrence." The last three were wrecked while searching for the entrance, and while within sound of a fog-bell on Point Bonita. The public press, however, have lately taken up this subject, and so many urgent and forcible articles have appeared, and have, doubtless, met your eye, that it is hardly necessary for me to say more than that Point Bonita is admirably adapted for the site of a light-house and a fog-bell; that its position, with respect to the harbor and general trend of the coast, is prominent, and indisputably the best; and that the immense and valuable amount of shipping seeking the harbor of San Francisco demands, and should receive, every aid and safeguard—among which none are so important as such light-house and fog-bell.

Extreme height of hill above high-water mark, 282 feet; height of site of light-house, (summit of hill to be cleared away,) 265 feet; height of lantern above high-water mark, 285 feet; distance visible in nautical miles, observer elevated 10 feet above sea-level, 23 miles; extent of sea-horizon, 119°.

References on sketch.

○—Circle in black, triangulation point U. S. Coast Survey.
✱—Circle in red, and marked L. H., proposed site for light-house.
A—Bay Landing.
B—Southeast Landing.
C—Pond Landing.
D—True meridian.
} Scale in feet $\frac{1}{10000}$.

I append herewith the report of Assistant A. F. Rodgers, containing the result of his examination at Point Bonita.

I am yours, truly,

RICHARD D. CUTTS.

Prof. A. D. Bache,
Superintendent U. S. Coast Survey.

U. S. Surveying Schooner "Baltimore,"
San Francisco, June 14, 1853.

Dear Sir: In accordance with your instructions, I proceeded to Point Bonita and made a careful examination of the locality with reference to a site for the proposed light-house. I made a critical review of the general survey made in the regular prosecution of the work of the Coast Survey, and have to report that it is sufficiently minute to answer every purpose, the attainment of which would be sought in a resurvey for the particular object in view.

The best sight for the light-house is immediately east of the Coast Survey triangulation point, known as "Point Bonita." The greater comparative eligibility of this position is, I think, so apparent when upon the ground, as to leave little latitude for the exercise of judgment. Its advantage over the point near it is in its greater elevation, while with an equally large arc of clear horizon, and with equal acceptability, it is the nearest point to the entrance, thus rendering it a better mark for vessels passing the light when the night is too dark to make the land. Its superior elevation gives it another advantage than that simply of greater visibility in clear weather, from the fact that the fogs, so common and troublesome to vessels entering this harbor, do not extend more than fifty or one hundred feet above the water; hence it might be possible to make Point Bonita light above the fog from a ship's masthead, when, if it were in a less elevated position, it would be useless.

Upon reference to the topographical map of Point Bonita you will observe that the formation of the bluff upon the west or ocean side is nearly perpendicular, while to the eastward there is a gradual slope for a distance of one hundred yards. The particular spot selected for the light-house is twenty-six feet from the edge of the bluff, in a line due east of the triangulation point. The proper bearing for the greatest length of the light-house is in a north and south line, which will place it parallel with the bluff, and at right-angles to the slope of the ground, the latter saving material in building, and labor in digging the foundation. I placed a barrel in the ground, and, filling it with earth, left it sufficiently exposed to be readily found. This I proposed to make the southwest corner of the light-house. If, in view of the wearing away of the bluff, the distance from it shall be considered too small, it can be moved further to the eastward, without altering the relative expense of building and its foundation, except in the necessarily increased height of the former.

In digging, to ascertain the character of the rock beneath the surface of the ground, in two different places at depths of four and five feet, I could find no indication of its proximity. I examined the face of the bluff upon the outside, and, from that examination, think it safe to say that the surface soil is two feet in depth, resting upon a sub-stratum of reddish clay, which appears to be from ten to twenty feet in thickness. I enclose specimens of rock found on the face of the bluff, twenty feet below the surface. It is of the same character as that which forms the base of Point Bonita, but from exposure to the weather has become hard and very brittle. When found beneath the surface it is firm and tenacious, but so soft as to be easily worked. The direction of the rocky strata, forming the base of Point Bonita, is nearly northwest; the dip is to the eastward, and parallel with the slope of the surface.

I made examinations for a landing and road to the point selected for the light-house. I decided that three landings were practicable, and the road from each so good as to require in the worst instance not more than an outlay of four hundred dollars to make it perfectly good. Of these three, (see Sketch,) the Pond landing (C) would be best, if it were no object to wait for smooth weather; the road thence, though the longest, is much the best, and it could be made a good wagon road for fifty dollars, cutting being necessary at one point only, and that for a distance of fifty yards, in a clay soil. The next landing (B) is in the SW. corner of Rodier beach, under the lea of a large rock. Here I found, upon two days, scarcely more surf than is usually found on the leeward shores of the bay in bold water. The road thence would follow for fifty yards the course of a ravine cut by the rains of last winter; this would have to be filled up from the sides of the valley through which it runs. During the rainy season, this road would be liable to wash out at any moment, unless built substantially, with a culvert to lead off the water. The third landing (A) is on the bay side of Point Bonita. Here the landing is better than at either of the other places mentioned, and more certain, at all times, from its better protection. A southeast storm only would render it dangerous. A loaded scow could lie alongside of the rocks, if sufficient fenders were used; but it would be necessary to use cranes to hoist the load—a height of twenty-five feet in the best spot found. The road thence to the site is of easy grades, and would require no improvement.

In regard to supplies of wood and water, I would state that the keeper of the light will always be able to supply himself with good fire-wood from Rodier beach, without other expense than that of cutting and hauling. After a southeast gale, this beach is strewn with drift-wood, ships' spars, boats, &c. Of the facilities for getting water, I cannot speak with certainty; water can be procured by digging anywhere in the wooded valley through which the road from the Pond landing runs. The same valley could be cultivated as a garden, and could be irrigated with but little expense.

The land belongs to Captain William A. Richardson. His claim is before the land commission.

I am, very respectfully,

AUGUSTUS F. RODGERS.

Rich'd D. Cutts, Esq.,
Assistant U. S. Coast Survey.

APPENDIX No. 58.

Errata in the list of Geographical Positions in the Annual Report of the Coast Survey for 1851, discovered since published.

Page.	Line.	For—	Read—
163	38	6356079.11	6356078.96.
169	3	07″.20	07″.23.
169	3	11″.36	11″.33.
189	3	Sursuit Creek, 41° 45′ 32″.29, 70° 08′ 07″.07	Sursuit Creek, 41° 45′ 30″ 25, 70° 08′ 15″.94.
189	3	55° 49′ 44″, Scargo Hill 235° 48′ 11″	54° 49′ 44″, Scargo Hill 234° 48′ 11″.
189	3	3943.7, 4312.7, 2.45	3744 1, 4094.4, 2.33.
189	4	5799.3, 6341.9, 3.60	5588.6, 6111.5, 3.47.
189	12	10794.9, 11805.0, 6.71	108813.2, 11825.0, 6.72.
190	5	3815.6, 4172.6, 2.37	3849.6, 4209.8, 2.39.
190	6	87° 45′ 11″, West Chatham 267° 42′ 02″	87° 58′ 54″, West Chatham 267° 55′ 45″.
190	6	6546.4, 7159.0, 4.07	6567.8, 7182.3, 4.08.
191	23	6789.0, 7424.3, 4.22	6797.6, 7433.7, 4.22.
194	11	70° 09′ 45″, Monk's Hill 250° 06′ 58″	318° 08′ 24″, Manomet 138° 10′ 55″.
194	16	224° 09′ 47″	264° 09′ 47″.
217	21	70° 37′ 44″.63	70° 37′ 04″.63.
218	6	53″.07	53″.04.
220	19	43° 38′ 02″.03, 70° 17′ 02″.33	43° 37′ 55″.59, 70° 16′ 49″.00.
220	19	218° 48′ 26″, Bramhall's Hill 38° 49′ 00″	207° 07′ 39″, Bramhall's Hill 27° 08′ 03
220	19	1758.5, 1923.1, 1.09	1763.2, 1928.2, 1.10.
258	19	Sawpits	Port Chester.
258	20	Captain's Island	Little Captain's Island.
271	9	W. Hubbel	Uriah Hubbel.
276	17	Kakeout Hill	Kieckout Hill.
286	11	Aquackanonk	Acquackanonk.
286	14	Aquackanonk	Acquackanonk.
286	17	Aquackanonk	Acquackanonk.
286	19	Aquackanonk	Acquackanonk.
324	9	76° 13′ 58″.50	76° 13′ 58″.30.
360	21	38° 24′ 06″.56	38° 28′ 06″.56.
372	19	04″.86	04″.90.
374	15	76° 14′ 24″.22	76° 14′ 24″.33.
375	14	45″.55	44″.55.
378	19	75° 10′ 08″.51	75° 10′ 10″.51.
400	12	47° 54′ 14″	227° 54′ 14″.
400	13	294° 22′ 49″	294° 32′ 49″.
400	17	124° 49′ 48″, Jack Shoal 304° 48′ 54″	94° 22′ 01″, Jack Shoal 274° 21′ 13″.
400	18	168° 39′ 02″; New Inlet, North Point, 348° 38′ 47″.	167° 38′ 20″; New Inlet, North Point, 347° 38′ 11″.
400	21	94° 22′ 01″, Jack Shoal 274° 21′ 13″	124° 49′ 48″, Jack Shoal 304° 48′ 54″.
400	22	167° 38′ 20″; New Inlet, North Point, 347° 38′ 11″.	168° 39′ 02″; New Inlet, North Point, 348° 38′ 47″.
402	12	Little Hill, 52° 52′ 09″	Little Hill, 52° 42′ 09″.
404	17	11869.0, 12979.6, 7.38	6506.3, 7115.1, 4.04.
404	18	6506.3, 7115.1, 4.04	11869.0, 12979.6, 7.38.
409	17	81° 05′ 14″.32	81°, 05′ 16″.85.
416	3	14678.7, 16052.2, 9.12	14613.6, 15981.0, 9.08.
416	4	181° 47′ 42″, Black Point 1° 48′ 34″	181° 48′ 35″, Black Point 1° 48′ 40″.
425	9	2376.1, 2598.3, 1.48	2576.1, 2817.1, 1.60.
480	33	4h. 44m. 29.05s.	4h. 44m. 29.50s.

ERRATA.

Page	Line	For	Read
42	13th from bottom	Appendix 114	Appendix 14.
*96	2d from bottom	Narren	Narrien.
*97	2d under Class II.	there	then.
*97	1st under Class III	positions	portions.
*98	8th from bottom	one	an.
*102	17th from bottom	levelled	bevelled.
*134	5th from top	Minutes of long. 1″	Minutes of long. 1′.

ALPHABETICAL INDEX.

A.

B.

C.

D.

E.

F.

G.

H.

I.

J.

K.

L.

M.

N.

O.

P.

R.

S.

LIST OF SKETCHES.

National Oceanic and Atmospheric Administration

Annual Report of the Superintendent of the Coast Survey

Please Note:

This project currently includes the imaging of the full text of each volume up to the "List of Sketches" (maps) at the end. Future online links, by the National Ocean Service, located on the Historical Map and Chart Project webpage (http://historicals.ncd.noaa.gov/historicals/histmap.asp) will includes these images.

NOAA Central Library
1315 East-West Highway
Silver Spring, Maryland 20910