# SHORE AND SEA BOUNDARIES

Volume Two

FERDINAND RUDOLPH HASSLER
The First Superintendent of the "Survey of the Coast."

# SHORE AND SEA BOUNDARIES

WITH SPECIAL REFERENCE
TO THE INTERPRETATION AND USE
OF COAST AND GEODETIC SURVEY DATA

BY

AARON L. SHALOWITZ, LL.M.
*Special Assistant to the Director*

In Two Volumes

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Volume Two

# Interpretation and Use

# of

# Coast and Geodetic Survey Data

# About the Author

AARON L. SHALOWITZ devoted a lifetime as a prelude to the preparation of this two-volume treatise on *Shore and Sea Boundaries.* His early training in engineering, his later training in the law, and his long affiliation with the Coast and Geodetic Survey have prepared him admirably for the writing of this publication. He graduated from the Baltimore Polytechnic Institute in 1911, and in 1916 entered the service of the Coast Survey—first, as a commissioned officer in the field, engaged on geodetic, topographic, and hydrographic surveys in the United States, Alaska, and the Virgin Islands; later, as a cartographic engineer in the Washington Office; and finally, as a special assistant to the Director.

Mr. Shalowitz's interest in legal-technical matters began many years ago when he was called upon to interpret original Bureau surveys and nautical charts in the light of court decisions. Recognizing the close relationship that exists between Coast Survey technical data and riparian boundaries, he began the study of law at night while continuing his regular duties in the Bureau. He received his LL.B. degree (with first honors) from Georgetown University and his LL.M. degree from George Washington University, and is a member of the bar in the District of Columbia and in Maryland. He was technical adviser to the Department of Justice on the boundary aspects of the far-reaching California "tidelands" decision, and was the Government's principal witness on the interpretation of Bureau surveys and charts before a Special Master of the Supreme Court.

He is the author of many technical and legal-technical papers on shore and sea boundaries and related subjects that have been published by the Bureau and in scientific and legal journals. He collaborated in writing the 1942 edition of the Hydrographic Manual of the Coast Survey, and was editor-in-chief of the journal "Surveying and Mapping" and the "Journal of the Coast and Geodetic Survey."

Mr. Shalowitz has served the Bureau with distinction in many capacities for nearly five decades and has furnished guidance and direction to the engineering and legal professions in the highly specialized area of waterfront boundaries, in particular those determined by tidal definition. In 1952, the Department of Commerce awarded him its Gold Medal and Citation for "outstanding contributions to science and technology in the fields of hydrographic and cartographic engineering." Because of his unique training and background, Mr. Shalowitz, at the urgence of officials in the Coast Survey, undertook the preparation of *Shore and Sea Boundaries.* Not only is this a monumental achievement, which will stand as a basic reference for years to come, but it is the culmination of a lifetime of dedicated and efficient service to the public.

H. Arnold Karo

H. ARNOLD KARO
Rear Admiral, USC&GS
*Director*

# Preface

One of the purposes of the publication *Shore and Sea Boundaries* is to meet a long-felt need, both within and without the Bureau, for a treatise on the technical aspects, interpretation, and use of the surveys and charts of the Coast and Geodetic Survey, with special emphasis on those features that may have legal significance. To this end, the publication is oriented to reflect the many inquiries that the Bureau has had to deal with in the past, and to furnish the technical and legal background for an understanding of the problems that may arise in the future.

In its inception, the primary function of the Coast and Geodetic Survey was to survey the coastal regions of the United States and to publish nautical charts for the safety and promotion of waterborne commerce. Because of the precise methods used and the carefully accumulated observational data, it soon became apparent that the Bureau could serve many collateral interests other than those strictly maritime. This has manifested itself over the years in advice and services rendered, and in the utilization of Bureau records and expert testimony in important waterfront litigations.

Volume One reflected the high point of Bureau participation in this area of collateral interest by recording its long association with the technical and legal-technical problems which the Submerged Lands Cases (sometimes referred to as the "tidelands" cases) and the Submerged Lands Acts posed. The pertinent surveys, charts, and technical data were considered and interpreted in relation to a specific problem—the delimitation of sea boundaries along the California and Gulf coasts. Volume Two extends this area of application to waterfront boundaries in general. Many types of information are shown on the surveys and charts of the Bureau, the significance and import of which are not always apparent. This is true in particular of the early surveys and charts. The present volume aims to provide such basic reference. Interpretation is approached through the early manuscript instructions and the published manuals for field and office work—copies of which are no longer available—so that further reference to these sources should be unnecessary. Photogrammetric and echo-sounding surveys are not considered in detail because they represent modern developments in topographic and hydrographic surveying and the procedures and techniques for their prosecution are adequately covered in available manuals.

Volume Two is divided into three Parts. Part 1 is introductory in nature and deals with the origin and history of the Coast Survey, its growth and expansion, and its present orientation in the areas of scientific research and oceanography. Also included in Part 1 is a discussion of the types of technical data available in the Bureau for use in establishing shore and sea boundaries. Part 2 deals with the early surveys and charts—their interpretation and use. Significant features and practices are analyzed, particularly those that may have boundary significance. Part 3 treats of the application of Coast and Geodetic Survey data to engineering and legal problems. To provide the background for an understanding of these problems, chapters are included on the judicial structure in the United States and on the basis for land ownership.

The text is subdivided by a decimal system of numbering, and cross-referencing is by these numbers. Each Part is subdivided into not more than nine chapters, each of which is divided into not more than nine sections. Each section is subdivided into not more than nine subjects and each subject into not more than nine numbered headings. The first digit of a number identifies the chapter, the second digit the section, the third digit the subject, and the fourth digit the heading. For example, the number 6581, which identifies the heading "Extreme Low Water," is the first heading under the eighth subject in the fifth section of Chapter 6, entitled "Interpretation and Use of Nautical Charts." Further subdivisions of the headings are identified by letters "A," "B," etc. Cross-references within any one Part are given by number only, thus (*see* 658), but where the reference is to another Part of the volume, the number of the Part is also given, thus (*see* Part 3, 41).

The form of legal citations follows generally the rules formulated in the manual, *A Uniform System of Citation,* a joint publication of the law reviews of Columbia, Harvard, Pennsylvania, and Yale Universities. Wherever possible, citations are given to cases reported in the National Reporter System.

*Shore and Sea Boundaries* has been actively undertaken and carried to completion during the incumbency of Rear Admiral H. Arnold Karo as Director of the Bureau, although in concept it antedates this period by many years. The author feels greatly indebted to him for his intense interest in the progress of the work and for his patient and helpful review of the entire manuscript. The opportunity of this undertaking is traceable directly to Admiral Karo's leadership in recognizing the urgent need for this basic reference work.

April 1964 *Aaron L. Shalowitz*

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## CHAPTER I

# The United States Coast and Geodetic Survey

### 11. GENERAL STATEMENT

The United States Coast and Geodetic Survey performs public services essential to the safety and advancement of marine and air commerce, to science and industry, to surveying and mapping and other engineering work, and to the economic development of the country's natural resources. The early leaders of the Nation wisely considered such services as elements of the constitutional power of the Nation to promote and develop trade and commerce between the several states and with foreign nations. Through the years the wisdom of this undertaking has become increasingly evident from the benefits that have accrued to industry and to science, engineering, and other related fields.

As a leading maritime nation, the United States must have a continually expanding knowledge of the sea around it, its coasts, the location of dangerous reefs and shoals, the extent of fishing banks and submerged lands, the rise and fall of the tide, the direction and strength of sea currents, and the magnetic changes affecting navigation and communications.

As a leading nation in commerce and industry generally, the United States must have continually increasing knowledge of its natural resources, of the details of the topography and geology of its lands, and of the potentials for development of structures to further trade and commerce.

Directly or indirectly the work of the Coast Survey affects the daily lives of all Americans. The ships that bring coffee and sugar to the United States use the nautical charts of the Survey for their safe navigation; the air pilot who carries passengers, mail, or cargo uses its aeronautical charts to guide him safely to his destination; the surveyor who locates the boundaries of farms and city lots, and the engineer who plans hydroelectric, superhighway, flood control, and other construction projects use the markers it has established throughout the land; and the safety engineer who establishes building codes against earthquake hazards uses its information to determine the stresses and strains that buildings must withstand.

The work program of the Survey, continuous by nature, is planned to satisfy the needs of new and future developments in transportation and communications. It is performed so far as possible at an overall rate of progress calculated to make the services available when and where needed.

Safety of life and property frequently depends directly upon the reliability of the Survey's charts and publications; and the geodetic control of the country is the foundation of all topographic and geologic mapping, land surveys, and many extensive engineering projects. It is therefore the policy to stress accuracy and dependability in all field observations and publications for which the Survey is responsible.

## 12. ORIGIN AND HISTORY

The history of the Coast and Geodetic Survey goes back to the early days of the Republic. Fifteen states or territories comprised the coastal area of the newly formed Union. Land transportation was difficult and commerce between the states was largely by coastwise shipping. Foreign trade—indispensable to the life of the Nation—was entirely by sea. With many ships plying the coast and entering harbors, shipwrecks were common. The founding fathers recognized a responsibility of the central government in this field and provided that Congress shall have the power "To regulate Commerce with foreign nations, and among the several States, and with the Indian Tribes."[1] This national obligation and constitutional power was given force and effect on February 10, 1807, when Congress, acting on the recommendation of President Jefferson, adopted a resolution for a "Survey of the Coast."

### 121. The Organic Act of 1807

The Act of February 10, 1807, authorized the President "to cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shores of the United States; and also the respective courses and distances between the principal capes or head lands, together with such other matters as he may deem proper for completing an accurate chart of every part of the coasts within the extent aforesaid." Section 2 of the act further

1. Art. I, sec. 8, cl. 3 of the Constitution (the commerce clause).

authorized "such examinations and observations to be made, with respect to St. George's bank, and any other bank or shoal and the soundings and currents beyond the distance aforesaid to the Gulf Stream, as in his opinion may be especially subservient to the commercial interests of the United States."[2] This was the inception of what today is the Coast and Geodetic Survey.

### 1211. *Legislative History of Act*

The Act of 1807 was not of sudden origin. As far back as February 27, 1795, during the Third Congress, a special committee submitted a report which began with the statement that "the sea coast, not only of Georgia, but also of South Carolina, North Carolina, and Virginia," had never been surveyed with the requisite accuracy, and concluded with a recommendation for the adoption of resolutions which should request and authorize the President to cause a survey to be made of the coast between Chesapeake Bay and St. Mary's River.[3]

A similar report was made late in 1795, and on May 14, 1796, during the Fourth Congress, a report was submitted by the Committee of Commerce and Manufactures of the House of Representatives recommending the procurement of "such accurate charts of the Atlantic coast of the United States, including the bays, sounds, harbors, and inlets thereof, as have been made from actual observation and surveys; and that, in all those parts, of which no actual survey has been made . . . to employ proper persons to survey and lay down the same."

The language of these recommendations was broad enough to have resulted in the immediate establishment of a national survey, but apparently other factors required crystallization before the country was to commit itself to such a major undertaking. But partial surveys of particular parts of the coast seem to have been authorized.[4]

When Thomas Jefferson became President, the matter of a survey of the coast gained momentum. A man of science himself, he had a wide acquaintance among scientific men of the day. One of these was Professor Robert Patterson, a distinguished scholar and then Director of the Mint. Patterson is credited

2. 2 Stat. 413 (1807). To carry into effect the provisions of the act a sum not exceeding $50,000 was appropriated. *Id.* at 414. The full text of the act is given in Appendix C.

3. The report was in response to a petition of certain individuals who as a private enterprise had previous to 1795 undertaken a survey of the coast of Georgia from St. Mary's River to Savannah. Having exhausted their funds in the field work they petitioned Congress for a grant of $3,000 to cover the cost of engraving the proposed map.

4. In 1802, Congress authorized a survey of Long Island Sound. The work called for was actually carried out and a map made, though no very definite information in regard to the execution or value of the map is available. Also, in 1805, another act provided for a survey of the coast of North Carolina, between Cape Hatteras and Cape Fear. The work was actually done by a party using one of the revenue cutters, but the vessel was wrecked by a severe storm and the records lost except for a map made in the field.

with having contributed to the idea of a trigonometric survey of the coast of high precision,[5] and appears to be one of the men chiefly responsible for having the need for a survey of the coast brought to the attention of Congress.

On December 15, 1806, in the House of Representatives, Mr. Dana, of Connecticut, addressed the House upon the need for a survey of the whole extent of the coast of the United States. He referred to the recent surveys of Long Island Sound and the North Carolina coast (*see* note 4 *supra*), and made the following remarks:

> The surveys, which have thus been authorized, were perhaps of the most urgent necessity; but other surveys of the coast are desirable. What has already been done may be regarded as introductory to a general survey of the coasts of the United States under authority of the Government. With a correct chart of every part of the coast, our seamen would no longer be under the necessity of relying on the imperfect or erroneous accounts given of our coast by foreign navigators. I hope the lives of our seamen, the interest of our merchants, and the benefits to the revenue, will be regarded as affording ample compensation for making a complete survey of the coasts of the United States at the public expense.
>
> The information which may be obtained will also be useful in designating portions of territorial sea to be regarded as the maritime precincts of the United States, within which, of course, the navigation ought to be free from the belligerent searches and seizures.
>
> It is proposed to extend the survey to the distance of twenty leagues from the shore. This distance is mentioned with a view to the second article of the treaty with Great Britain in 1783, which describes our boundaries as "comprehending all islands within twenty leagues of any part of the shores of the United States." [6]

Mr. Crowninshield, of Massachusetts, agreed with the proposal but felt that the survey should be more extensive. He believed there were many shoals off the coast at distances greater than 20 leagues and thought it important to have them surveyed. He therefore moved to strike from the resolution 20 leagues and insert 50 leagues.[7]

Mr. Dana agreed with Mr. Crowninshield on the utility of an accurate survey of the shoals or banks that had been mentioned, but was opposed to including in the resolution any islands at a greater distance than 20 leagues from shore. He believed that if any shoals at a greater distance are to be surveyed, special provision for such purpose may be made in the details of a bill rather than in a general resolution of inquiry.[8]

5. Smith, *Ferdinand Rudolph Hassler,* 13 UNION WORTHIES 7 (1958).

6. 16 ANN. OF CONG. 151–153 (1806). Mr. Dana proposed the following resolution: "Resolved That the Committee of Commerce and Manufactures be instructed to inquire into the expediency of making provision for a survey of the coasts of the United States, designating the several islands, with the shoals and roads or places of anchorage within twenty leagues of any part of the shores of the United States." *Ibid.*

7. *Ibid.* Mr. Cook, of Massachusetts, doubted whether all of St. George's Bank was within even 50 leagues of the shore, and he proposed to substitute 70 leagues. (George Bank, as it is now known, actually extends for a distance of 60 leagues from the nearest point on the mainland.)

8. The resolution previously proposed by Mr. Dana (*see* note 6 *supra*) was agreed to but with the following provision added: "And that the committee be further instructed to inquire into the expediency of surveying St. George's bank, or any other shoals or banks, which may be deemed dangerous to vessels approaching the shores of the United States." *Id.* at 165.

On January 6, 1807, a bill was reported to the House, by the Committee of Commerce and Manufactures, for surveying the coasts. After amendment, it was enacted and approved as the Act of February 10, 1807 (*see* 121).[9]

## 1212. *Interpretation of Act*

This legislative history of the 1807 act is an important facet in its interpretation. It has been stated in connection with the seaward boundary of Louisiana under the Submerged Lands Act (*see* Volume One, Part 2, 153), that "When Congress defined Louisiana's boundary in the Act of its admission into the Union as being three leagues from coast into the Gulf of Mexico, Congress must be taken to have intended that the three league boundary line into the Gulf was from the coast line to be designated and defined by the agency of the federal government provided by said Act of Congress of February 10, 1807." [10] It has also been stated that "In the second article [Treaty of 1783, 8 Stat. 80, 82] the State boundaries were also definitely described as a line drawn east in the Atlantic Ocean, comprehending all islands within 20 leagues of any part of the shores of the United States" and that "By act of Congress approved February 10, 1807, the President was authorized and requested to have this 20 leagues line surveyed and charted." [11]

These quotations carry the implication that the 20-league reference (60 nautical miles), in the Act of February 10, 1807 (*see* 121), was meant to establish that distance as the *coast line* of the United States which the Coast Survey was to survey and chart. This conclusion does not appear to be supported by the legislative history of the act nor by subsequent action of Congress.

The legislative history shows no intent on the part of Congress to establish a specific line in the water at 20 leagues or at any other distance from shore. The act merely calls for a survey of the *coasts* of the United States and a designation of the *islands, shoals, roads,* and *anchorages* "within twenty leagues of any part of the shores of the United States." It was to be a survey of the land area (with no defined limits) and of the water area to a distance of 20 leagues from shore, but no mention was made of surveying or charting a boundary line at that distance.[12] This is borne out by the discussion in the House of Repre-

9. The measure passed the House on Jan. 20, and the Senate, with amendments, on Jan. 30. The Senate amendments were accepted by the House on Feb. 5, 1807. 16 ANN. OF CONG. 50, 373, 456 (1807).

10. Brief of the State of Louisiana in Opposition to Motion for Judgment on Amended Complaint by the United States, 81–82, United States v. Louisiana et al., Sup. Ct., No. 10, Original, Oct. Term, 1958.

11. From *Hearings before Committee on Interior and Insular Affairs on S. 1901,* 83d Cong., 1st sess. 672, 673 (1953).

12. The term "coasts" appears to be used in the act in a very broad sense to cover both the land and the water areas. Modern usage confines "coast" to a zone of land of indefinite width (perhaps 1 to 3 miles) bordering the sea; the land extending inland from the shore (*see* Volume One, Part 2, 1548(*d*)).

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sentatives on December 15, 1806, by Mr. Dana, the proponent of the measure for a survey of the coasts, by such phraseology as "other surveys of the coast are desirable," "introductory to a general survey of the coasts of the United States," and "a correct chart of every part of the coast" (*see* text following note 5 *supra*).

It is also of interest that Mr. Dana noted that the distance of 20 leagues was mentioned because the treaty with Great Britain in 1783, which settled the Revolutionary War, "describes our boundaries as 'comprehending all islands within twenty leagues of any part of the shores of the United States.'"[13] This correspondence in distance in the two documents, together with the wording of the Treaty of 1783, has been advanced as having "fixed the boundaries of the Atlantic Coastal States as 20 leagues offshore," and that the Act of February 10, 1807, authorized the surveying and charting of that 20-league boundary line.[14]

Insofar as the Treaty of 1783 is concerned, the Supreme Court has held that the words "comprehending all islands within twenty leagues of any part of the shores of the United States" were not intended to establish United States territorial jurisdiction over all waters lying within 20 leagues of the shore. The Court noted that Secretary of State Jefferson's proposal only 10 years later (in 1793) that a 3-mile limit should be placed upon the extent of territorial waters bears out the conclusion that "language claiming all islands within a certain distance of the coast is not meant to claim all the marginal sea to that distance."[15] And it was Jefferson who as President was instrumental in having Congress pass the Act of 1807 calling for a survey of the coast (*see* text at note 5 *supra*). This would seem to be subject to the same limitation which the Court placed on the wording of the Treaty of 1783, and negatives the theory that Congress intended to establish a 20-league boundary line.

This is further substantiated by the provision in the Plan of 1843 (*see* 122) that "soundings shall be made along the whole line of the coast, as far inland as the ports and harbors for commerce, and as far seawards as to soundings of

13. Proposals were also made for substituting 50 leagues and 70 leagues for the 20-league provision based on the belief that there were many shoals off the coast at distances greater than 20 leagues, particularly St. George's Bank (*see* note 7 *supra* and preceding and following text). This indicates that the purpose of the provision was to make certain that the survey would include all islands, shoals, and banks of importance to vessels approaching or leaving our shores, rather than the establishment of a boundary line at that distance. The reference to the 20-league provision in the Treaty of 1783, was merely a convenient figure to tie up to and carried no special significance, especially in the light of the Supreme Court's interpretation of the language of that treaty (*see* text following note 14 *infra*).

14. This has been stated as indicating a repudiation by President Jefferson of the letter he wrote as Secretary of State on Nov. 8, 1793, to the minister of Great Britain, provisionally setting forth the distance of 3 miles from shore as the limit of the territorial seas of the United States. 104 Cong. Rec. A894 (Jan. 30, 1958). Yet one week prior to the passage of the Act of Feb. 10, 1807, President Jefferson's Secretary of State, Mr. Madison, reiterated Mr. Jefferson's position with respect to the 3-mile limit. MOORE, I DIGEST OF INTERNATIONAL LAW 718–721 (1906).

15. *United States* v. *Louisiana et al.*, 363 U.S. 1, 68–69 (1960).

120 fathoms depth." This is a definite modification of the 20-league provision in the Act of 1807, and is a varying rather than a constant distance.[16]

But over and above these considerations is the overriding one that the Coast and Geodetic Survey has never interpreted the 20-league provision to require it to establish a boundary line at that distance from shore nor to chart such a line, and no such line has ever been charted. The Act of August 6, 1947 (*see* 14(*a*)), which specifically defined the functions and duties of the Bureau placed no distance or depth limitation on its offshore surveys. This has been further broadened by the Act of April 5, 1960, which removed certain geographical limitations on the Bureau activities contained in the 1947 act (*see* 14(*b*)).

## 122. THE PLAN OF 1843

A significant milestone in the history of the Coast Survey was reached when Congress passed the Act of March 3, 1843 (5 Stat. 630, 640). This provided that future appropriations should be "expended in accordance with a plan of reorganizing the mode of executing the survey" to be formulated by a board of officers from the Coast Survey, Navy, and Army.[17] The board submitted its report to the President on April 9, 1843, in the form of a plan for reorganization of the Survey and a recommendation that the work be kept in the Treasury Department. The plan adopted was based on Hassler's paper of March 21, 1843, which was in many respects a refinement and enlargement of his original proposal in 1807, as dictated by the needs of a growing America.

The plan defined the requirements for triangulation, astronomic, topographic, and hydrographic work, and provided for the first time the making of magnetic observations "as circumstances and the state of annual appropriations may allow." Hydrographic surveys were extended seaward to include soundings of 120 fathoms depth.[18] The board recommended that the Survey be kept in the Treasury Department on the ground that the object and purpose of the survey of the coast refers principally to the commercial interests of the country. President Tyler approved the plan of reorganization on April 29, 1843, includ-

16. Along the Atlantic coast, it varies from a maximum of 64 leagues east of Cape Cod to a minimum of 2 leagues off Miami Beach; in the Gulf of Mexico, it extends to a distance of 37 leagues off Tampa and 40 leagues at the boundary between Louisiana and Texas. The wording of the provision as to 120 fathoms depth in the Plan of 1843 also bears out the interpretation placed on the word "coasts" in the Act of 1807 that it referred to land and water areas rather than to a boundary line at a distance of 20 leagues from shore (*see* note 12 *supra* and accompanying text).

17. The act also stipulated that the plan of the board should provide for the employment of "the officers of the navy . . . on the hydrographical parts, and the officers of the army on the topographical parts."

18. This depth approximates the conventional edge of the continental shelf, which is taken as 100 fathoms. Along the northeast Atlantic coast and along the Gulf coast, this depth is considerably at variance with the 20-league belt contained in the Act of 1807 (*see* note 16 *supra*).

ing the recommendation that the work be continued in the Treasury Department.[19]

Although the responsibilities of the Survey were vastly increased during the ensuing years, the Act of March 3, 1843, and the plan of organization adopted pursuant thereto, governed its operations for more than a century until passage of the Act of August 6, 1947 (*see* 14(*a*)).[20]

## 123. EARLY HISTORY—A PIONEERING EFFORT

In implementing the Act of 1807 (*see* 121), President Jefferson, through his Secretary of the Treasury Albert Gallatin, sought the advice and assistance of the American Philosophical Society—the leading scientific body of the period—as to the best method of approaching the task. A circular was issued setting forth a project of a survey of the coast and inviting the attention of scientists to it, and requesting plans for carrying it into effect.[21]

Among those who responded to this invitation was Ferdinand R. Hassler, a Swiss geodesist and scientist of outstanding reputation, then serving as professor of mathematics at West Point.[22] Hassler's fundamental plan provided for a division of operations into three great branches—the geodetic, the topographic, and the hydrographic. Of these, he considered the geodetic operation to be the most important, for it affected the accuracy of the other two. This plan was recommended for adoption by the Philosophical Society and was accepted by the President. Hassler later became its directing head.

The early work of organizing the Survey was indeed a pioneering effort. There were no American precedents to follow. The work had to be planned

19. The Bureau remained in the Treasury Department until July 1, 1903, when it was transferred to the newly created Department of Commerce and Labor by the Act of Feb. 14, 1903 (32 Stat. 825, 826, 830). When the Department of Labor was created by the Act of Mar. 4, 1913 (37 Stat. 736), the Bureau remained in what was thenceforth designated as the Department of Commerce, where it is now located.

20. For a full recital of the Plan of 1843, and other legislative authorizations pertaining to the Coast Survey *see* Jeffers, *Legislative History of the Coast and Geodetic Survey*, 5 JOURNAL, COAST AND GEODETIC SURVEY 123 (1953).

21. The circular set forth with remarkable clarity an understanding of the basic principles on which any great national survey must rest. This was disseminated not for the purpose of pointing out any one plan in preference to another, but only in order to show the view that was taken of the subject and the degree of accuracy it was desirous of attaining. The plan provided for "ascertainment by a series of astronomical observations, of the true position of a few remarkable points on the coast; . . . a trigonometrical survey of the coast between those points;" and "a nautical survey of the shoals and soundings off the coast, of which the trigonometrical survey of the coast itself, and the ascertained positions of the light houses and other distinguishable objects would be the bases." HASSLER'S ADMINISTRATION (Part I) 18. This material is in typescript form and is unauthored and undated. It is filed in the Survey library and is identified as USCGS/.091/1921–2.

22. Other plans submitted were those by Robert Patterson, Andrew Ellicott, John Garnett, Isaac Briggs, Joshua Moore, and James Madison. WRAIGHT AND ROBERTS, THE COAST AND GEODETIC SURVEY (1807–1957) 5, PUBLICATION, U.S. COAST AND GEODETIC SURVEY (1957).

and systematized. Assistants had to be trained, and when the results of the field operations accumulated, provision had to be made for compilations and reductions and for the preparation of charts and maps. In addition, instruments, such as those necessary for a geodetic survey, were not kept in stock at the beginning of the 19th century, nor were artisans capable of making such instruments available in this country. Copper of suitable quality for the chart engravings was lacking, as were qualified engravers themselves, and these had to be brought from abroad. And it is an interesting fact that not a single working observatory existed in this country at that time for the training of astronomers, and there was not a single college that included a course in geodetic surveying in its curriculum.

For these and other reasons, actual survey work was not undertaken immediately. But in 1811 Hassler was commissioned to go to Europe to arrange for the purchase or manufacture of the needed instruments and equipment. While in London he prepared his own drawings and designs, and some of the more important instruments, such as theodolites and chronometers, eventually constructed for him, bear the impress of his own inventive genius in the shape of modifications which he devised. Among these was a mammoth (by present standards) theodolite with 24-inch circle which E. Troughton, the noted instrument maker, built for him (*see* fig. 1). He collected reference books, standards of measurement, and other necessities. Caught in the War of 1812 he was unable to depart from Europe until the latter part of 1815. Upon his return to Washington, he was named head of the Survey of the Coast with the designation "Superintendent." [23]

The first field work was begun in 1816 with reconnaissance for the measurement of two geodetic base lines—one in the vicinity of English Creek, near Englewood, N.J., and the other at Gravesend Village, Long Island. Between these a small network of triangulation was extended over the bay and harbor of New York in 1817 (*see* fig. 2).[24] But the work was scarcely begun when it was suspended because of the failure of Congress to provide further funds for its continuance under the Acts of 1807 and 1816, and the Survey of the Coast was eclipsed for a period of 14 years thereafter.[25] On July 10, 1832 (4 Stat. 570),

23. The name "Superintendent" was changed to "Director" by the Act of June 5, 1920 (41 Stat. 874, 929).

24. Wraight and Roberts (1957), *op. cit. supra* note 22, at 7.

25. Dissatisfaction in Congress with the progress of the Survey—brought about by a failure to comprehend the enormity and scope of the undertaking—caused a modification of the 1807 law and took the Survey out of the Treasury Department and placed it under the Navy. On April 14, 1818 (3 Stat. 425), so much of the Act of 1807 "as authorized the employment of other persons in the execution of said act than by persons belonging to the army and navy" was repealed. The effect of this was to exclude Hassler and other civilian personnel from the work. It is an interesting but ironical commentary that within 7 months after Hassler took charge of the Survey he was requested to state "the probable time which will be required for the execution of this survey." Hassler's Administration, *op. cit. supra* note 21, at 30.

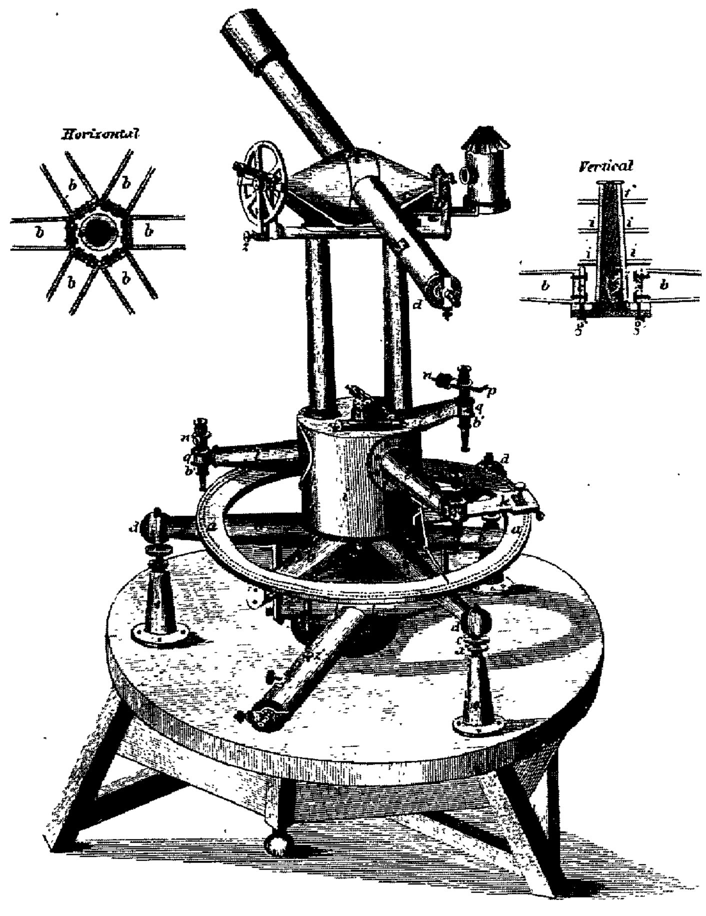


FIGURE 1.—The 24-inch theodolite used by Hassler.

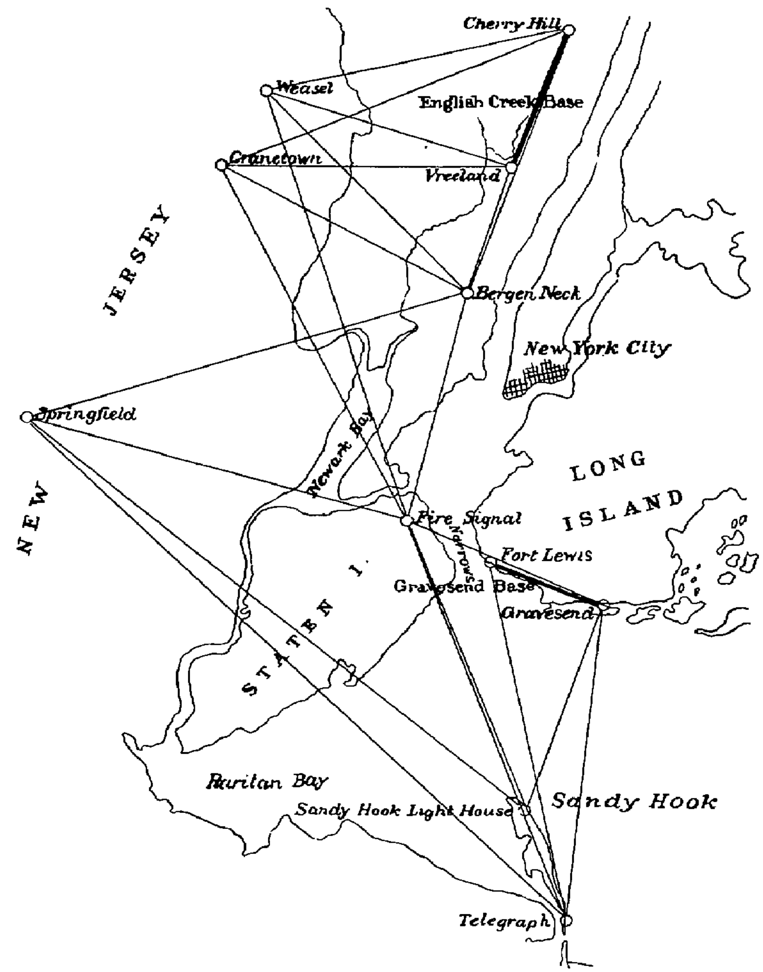


FIGURE 2.—Earliest Coast Survey triangulation, 1816–1817.

Congress revived the original act and the work was extended to specifically include the coasts of Florida. Hassler was again named to the superintendency and the Bureau placed under the Treasury Department.[26]

The first topographic and hydrographic surveys were completed in 1834 and covered the area of Great South Bay, Long Island (*see* Part 2, 43, 52). The earliest nautical chart (issued in 1835) was of Bridgeport Harbor, Conn. (*see* Part 2, 127). It was probably produced commercially on contract, and Congress had the engraving done.[27] In May 1839, the first actual steps towards copper engraving were taken in the initiation of measures for procuring plates of Hungarian copper from Vienna.[28] By 1842, a copper-plate printing press was obtained, and a chart of "New York-Bay and Harbor and the Environs" was issued in 1844 and showed the fine detail that was possible from a copperplate engraving.

## 1231. *Early Pioneers*

When one peruses the early reports of the Coast Survey, he finds a veritable bibliography of the most advanced scientific thought and achievement of the day. The names of many men of high talent and ability grace its pages—men who in one field or another have helped push forward the frontiers of science and engineering. Mention should be made of all those personalities who in their respective fields broadened the horizons of the Survey—men such as George Davidson, who authored the Pacific Coast Pilot of 1889, the most complete record of the coast ever to be published for the use of the mariner; Rollin Harris, who pioneered in the field of tidal research, and published a voluminous Manual of Tides in which a new and comprehensive theory was formulated; Henry Whiting, who served the Bureau with distinction for 59 years and whose pro-

26. On Mar. 11, 1834, President Jackson directed its retransfer to the control of the Navy Department, but this change was short lived and on Mar. 27, 1836, it was returned to the Treasury Department. Sometime between 1832 and 1845 the name of the Bureau was changed from "Survey of the Coast" to "Coast Survey." While published statements have appeared that suggest the name was changed in 1836 (*see* for example, WEBER, THE COAST AND GEODETIC SURVEY (Service Monographs of the United States Government No. 16) 4 (1923) and WRAIGHT AND ROBERTS (1957), *op. cit. supra* note 22, *at* 9), no specific directive could be found pin-pointing the year 1836 as the date of change. What seems to be rather positive is that until the Act of July 10, 1832 (4 Stat. 571) was passed, reviving the Act of Feb. 10, 1807, the name was definitely the "Survey of the Coast." Beginning with 1832, references to the name "Coast Survey" appear in official correspondence to and from Superintendent Hassler, but not consistently so (*see* HASSLER, REPORTS 1816–1843). In Nov. 1844, A. D. Bache signed his report to Congress as "Superintendent Survey of the Coast," but in his Nov. 1845 report his designation appears as "Superintendent United States Coast Survey." The latter date appears to mark a definite break with the name "Survey of the Coast."

27. Adams, *Engraved Charts,* 10 FIELD ENGINEERS BULLETIN 93, U.S. COAST AND GEODETIC SURVEY (1936).

28. Hassler wrote to the Secretary that he knew the Hungarian copper to be the best, and that it was very important to obtain plates free from any admixture of iron, which would ruin the plates by oxidation. It was not until about 1844 that the great deposits of native copper in the United States were developed for commercial use. HASSLER'S ADMINISTRATION, *op. cit. supra* note 21, at 108.

fessional excellence as a topographer was internationally recognized; Charles Sanders Peirce, who pioneered in the development and use of pendulums in gravity measurement, and who laid the foundation for the philosophy of pragmatism; Charles Schott, who for 50 years directed all the intricate computations and adjustments of field observations required in the geodetic, magnetic, cartographic, and tidal operations; and John Hayford, whose investigations of the size and shape of the earth resulted in the derivation of a new figure—the International Ellipsoid of Reference. These are only a few in a long roll—a roll of honor in the annals of the Survey.[29] But particular mention should be made of two early leaders—Ferdinand Hassler and Alexander Bache—who stand in the front rank of those who left the greatest impress on the Bureau's work during its difficult, formative period, and under whose direction the Survey evolved from a mere concept into an organizational entity with a fully developed plan of execution that became easily adaptable to a developing and expanding America. Both bequeathed to the Coast Survey a heritage of zeal and singleness of purpose that has been an inspiration to those who have followed them. The tradition of accuracy which they inaugurated has been steadfastly maintained through more than a century and a half of progressively increased activity.

### A. FERDINAND RUDOLPH HASSLER

Ferdinand Hassler (*see* Frontispiece) may rightly be regarded as the "Father of the Coast Survey," for it was to him that President Jefferson first entrusted the important task of directing the "Survey of the Coast." It was fortunate for the country in general, and for the Bureau in particular, that so farseeing a person as Professor Hassler, with the indomitable will and courage of the pioneer, was chosen to organize and direct the operations of the Survey. A student of mathematics and geodesy under Professor Tralles at the University of Bern, and associated with him as cofounder of the Geodetic Survey of Switzerland, Hassler numbered among his many friends and associates such leaders of geodetic thought in Europe as Bohnenberger, the father of the Austrian precise surveys; Gauss and Bessel, formulators of modern geodesy; and Delambre, a principal in the triangulation upon which the metric system is based.

Hassler immigrated to the United States in 1805, at the age of 35, after filling a number of the most important official positions in Switzerland, among

29. For a more extended account of these and other personalities who served with distinction in the Coast Survey and their specialized contributions, *see* Colbert, *Pioneer Personalities in the Coast and Geodetic Survey*, 3 JOURNAL, COAST AND GEODETIC SURVEY 25 (1950).

which were the office of Attorney General and member of the Supreme Court. Disturbed by the turbulent political conditions which existed in his country at the time, he organized a colony of 120 of his native countrymen, chartered a vessel for their transportation, and sailed for the United States, landing in Philadelphia in September 1805. He brought with him a remarkable collection of instruments and standards of precision, together with a mathematical and scientific library of over 3,000 volumes.

Hassler's early association with President Jefferson, Secretary Gallatin, Professor Patterson, and other distinguished scholars who composed the American Philosophical Society, gave strong impetus to the idea of a comprehensive coastal survey as an aid in the development of the country's waterborne commerce. The plan for the survey of the coast, which he submitted (*see* 123), met with the approval of eminent scientists of Europe and this country. It is a tribute to his farsightedness and his genius that his original plan of organization, broadened and thoroughly worked out in succeeding years, is still the fundamental directing plan of the Bureau.

The difficulties that faced Hassler would have completely discouraged one of less strength and fortitude. Besides those inherent in organizing so vast and pioneer an undertaking, he had to withstand much criticism heaped upon him by some politically minded men of the day who could see no need for elaborate base measurements and triangulation systems. To them, a triangulation scheme was still a "scheme" to be guarded against, and they could not understand why the survey of the coast could not be accomplished by a few astronomic determinations along salient points tied together by means of topographic surveys.

Although the need for results was urgent, the level-headed Hassler fortunately did not allow himself to be stampeded into haphazard decisions. Instead, he approached the great task scientifically and never deviated from the high standards he set for the work. He knew that the survey of the coast, if it were to have a lasting value, could not be attacked as a problem in ordinary surveying. The operations were to be bound together by a trigonometric survey, with long lines, and executed by the most accurate instruments and the most refined methods. The best of foundations was thus laid for the geodetic operations of the Bureau and for all other phases of the Survey of the Coast. Standards established by him a century and a half ago are in keeping with the exacting scientific demands of 1963. This was Hassler's great contribution. Had he planned to meet only the needs of his time, he would have effected only a negligible saving, and his work would have had to be done over at greater expense in later years. Instead, the first Hassler surveys, still form part of the primary network of the country.

Administratively, Hassler exhibited impatience with what he considered unnecessary hampering and imposing of restrictive measures in connection with the supervision and auditing of the accounts of the Survey. Consequently, much of his energy during the last years of his life was taken up with controversies over details regarding financial procedures. But Hassler's personality made an intense impression on his contemporaries. The thoroughness of the training he had received, the broad scope of his learning, and the wide range of scientific applications and employments in which he had demonstrated expert mastery, left no doubt of his uniqueness in his day and generation. This uniqueness was fittingly summed up by Rear Admiral Karo, the present Director of the Coast and Geodetic Survey, in the following words: "He [Hassler] represented that element of scientific inquiry which is eminently spiritual in nature. It is one of the few pursuits in life which gains momentum from pure intellectual expression, from a love of seeking out the truth. It is the spirit of man insisting upon squaring himself accurately with his environment." [30]

### B. ALEXANDER DALLAS BACHE

When Hassler died in 1843, the foundation for the Survey of the Coast had been laid, and the detailed surveys of the ports and harbors were begun with a survey of the approaches to New York Harbor. The building of the superstructure fell to his successor in office, Alexander Dallas Bache (*see* fig. 3). Bache was the great-grandson of Benjamin Franklin and a grandson of Alexander Dallas, Secretary of the Treasury under President Madison.

During his lifetime, Bache held many responsible positions, any one of which might have been considered the successful culmination of a life's work and ambition. As a West Point cadet, he distinguished himself by his scholastic excellence, graduating at the head of his class at the age of 19. At 22 he was named to the faculty of the University of Pennsylvania as professor of natural philosophy and chemistry. In addition to his 8 years at the university, his service to American education included the presidency of two of the country's then foremost schools (Girard College and the Central High School of Philadelphia), the general superintendency of a city school system, and the publication of a monumental work on European education resulting from 2 years of intensive study abroad.

The crowning achievement of Bache's career came on December 12, 1843, when President Tyler named him to the superintendency of the Coast Survey,

30. Karo, *Fifteen Decades of Scientific and Engineering Progress*, 13 UNION WORTHIES 13 (1958). For a comprehensive biography of Hassler, set in the context of his impact on early science in America, *see* CAJORI, THE CHEQUERED CAREER OF FERDINAND RUDOLPH HASSLER (1929).

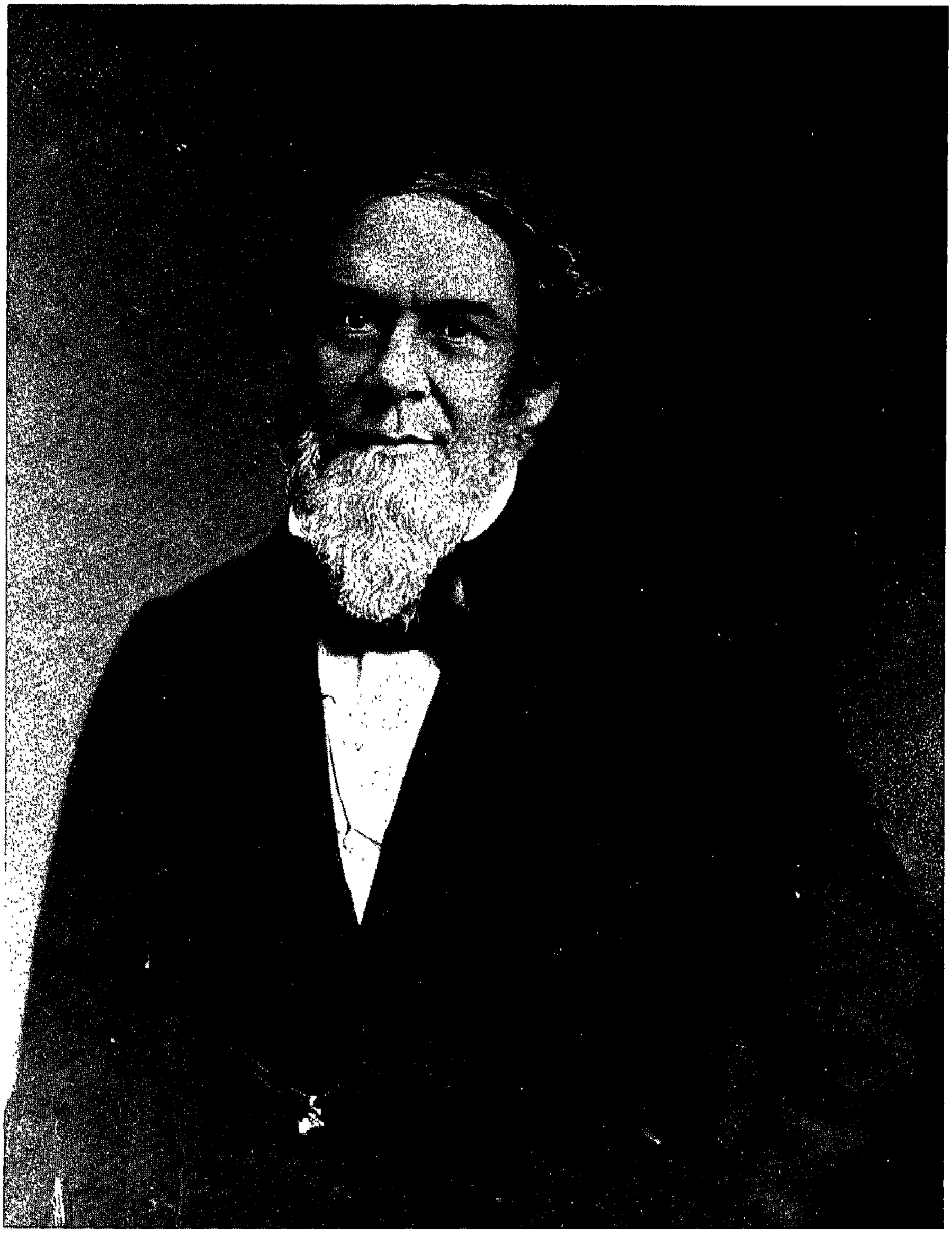

FIGURE 3.—Alexander Dallas Bache—Second Superintendent of the Coast Survey.

upon the death of Hassler. His selection had the concurrence of all the principal scientific and literary institutions of the country, and of many in Europe. It was said that no such weight of commendation was ever brought at any time in support of a candidate for office on purely intellectual grounds. Bache attained preeminence while serving as head of the Survey. He possessed by nature those qualities most conducive to success in the management of widely extended public interests. An orderly and scientific mind, combined with administrative ability of a high order, enabled him to cope successfully with the many organizational problems that faced his administration, and to govern and guide the diverse elements of the vast undertaking with tact and skill.[31] Bache's conciliatory and magnanimous nature won for him the respect and cooperation of those with whom or under whom he had to work.

But Bache too had his difficulties. More than once he was sorely beset by committees of Congress demanding to be furnished a date when the operations of the Survey would "cease and determine." Bache weathered many attacks on the floor of Congress, some of which bordered on the grotesque.[32] Congressional uneasiness was allayed with the report of the "Committee of Twenty," appointed in 1857, by the American Association for the Advancement of Science, to examine into the character and progress of the Coast Survey. The committee, consisting of leading scientists and educators, was highly laudatory of the management, progress, and outstanding achievements of the Survey. Two of the findings held special significance for the Bache administration:

> 5. This work has conferred many valuable benefits upon science, indirectly and incidentally, in the invention or perfection of instruments, in the improvement of methods of observation or of computation, in the development which it has given to special subjects of interesting inquiry, and in the stimulus which it has furnished to the scientific talent of the country, especially in the field of astronomical observation and investigation.
>
> 6. A careful study of the progress made from year to year, especially since the enlargement of the scale of operations under the present superintendent, affords ample evidence that the work has been expeditiously prosecuted, and that the amount accomplished up to the present date is materially greater than has ever been accomplished in any other country in the same length of time, and with the same means.[33]

In original concept, the plan for the Survey of the Coast was Hassler's, but Bache gave it form and direction. He adapted Hassler's plan to an expanding and developing America. The 10-year period following Bache's appointment saw more land added to the United States than in any other decade of American

31. In this characteristic, Bache was almost the antithesis of his predecessor, which perhaps accounts for his success and for Hassler's administrative difficulties.

32. One of the charges against the Coast Survey was that making astronomical observations for latitude, longitude, and azimuth at various field stations violated the provisions of the Act of 1832 against the establishment of a national observatory by the Survey.

33. Committee of Twenty (American Association for the Advancement of Science), Report on the History and Progress of the American Coast Survey 121 (1858).

history. (Texas and the whole Pacific region were added during his tenure.) Early in his administration, Bache saw that by working north and south from New York as a center, as Hassler had done, there would be a limit put on progress. His first major move therefore was to divide the Atlantic and Gulf coasts into nine sections, in each of which the essential operations were to be performed simultaneously by separate parties. This arrangement had both practical and political advantages. It permitted the production of charts of important southern harbors, in advance of the tedious process of surveying the long stretches of intervening coastline, and thus opened these ports to commerce. But of even greater benefit at the time was the support it gained from these states in Congress who hitherto had difficulty in relating the operations of the Survey to their particular needs. Before the close of the forties, field parties worked in every state along the two coasts, and the first geodetic party set out with instruments on the long journey to the Pacific coast.

Under Bache's careful guidance and sympathetic understanding, the Coast Survey not only kept pace with the progress of art and science but also made many notable and original contributions in the fields of practical astronomy, hydrography, and cartography. The whole intellectual resources of the country were made tributary to its usefulness, and Bache enlisted, either as officers of the Survey or as temporary assistants for some special assignment, such men as Agassiz, Mitchell, Walker, Peirce, Bond, Gould—all in the forefront of scientific thought. From the Army and Navy he recruited the ablest officers. These not only attained distinction in the Coast Survey, but distinguished themselves later as military and naval officers. Among them were Humphreys, Stevens, Hunt, Johnston, and Hill of the Army, and Porter, Davis, Rodgers, Alden, Craven, and Luce of the Navy.

Bache's outlook was so broad, and his interest so universal, that any aspect of the work of the Survey received his enthusiastic encouragement and support. The Horrebow-Talcott method of latitude determination with the zenith telescope received great impetus toward worldwide use through its adoption and refinement by Professor Bache. The accuracy of the results obtained was superior to that of every other field method and compared favorably with the results obtained with the largest observatory instruments. It became so intimately identified with the work of the Survey, that it was known abroad as the Coast Survey method. And within a few months after Morse flashed his first telegraphic message over the wires between Baltimore and Washington, Bache began experiments for an application of the telegraph to longitude determinations. For fixing the longitude of the United States with respect to Greenwich, the Coast Survey, during the years 1849 to 1855, instituted expeditions to exchange chronometers between Cambridge, Mass., and Liverpool, England; and upon the completion of the first transatlantic cable in 1866, a project was organized to make use of the cable to measure the difference in longitude between the two continents.[34]

The adoption and perfection of these methods of determining latitude and longitude placed this country well in the forefront of astronomic achievement, and it was freely stated at the time that geographical values of the positions of the principal astronomic stations of the Coast Survey were determined with greater accuracy than the values known for any European observatory. But astronomy and geodesy were not the only gainers of these new methods and researches. Other sciences were similarly promoted and their advancement stimulated. The range of the Survey was made to cover almost the whole range of the physical sciences. Bache's determination that the maps and charts of the Coast Survey should be carried to every man's door having an interest in commerce, navigation, geography, or science is an indication of his broad vision of the scope and purpose of the Survey.

Many studies in oceanography were undertaken. Special attention was given to an investigation of the Gulf Stream and its structure. Louis Agassiz—the great naturalist—was twice sent to Florida to study the coral reefs, their method of formation, and the laws which promote and restrict their growth. Tides and currents also received much attention, leading to the adoption of new methods and instruments. A self-registering tide gage was designed to record automatically the rise and fall of the tide. This gave the first strong impetus to the systematic study of tidal phenomena in the United States, with the result that the first published tables of tidal predictions were brought out by the Survey in 1853 (*see* 2322).

Hydrographic operations were extended and our coastal charts became fringed with soundings. The first surveys of the important Georges Bank were begun by Stellwagen; and James Alden began his surveys along the Pacific coast, following the discovery of gold in California. In nautical charting and related fields, studies were made of map projections, an electrotype process was experimented with for reproducing the original engraved copper plates, and toward the end of Bache's administration an attempt was made to print charts in color.

Nor were history and geography overlooked. Bache fostered several studies of the history of the early discoveries and explorations along both the Atlantic and Pacific coasts, notably those of Kohl (*see* Part 2, 6561).

34. Knox, *Precise Determination of Longitude in the United States*, 47 The Geographical Review 555, 561 (1957).

In short, as Superintendent of the Coast Survey, Bache was able to give full scope to his rich scientific background and to his extraordinary administrative talents in charting the course of the Survey for many years ahead. No finer tribute, in this respect, could be paid him than what was said by Benjamin Peirce, foremost American mathematician of his time, on his succession to the superintendency of the Coast Survey upon the death of Bache in 1867: "This important service originated with Hassler; but it received its efficient organization from Bache . . . . It is only necessary to conscientiously and faithfully to follow in his footsteps, imitate his example, and develop his plans in the administration of the Survey. To describe what the Superintendent should do is to simply describe what Bache actually performed . . . . I have before me the inspiration and example of my friend Bache. It is his organization. I have only to administer as he showed the way."

During the 24 years of his superintendency, Bache left an indelible impress on the Coast Survey. Both science and education have been enriched by his impact on them. His life has become an inseparable part of the history of America.[35]

## 124. Expansion and Growth

When the Survey of the Coast was first authorized in 1807, the tidal shoreline of the country comprised about 30,000 statute miles (25,000 along the Atlantic coast and 5,000 along the Gulf coast) (*see* Table 4). The activities of the Survey grew with the Nation's territorial expansion. When Florida was acquired, over 8,000 miles of shoreline were added. By the middle of the 19th century, the Texas accession was consummated, as were the cessions along the Pacific coast which later became the States of California, Oregon, and Washington, all of which added another 11,000 miles to the country's shoreline. This was followed by the purchase of Alaska in 1867 which added 34,000 more miles of tidal shoreline. The acquisition of Hawaii and of other island possessions at the beginning of the 20th century, together with the stewardship which we assumed over the Philippine Islands, further increased the shoreline to be surveyed to a total of over 110,000 miles. Bordering this extensive coastline was a belt of over 2,500,000 square miles of coastal waters that required surveys in the interest of waterborne commerce and navigation.

A major extension of the field operations of the Bureau occurred when Congress passed the Act of March 3, 1871 (16 Stat. 495, 508), authorizing a geodetic connection between the Atlantic and Pacific coasts. This was the

35. An evaluation of Bache as scientist and educator is contained in Odgers, Alexander Dallas Bache (1947).

beginning of a survey control system that eventually was to provide starting data for federal and state surveys in the interior of the country, as well as for private surveys and engineering undertakings. Originally, the geodetic surveys were made for the control of the topographic and hydrographic work along the coasts and to provide a proper tie for the nautical charts. The new authorization resulted in a great transcontinental arc of triangulation along the 39th parallel, one of the most famous arcs in the history of geodesy and at the time the longest in the world, extending over a 2,500-mile distance. This transcontinental triangulation joined the many separate systems, that had been established, into one continuous system and paved the way for the adoption of a single geodetic datum for the country (*see* fig. 4) and eventually for the whole continent—the North American 1927 Datum (*see* Part 2, 225).[36]

When Alaska was ceded to the United States, a major area of operation was opened up for the Coast Survey. This was the largest single land acquisition since the Louisiana Purchase in 1803, and represented about one-sixth the area and two-thirds the shoreline of conterminous United States. Work in Alaska was truly a pioneering effort and a constant challenge to the ingenuity of Bureau personnel (*see* fig. 5). Surveys in this northernmost outpost were begun soon after its purchase. The coastal area and the numerous intricate inland waterways were known only to a few explorers and trading vessels. Its vast interior was almost completely unknown. During the first 15 years or so of our ownership, only sporadic surveys were undertaken, aimed chiefly at tying together the positions of the various sketches of the early explorers. In 1882, the first comprehensive survey was begun. From that time on, the Bureau's work in Alaska has progressed continuously but with fluctuating tempo responding to the wax and wane of discovery and development—the discovery of gold near Juneau, the opening of the gold fields in the Klondike region, the discovery of copper in Prince William Sound and Southeast Alaska, the development of the salmon fishing industry, the beginning of the Alaska railroad in Resurrection Bay, and finally the emergence of Alaska as an important strategic region.

The last major extension of Coast Survey responsibilities occurred towards the close of the 19th century, when Spain ceded the Philippine Islands to the United States. The production of nautical charts for the islands then became the official responsibility of the Bureau. Although many maps had been produced in the years following Magellan's first visit to the islands in 1521, the

36. This added responsibility of providing geodetic control for the interior of the country was formalized by the Act of June 20, 1878 (20 Stat. 206, 215), which changed the name of the Bureau to "Coast and Geodetic Survey."

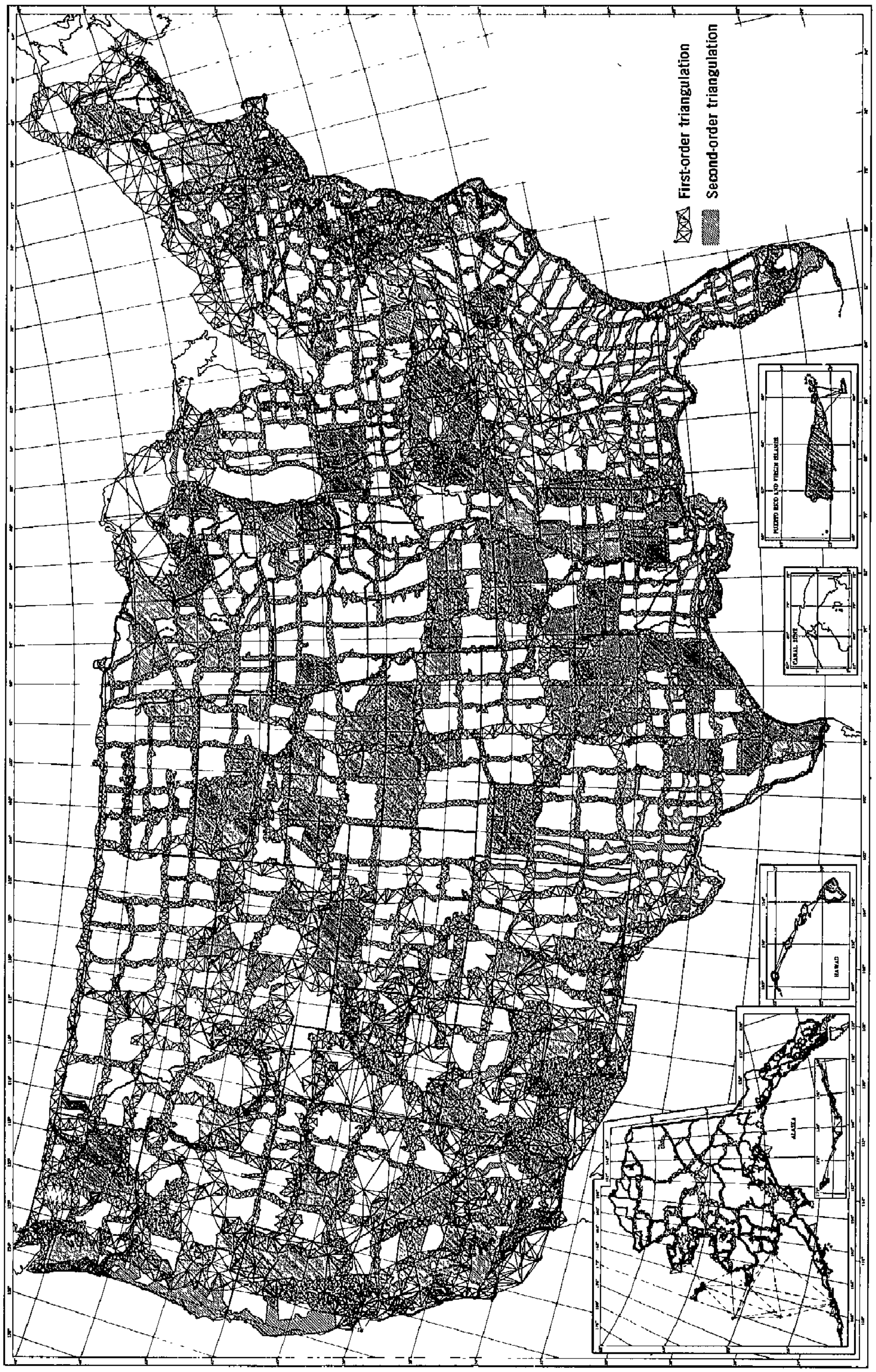


FIGURE 4.—A continuous network of triangulation provides control for mapping and engineering projects. As of May 1963, there were 170,400 permanently marked or otherwise identifiable stations in the United States.

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FIGURE 5.—Triangulation observer on Alaska mountain peak.

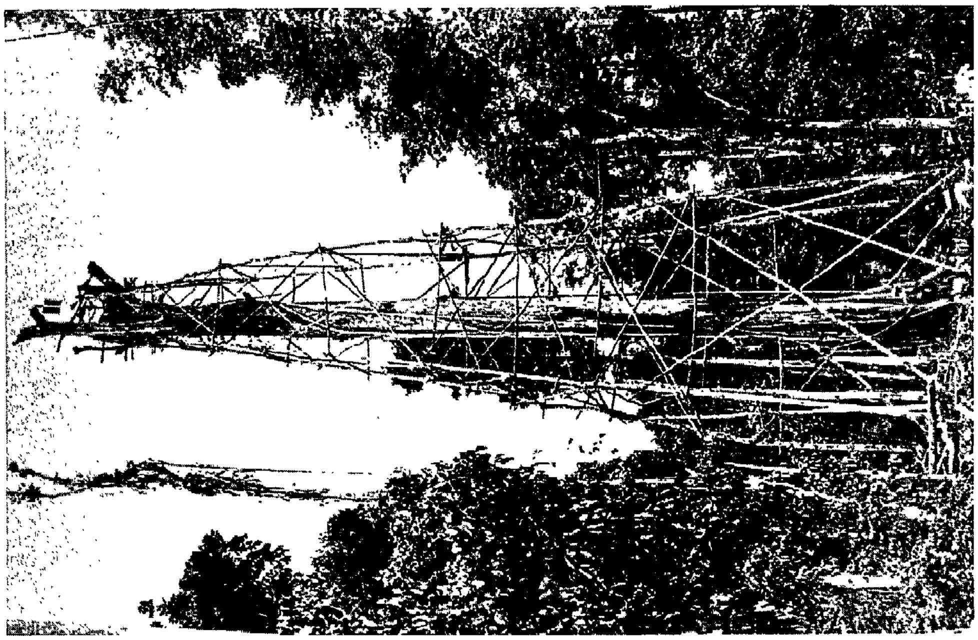

FIGURE 6.—Survey tower in the Philippine interior.

available nautical information was far from complete.[37] The magnitude of this undertaking is emphasized by the existence of 7,000 islands and rocks above water in the archipelago, comprising a tidal shoreline of 21,000 statute miles. Remote areas in the interior had to be explored for the first time in order to establish the necessary geodetic control for the surveys and charts (*see* fig. 6). It took four full decades, a considerable force of men, and a number of surveying vessels to bring the task to near completion. When the United States relinquished its stewardship over the islands, surveys of approximately 98 percent of the water and coastal areas had been completed, and the 136 Spanish charts had been replaced by a modern series of 12 general sailing charts and 152 coast and harbor charts. These had benefited the merchant marine and the Navy and advanced the economy of the Republic through the protection and aid which this work afforded for the exchange of products of the islands with the world, particularly with our own country.

## 13. SCIENTIFIC BYPRODUCTS AND SIGNIFICANT ACHIEVEMENTS

Throughout its history the Coast Survey has contributed directly and indirectly to the advancement of science and engineering. It has provided leadership in the various areas of its competence. New surveys into previously unexplored areas and continuous explorations for precision and efficiency have resulted in technical and scientific discoveries. For example, the theory that the earth was in isostatic compensation was given a quantitative test in the Bureau by a study of the differences between astronomic and geodetic determinations at numerous triangulation stations and comparing these differences with the attractive force of the surrounding topography on the plumb line. This condition of approximate equilibrium was later used to determine a more accurate figure of the earth—the International Ellipsoid of Reference (*see* Part 2, 211).[38]

A contribution of major significance to mapping and engineering was the establishment by the Bureau of systems of plane coordinates for the country. Until 1933, triangulation data were expressed in terms of geographic coordinates (latitudes and longitudes)—a universal system, especially convenient where extensive areas are involved. The Bureau recognized, however, that

37. This was contained in a collection of 136 Spanish charts of various dates and in the *Derotero del Archipielago Filipino*, or Spanish Coast Pilot. This had last been published in 1879 and was very much outdated. Deily, *The Coast and Geodetic Survey in the Philippine Islands*, 7 JOURNAL, COAST AND GEODETIC SURVEY 4 (1957).

38. This is of practical value in obtaining the highest precision in determining distances between points on the earth's surface, and in geophysical prospecting by gravity methods.

engineers and surveyors, unfamiliar with the computational methods involved, hesitated to use geographic coordinates for surveys of smaller areas, such as those performed within a state, county, or city. Considering the desirability of having all surveys, no matter how localized, tied into the federal network of geodetic control, the Coast Survey devised systems of plane coordinates for each state and developed the formulas for the transformation of geographic coordinates to their corresponding *X* and *Y* values. By these systems, surveys between points on the surface of the earth can be treated as though accomplished on a plane instead of a spheroidal surface (*see* 2113 B).

In the field of tides, a comprehensive theory of the nature of tidal phenomena was formulated during the latter part of the 19th century. This theory, developed in the Bureau and known as the stationary wave theory, replaced an older theory of a single world phenomenon, and substituted the idea of local responses in the different ocean basins to the tide-producing forces as the origin of the dominant tides in each basin. The accumulation of tidal knowledge has borne out the correctness of that assumption.

The Bureau has pioneered in the development of methods and equipment for use in hydrographic surveying at great distances from shore. These improvements have made it economically feasible to extend coastal surveys seaward to the continental shelf and beyond. This has brought to light submarine features of major physiographic significance (*see* 22), and gave a new concept of the configuration of the ocean floor. This important discovery laid the foundation for a new design in nautical charts so as to make these features available to the mariner as an aid in locating the position of his vessel (*see* Part 2, 6241). Perhaps an even more far-reaching result of extending these surveys offshore has been the discovery near the outer edge of the shelf in the Gulf of Mexico of numerous shoals bearing strong resemblance to some of the buried salt domes along the coastal plains of Louisiana and Texas, where some of the rich oil reserves are located. These preliminary indications stimulated interest among prospecting companies in search of new potential oil fields and culminated in actual exploration many miles from shore.

In the development of the Radio Acoustic Ranging (R.A.R.) method for locating a survey vessel's position far offshore (*see* fig. 7), it was discovered in the early 1930's that certain depth layers exist where the combined factors of temperature and pressure cause a velocity inversion, resulting in a channeling effect that conserves energy and sends the sound signals almost undiminished over great distances. Although the R.A.R. method was abandoned during World War II for security reasons and was later superseded by electronic methods of position determination, the basic phenomenon of a minimum-

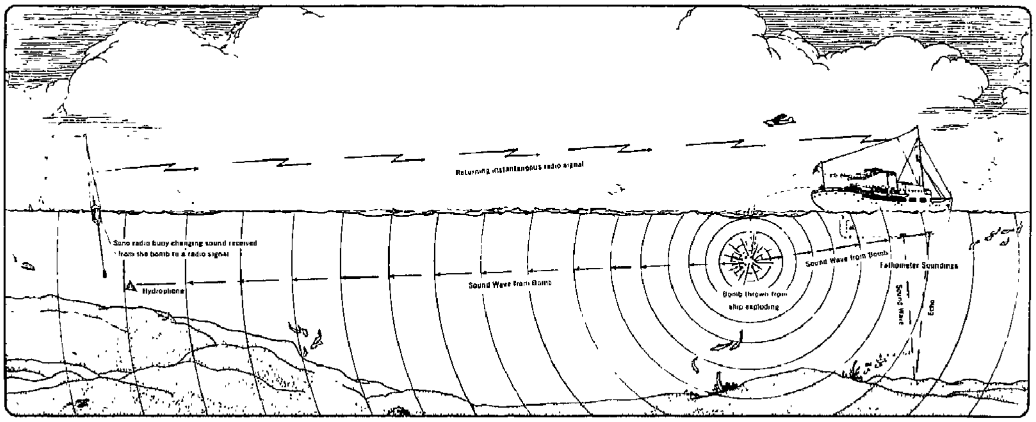


FIGURE 7.—Measuring depths and distances by sound. Radio Acoustic Ranging (R.A.R.) was a method used prior to World War II for locating a survey vessel's position far offshore.

velocity layer in the ocean was employed during the War by the U.S. Navy to develop and make operational its *Sofar* signaling system for distress calls at sea.[39]

## 14. PRESENT FUNCTIONS AND ORGANIZATION

(*a*) *Act of August 6, 1947.*—The Act of August 6, 1947 (61 Stat. 787), was the first of the recent legislation to define the functions and duties of the Coast and Geodetic Survey. It did not change previous authorizations to any great extent but eliminated a number of obsolete statutes and assembled into one place various items of substantive legislation which had been enacted at different times since 1807. The language is clear and concise and, in general, provides exact limitations. Section 1 sets forth the purpose of the act and the authority conferred upon the Director, under direction of the Secretary of Commerce, to conduct the following activities *in the United States, its Territories, and possessions:*[40]

(1) Hydrographic and topographic surveys *of coastal water and land areas (including surveys of offlying islands, banks, shoals, and other offshore areas)*;

(2) *Hydrographic and topographic surveys of lakes, rivers, reservoirs, and other inland waters not otherwise provided for by statute;*

39. For other scientific byproducts and significant achievements, see WRAIGHT AND ROBERTS (1957), *op. cit. supra* note 22, at 56–66.

40. The italicized words here and in the items that follow identify the language deleted from the 1947 act by the Act of April 5, 1960 (*see* (*b*), below).

(3) Tide and current observations;

(4) Geodetic-control surveys;

(5) Field surveys for aeronautical charts;

(6) Geomagnetic, seismological, gravity, and related geophysical measurements and investigations, and observations for the determination of variation in latitude and longitude.

Section 2 of the act provides for the processing and dissemination of the field data resulting from the activities authorized in Section 1, specifically the compilation, printing, and distribution of nautical and aeronautical charts and related navigational publications.

Section 5 authorizes such cooperative agreements with any state or subdivision thereof, or with any public or private organization or individual and authorizes the Director to receive and expend funds made available by any of them.[41]

(*b*) *Act of April 5, 1960.*—The Act of April 5, 1960 (74 Stat. 16), has for its purpose the removal of geographical limitations on activities of the Bureau, as contained in the Act of August 6, 1947 (*see* (*a*), above), in recognition of the fact that science has no boundary and in line with the new emphasis placed on worldwide oceanographic research.[42]

The full texts of the Acts of August 6, 1947, and April 5, 1960, are set out in Appendix C.

In consonance with the 1960 act, the Bureau underwent a major reorganization both in its emphasis in the areas of scientific research and oceanography and in the realignment of functions to provide for greater unity in the field of administration. These changes streamline and strengthen the organizational structure of the Bureau and are designed to meet the needs of modern science and technology.

The new organization arranges functions into logical and reasonable groups with clear-cut lines of responsibility and authority for achieving an objective. Five Offices were established, each headed by an Assistant Director, as follows: Oceanography, Physical Sciences, Cartography, Research and Development, and

41. The Coast Survey has entered into many such arrangements, one of the most recent being the low-water line survey of the Louisiana coast in cooperation with the State of Louisiana and the Bureau of Land Management (*see* Volume One, Part 2, 17).

42. In 1959, a Committee on Oceanography, working under the sponsorship of the National Academy of Sciences, submitted its report stressing the importance of an oceanwide, ocean-deep survey program through international cooperation in which the United States share would be about 30 percent. *Oceanography 1960 to 1970, 1-Introduction and Summary of Recommendations*, National Academy of Sciences—National Research Council (1959).

Administration (*see* fig. 8).[43] The following is a digest of the functions of these Offices as of March 26, 1963:

The Office of Oceanography conducts a broad and comprehensive program of collecting and analyzing oceanographic data to obtain a better understanding of the static and dynamic properties of the ocean and to disseminate such knowledge for application in charting, scientific, and defense endeavors. It plans, coordinates, and directs oceanographic surveys and supervises the analysis and processing of the resulting data; compiles and publishes tide and tidal current tables, tidal current charts, coast pilots, sea water temperature and density summaries, and other related reports, for charting, navigation, engineering, and scientific purposes; operates, jointly with the Office of Physical Sciences, the seismic sea wave warning system; studies and investigates the interrelationship of oceanic environment and meteorological phenomena; and provides the operating facilities, including ships and smaller vessels, ships' bases, and tide stations, required for the collection of oceanographic data.

The Office of Physical Sciences provides geodetic, geophysical, and cartographic data for charting, engineering, scientific, and defense purposes. It plans, coordinates, and directs the maintenance, adjustment, observations, and extension of the geodetic control network including astronomic observations and gravity surveys, and makes investigations relating to astronautics and astrophysics; plans and directs the recording and investigation of geomagnetic and seismological phenomena; operates, jointly with the Office of Oceanography, the seismic sea wave warning system; operates the latitude observatories, geomagnetic and seismological observatories and laboratories, and seismological stations; directs the photogrammetric field activities and the compilation of planimetric and topographic maps and airport obstruction charts; and plans and directs the operation of automatic data processing facilities, and office processing and analysis of survey data, including compilation, publication, and distribution of geodetic control data, and geomagnetic and seismological reports.

The Office of Cartography provides charts and related data for marine and air navigation to meet civil requirements and defense needs. It plans, coordinates, and directs the compilation and maintenance of nautical and aeronautical charts, the operation of a chart reproduction plant, and the administration of chart distribution facilities.

The Office of Research and Development plans, coordinates, and directs the Bureau's overall basic and applied research and development program in fields of interest to or within the Bureau's competence. This includes—but is not limited to—research and development in cartography, oceanography, geodesy, geomagnetism, seismology, photogrammetry, gravimetry, astronautics, and related supporting fields. It develops, applies, and disseminates resulting findings, theories, and hypotheses.

The Office of Administration provides administrative and technical services for all Bureau activities. It plans, coordinates, and directs budget and fiscal activities; civil service personnel activities; organization, management, and internal audit activities; procurement and supply activities; construction and maintenance of instruments and equipment; and library and map reference services.

Besides these operational and administrative functions, certain other functions are performed on a staff level under the Director and the Deputy Director, such as program planning and coordination, new ship design, officer personnel activities, international technical cooperation, and scientific and technical publications.

43. This is based on Department Order No. 87 (Revised July 11, 1960), entitled "Organization and Functions of the Coast and Geodetic Survey," which became operational in the Bureau on Oct. 1, 1960. Annual Report, U.S. Coast and Geodetic Survey 1 (1961). Figure 8 reflects some further changes made as a result of Department Order No. 87 (Revised Mar. 26, 1963), and other Bureau memoranda.

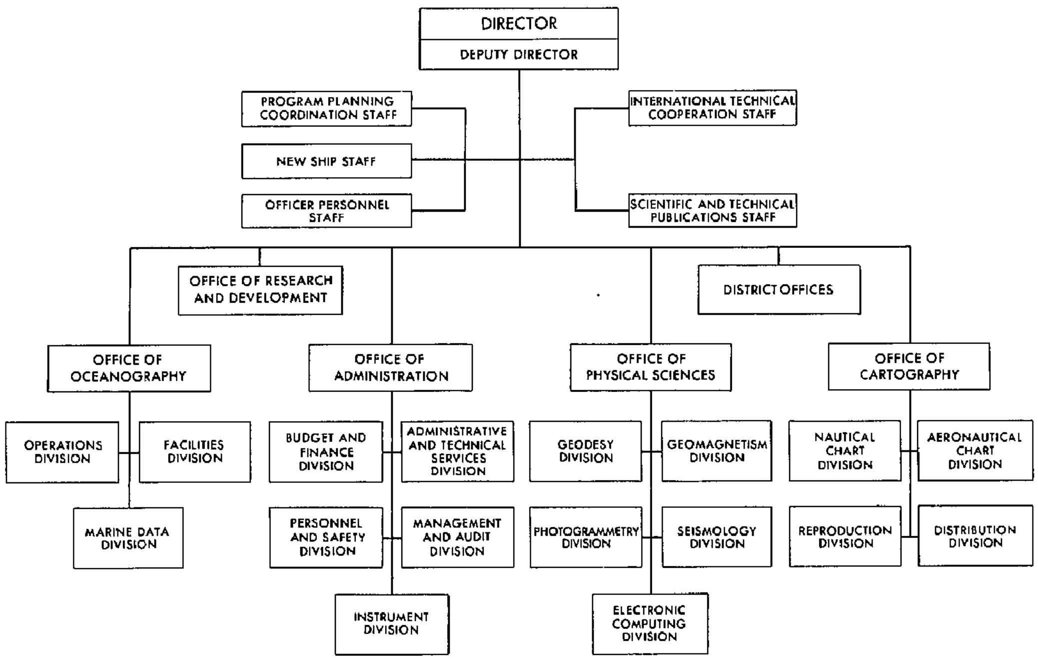


FIGURE 8.—Organization chart of the United States Coast and Geodetic Survey (to the Division level) as of July 1, 1963.

## 15. SUPERINTENDENTS AND DIRECTORS

The following is a list of all the Superintendents and Directors that have served the Bureau since its inception. The Title "Superintendent" was changed to "Director" by the Act of June 5, 1920 (41 Stat. 874, 929), during the administration of E. Lester Jones. Until the appointment of Raymond S. Patton as Director, in 1929, only three heads of the Bureau were appointed from the ranks—Carlile Patterson, Julius Hilgard, and Otto Tittmann; the other eight came from outside the Bureau. Following the establishment of a commissioned status for the field engineers, the Act of June 4, 1920 (41 Stat. 812, 825), required the Superintendent (Director) to be selected from the list of commissioned officers of the Survey not below the rank of Commander. It was also provided that while serving as Director his rank was to be that of Captain in the Navy. His present rank of Rear Admiral (upper half) was established by the Act of March 18, 1936 (49 Stat. 1164).

| *Superintendent or Director* | *Period of Service* |
|---|---|
| FERDINAND R. HASSLER | June 18, 1816—April 29, 1818 |
| | August 8, 1832—November 20, 1843 |
| ALEXANDER D. BACHE | December 12, 1843—February 17, 1867 |
| BENJAMIN PEIRCE | February 26, 1867—February 16, 1874 |
| CARLILE P. PATTERSON | February 17, 1874—August 15, 1881 |
| JULIUS E. HILGARD | December 22, 1881—July 23, 1885 |
| FRANK M. THORN | September 1, 1885—June 30, 1889 |
| THOMAS C. MENDENHALL | July 9, 1889—September 20, 1894 |
| WILLIAM W. DUFFIELD | December 11, 1894—November 30, 1897 |
| HENRY S. PRITCHETT | December 1, 1897—November 30, 1900 |
| OTTO H. TITTMANN | December 1, 1900—April 14, 1915 |
| E. LESTER JONES | April 15, 1915—April 9, 1929 |
| RAYMOND S. PATTON | April 29, 1929—November 25, 1937 |
| LEO O. COLBERT | April 8, 1938—April 7, 1950 |
| ROBERT F. A. STUDDS | May 16, 1950—July 31, 1955 |
| H. ARNOLD KARO | August 13, 1955—to date |

## CHAPTER 2

# Available Technical Data

In its long history of surveying and charting the coastal regions of the United States and possessions, the Coast and Geodetic Survey has accumulated a vast reservoir of precise facts of an engineering and scientific nature. These technical data often play an important role in the delimitation and demarcation of waterfront boundaries, and the engineer or lawyer who has to deal with such problems should have knowledge of the pertinent data available in the Bureau and have an understanding of the principles on which such data are based. The purpose of this chapter is to provide that understanding. Not all of the technical data available are described, but only those that are essential for the establishment of shore and sea boundaries with accuracy and permanence. These comprise, primarily, geodetic control data, topographic and hydrographic data, and tidal data.

### 21. GEODETIC CONTROL DATA

As its name indicates, the Coast and Geodetic Survey is the Bureau of the Federal Government which makes the geodetic control surveys. It was recognized at an early period in the history of the Survey that an undertaking of such vast magnitude could not be attacked as a problem in ordinary surveying, but had to be accomplished by methods which took into account the shape and size of the earth. Such surveys are termed geodetic surveys and represent the highest form of survey engineering. They include the determination of the latitudes and longitudes, and elevations above sea level, of numerous points throughout the country, and involve astronomic observations, measurement of base lines, and measurement of the force and direction of gravity. In addition, they include the computation and final adjustment of all field observations required for the establishment of a consistent network of marked points on a single basic horizontal control datum for latitudes and longitudes, and a single vertical control datum for elevations.

The basic geodetic networks of the country have many important uses. They serve to locate national, state, county, and private boundaries; provide rigid frameworks for all types of accurate maps, such as the topographic maps of the U.S. Geological Survey; make possible greater precision in the surveys of large cities than can be obtained by other methods; and coordinate into a single related system all local surveys connected to them, and help to assure the perpetuation of the positions of any marks established by such surveys.

Originally, the geodetic surveys in this country were made for the control of surveys along the Atlantic coast and to provide a proper base for the nautical charts of the coastal waters. By congressional action in 1871, these activities were expanded to furnish basic control for the interior of the country, including a geodetic connection between the Atlantic and Pacific coasts.[1] Since then, the Bureau has been actively engaged in extending triangulation and precise levels in the interior of the country for the purpose of establishing a federal framework on which all land surveys and engineering projects can be based.

For many reasons, it is in the best national interest to have all surveys, both public and private—no matter how localized they may be—tied in with the national control network. The extent to which this ideal is reached will depend upon the availability of control points to the local surveyor and engineer. The aim of the Bureau's geodetic program has therefore been to establish closely spaced control points as rapidly as possible, the distribution varying in accordance with the requirements of each region.

### 211. Horizontal Control Data

To span the country from coast to coast and from north to south, widely spaced arcs of triangulation were first established.[2] This gave a preliminary framework. Intermediate arcs, spaced 40 to 60 miles apart, provided control for boundary determinations and general purposes of the various states. The next logical step has been followed in the last two decades by filling in the areas between these arcs with "area" triangulation (*see* fig. 10).

An attempt is made to establish at least one triangulation station in each 7½-minute quadrangle area, with stations averaging about 4 miles along the main highways in agricultural areas and closer spacing in metropolitan areas and at towns, colleges, and airports. To coordinate local urban surveys, at least

1. Act of Mar. 3, 1871 (16 Stat. 495, 508).

2. Triangulation is a very efficient method for making surveys over extensive areas. It consists of a system of connected triangles with all angles carefully observed (*see* fig. 9), but with only an occasional length actually measured on the ground. Each measured length is known as a *base*. From these measured angles and bases, the lengths of all other sides of the connected triangles may be computed by trigonometric methods. If the latitude and longitude of one point are known, together with the azimuth to one of the other stations, the latitudes and longitudes of other points and the azimuths of all other lines may also be derived. Horizontal Control Data 1, Special Publication No. 227, U.S. Coast and Geodetic Survey (1957).

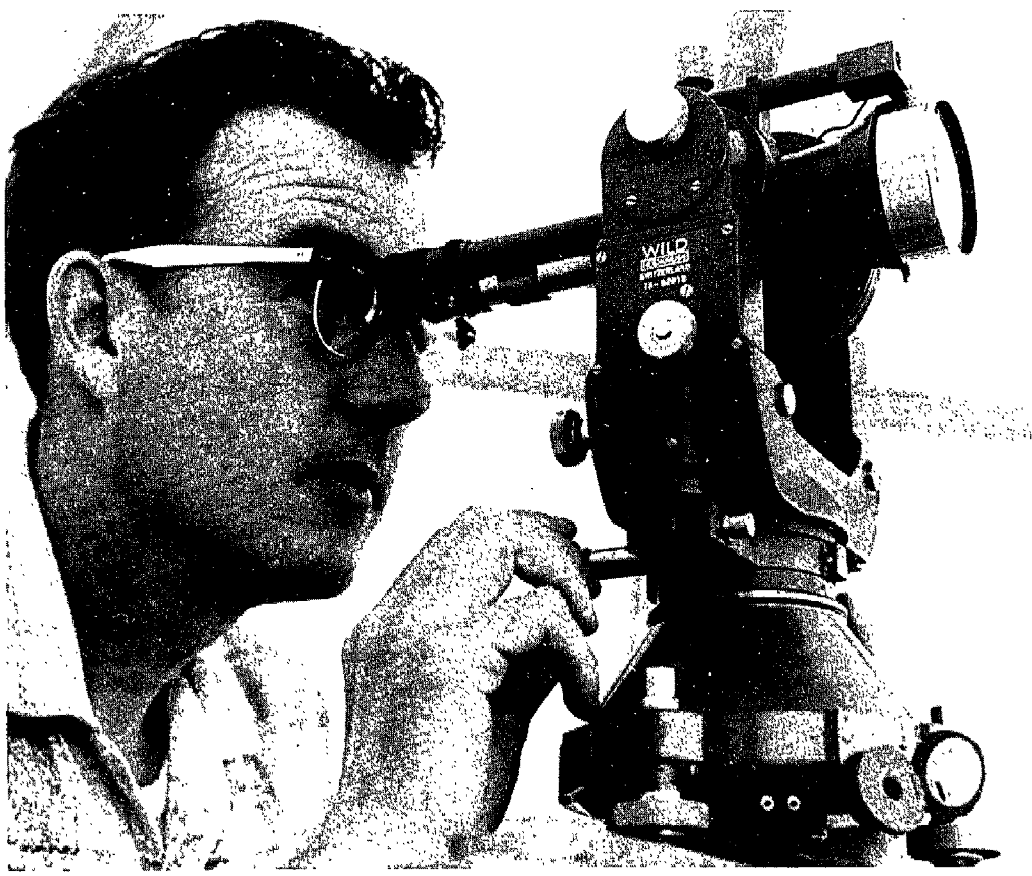


FIGURE 9.—Observer using a Wild T-3 theodolite in triangulation work.

one federal base is being established in metropolitan areas of 100,000 population or over.

### 2111. *A Network of Monumented Points*

Latitudes and longitudes have thus been determined for many thousands of marked stations scattered over the United States.[3] Surveys of small areas may be based on any of these marked points with the assurance that they will be correctly coordinated in position with all precise surveys and maps of the entire country and with all local surveys so connected. The permanency of surveys thus connected to the national triangulation network is also assured because any marked points that are destroyed may be relocated on the ground from their

3. As of May 1963, there were 170,400 permanently marked (*see* fig. 11) or otherwise identifiable stations in the United States, most of which can be used as starting points for all mapping and engineering projects in which geographic location is a consideration.

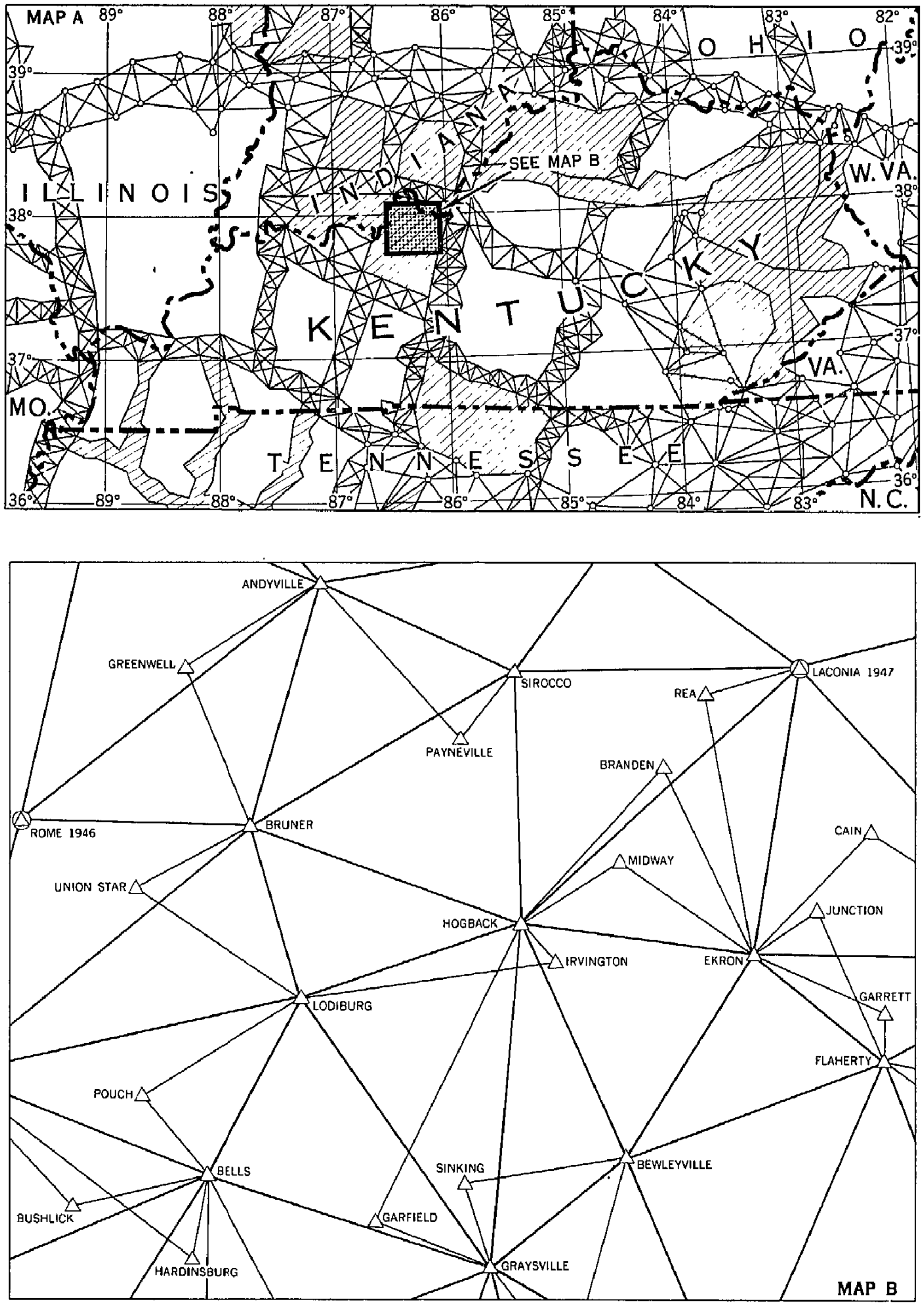


FIGURE 10.—"Area" triangulation is now used to fill in gaps between main arcs.

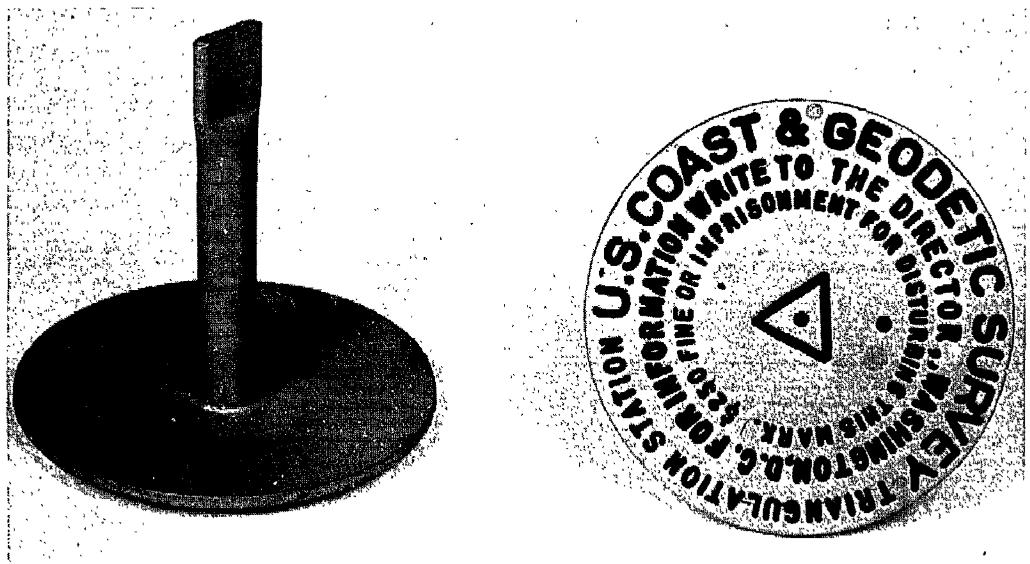


FIGURE 11.—Bronze marker used to identify a triangulation station.

relation to other marked points. To facilitate the use of the triangulation stations by local surveyors and engineers, a nearby azimuth mark is established which gives directional control and avoids the need of establishing a true meridian line.

### 2112. *Accuracy of Horizontal Control*

Control surveys are classified as nearly as possible according to the accuracy of the resulting lengths and azimuths of the lines. Since the absolute errors of these quantities cannot be ascertained, indirect gages must be used. For triangulation, the principal criterion is whether the discrepancy between a measured base and its length as computed through the network from the next preceding base is less than a certain fraction of the length of the base itself. For the basic first-order work, the computed length must agree within 1 part in 50,000, as a minimum, and should average about 1 in 75,000, or better.[4]

Another important indirect gage of the accuracy of the final results of the triangulation is the average closure of the triangles. After allowance has been made for spherical excess, that is, for the slight increase in the angles due to the spherical shape of the earth, the sum of the three angles of a triangle should be exactly 180°. The permissible variations from 180° are different for the different

4. Base lines are measured with the Geodimeter in one direction, observations being made on at least two nights. They are generally from 4 to 8 miles long with a probable error for the mean of the measurements averaging about 1 in 2,000,000.

classes of triangulation. For first-order work, the requirements are an average closure not in excess of 1 second.[5]

Although the base-to-base checks show an average discrepancy of the order of 1 part in 75,000, the loop closures developed in the 1927 adjustment of the triangulation in the United States (*see* Part 2, 225) indicate a much higher accuracy. In the adjustment of the western half of the United States, the average closure for 16 loops was 1 part in 450,000, with a maximum of 1 part in 162,000 (*see* fig. 12).[6] In the adjustment of the eastern half, the closures for 25 loops averaged 1 part in 193,000, the largest being 1 part in 94,000 (*see* fig. 12). In the figure, the number above the line is the total closure in feet; the number below the line is the approximate proportional part of the whole circuit represented by the closure.[7]

It is apparent then that for first-order triangulation involving very large loops, the average precision of the lengths of the arcs appears to be a little better than 1 part in 200,000. On the other hand, it has been found that for a small extension of triangulation in which two or more bases have been provided for length control (such as city work) it is difficult to exceed, for a certainty, an accuracy of 1 part in 100,000 as a base-to-base check.[8]

In 1960, a remarkably accurate horizontal control survey was carried out by the Bureau in east-central Florida, in connection with the test of an electronic missile-tracking device by the Air Force. The survey covered an area of approximately 4,000 square miles (*see* fig. 14), and while the requirements called for an accuracy of 1 part in 400,000, the final results indicated a probable error of 1 part in 1,300,000.[9] This project demonstrated clearly that with careful planning and great attention to details in the field, a very high degree of accuracy is attainable. It does not follow, however, as a result of this work,

5. For second-order work, the average closure does not exceed 3 seconds, and for third-order work the average does not exceed 5 seconds. A table of accuracy requirements for horizontal control, including closures and other specifications, are given in HORIZONTAL CONTROL DATA (1957), *op. cit. supra* note 2, at 10–11.

6. A more rigid test would probably be the closures of the sections forming the loops after the junction positions have been adopted, as these reflect to a greater extent the interrelations existing in the triangulation as a whole. For 42 sections (*see* fig. 13), the average closure was 1 part in 317,000, with a maximum of 1 part in 120,000.

7. The average closure for 55 sections was about 1 part in 175,000, with a maximum of 1 part in 66,000 (*see* fig. 13). In the figure, the number above the line is the total closure in feet; the number below the line is the approximate proportional part of the length of the section represented by the total closure.

8. Simmons, *How Accurate Is First-Order Triangulation?* 3 JOURNAL, COAST AND GEODETIC SURVEY 53 (1950). This paper also includes an empirical formula for determining the proportional accuracy of distances determined by triangulation. *Id.* at 54.

9. This was due in part to the numerous lines that were measured with the Geodimeter. Of the 200 lines in the triangulation net, 43 were thus measured. This was possible only because a special test demonstrated the feasibility of operating the Geodimeter from the top of a Bilby steel tower.

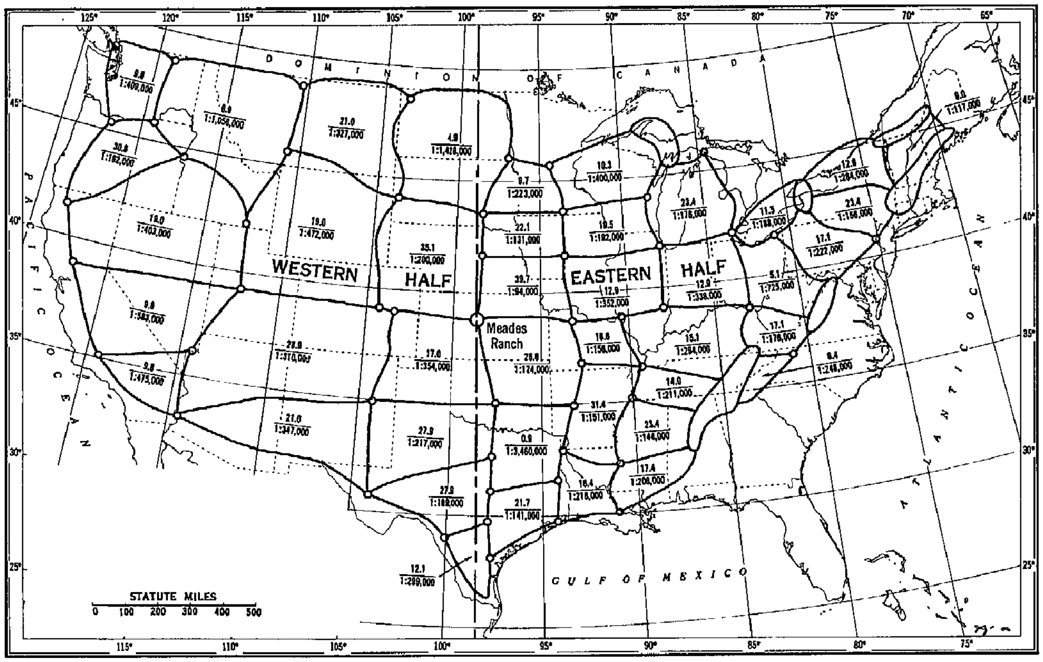


FIGURE 12.—Loop closures resulting from adjustment of the United States triangulation.

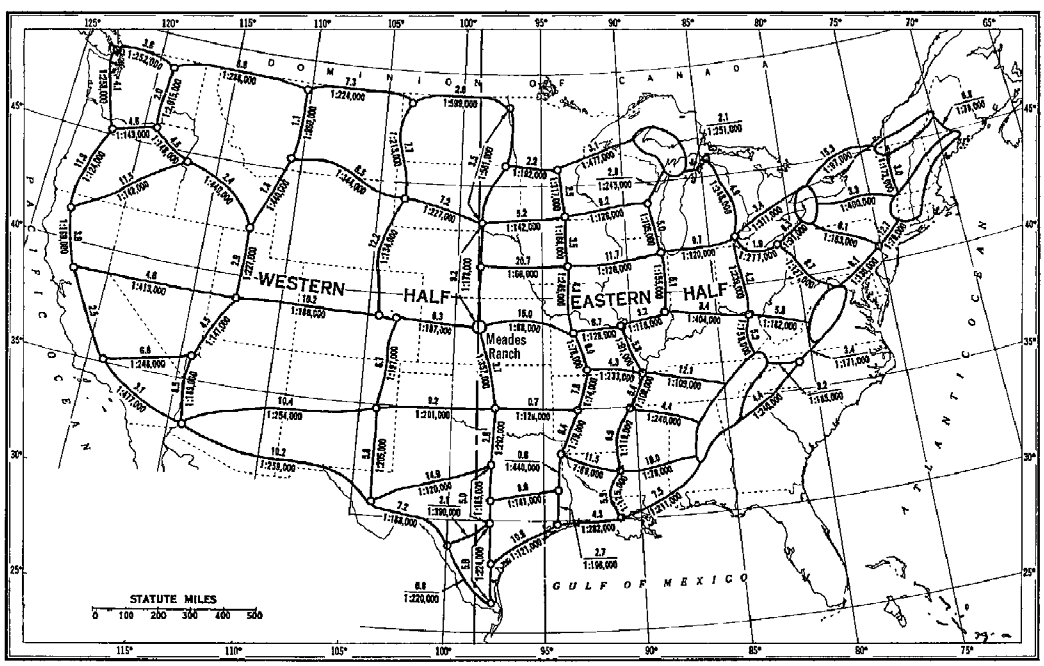


FIGURE 13.—Section closures resulting from apportionment of loop closures.

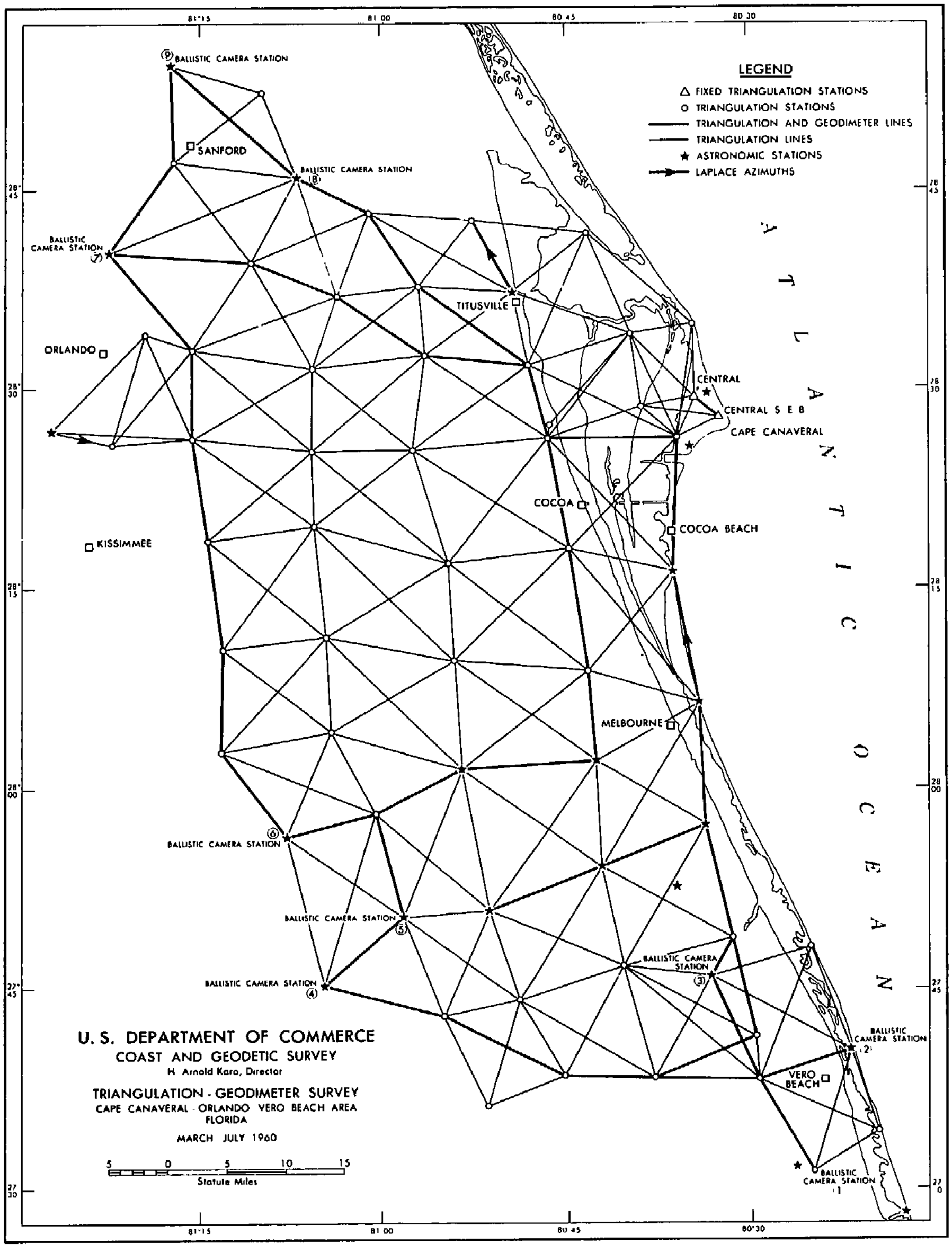


FIGURE 14.—An unusually accurate triangulation-Geodimeter survey for testing an electronic missile-tracking device. A probable error of 1 part in 1,300,000 was attained.

that comparable accuracies can be obtained everywhere. The conditions in Florida are singularly favorable to high precision of operations.[10]

## 2113. *Types of Available Horizontal Data*

The data for all triangulation and traverse stations established by the Coast and Geodetic Survey are available for the use of engineers and surveyors, either in the form of geographic coordinates or as plane coordinates.

### A. GEOGRAPHIC COORDINATES

Data defining the locations of stations in terms of geographic coordinates include their latitudes and longitudes and the lengths and azimuths of the lines between contiguous stations. In this system of computations, account is taken of the earth's curvature when extensive surveys are involved, and the computations are made on a spheroidal surface—the mathematical surface that represents the shape of the earth (*see* Part 2, 21). One advantage of this system is its universality . Each triangulation station has a definite position on the surface of the earth with reference to the equator and to the prime meridian of Greenwich. Any point located in this system is definitely related to any other point in the same system.

### B. STATE PLANE COORDINATES

Data defining the locations of stations in terms of State Plane Coordinates include their plane coordinates and the plane or grid azimuth to an azimuth mark.

For many engineering and property surveys, a rectangular system is used in which the plane of projection is a tangent plane, and the curvature of the earth is neglected. Surveys in such a system are started at a selected origin and conducted and computed as though all the observations were made on a flat surface. Such a system is adequate if it does not extend too far from the origin.

Where the survey covered a more extensive area, a system of rectangular coordinates was used in which the plane of projection was a tangent plane, but correction was made for the curvature of the earth. The plane coordinates resulting therefrom had an accuracy of 1 part in 50,000 at a distance of 25 miles from the origin of the system. The origin was usually a triangulation station whose latitude and longitude were known. In this method of computation the

10. For a detailed discussion of the planning, operations, and results of this project, *see* Simmons, *A Singular Geodetic Survey,* Technical Bulletin No. 13, U.S. Coast and Geodetic Survey (1960).

plane coordinates were derived from prepared tables.[11] As the distance from the origin went beyond 25 miles, a rapid decrease in accuracy resulted which could not be easily determined and allowed for. Where such reduced accuracy became intolerable, a new origin of coordinates had to be established, and for an extensive area even several origins were necessary, with resulting computational difficulties.

The State Coordinate Systems overcame these limitations. The unit of area became, in general, the state, and a single origin could be used which would give satisfactory results for most purposes. The systems provide the advantages of plane coordinates and at the same time make possible a perfect coordination of the work of different engineers throughout the whole region for which one system is adequate.

The establishment of a State Coordinate System not only simplifies the use of control data but it gives a permanent general grid for the whole or a large part of a state. County boundaries, township boundaries, property boundaries, intersections of roads and streets, and any prominent features of a region can be accurately located with definite $X$ and $Y$ coordinates. Such coordinates can readily be transformed into latitudes and longitudes, and any point can thus be definitely located in the network of meridians and parallels that serve to locate points on the earth's surface.[12]

In these systems two types of projections are used on which the plane coordinates are computed—the Lambert conformal conic, and the transverse Mercator which is also conformal.[13] The first is used for states whose greatest extent is in an east-west direction because the properties of this projection are such that the extent to which it can be carried in longitude is not limited and the scale on any parallel of latitude is the same throughout its entire length. The second projection—the transverse Mercator—is used for states having their predominant extent in a north-south direction.[14]

In order to avoid too great an error being introduced in the work when passing from geographic coordinates to plane coordinates, states are often divided

11. This system is fully described in REYNOLDS, RELATION BETWEEN PLANE RECTANGULAR COORDINATES AND GEOGRAPHIC POSITIONS, SPECIAL PUBLICATION No. 71, U.S. COAST AND GEODETIC SURVEY (1936).

12. The first statewide plane coordinate system was established in 1933 for the State of North Carolina. MITCHELL AND SIMMONS, THE STATE COORDINATE SYSTEMS VI, SPECIAL PUBLICATION No. 235, U.S. COAST AND GEODETIC SURVEY (1957). This publication is a manual for surveyors and deals comprehensively with the principles of the State Coordinate Systems and their use.

13. The projections are mathematical devices to permit the use of ordinary plane surveying methods and computations over much larger areas than would be permissible on a strictly local system of coordinates.

14. The transverse Mercator projection is the normal Mercator rotated through 90° so that it is based on a meridian instead of the equator (*see* Part 2, 613), thus making it an excellent projection for narrow bands extending in a north-south direction. The characteristics as to scale are identical to those of the normal Mercator, except that the scale is now dependent on distances east or west of the meridian instead of north or south of the equator (*see* Part 2, 6412).

into zones with a new origin for each zone and in such a manner that the error in any part of the system seldom exceeds 1 part in 10,000. This permits a single zone to cover a distance of 158 miles in a north-south direction on the Lambert projection and in an east-west direction on the transverse Mercator before a new origin is required. Sometimes the shape and extent of a state is such that both systems of projection are used. In Florida, for example, the Lambert projection is used for the northern part of the state, and the transverse Mercator with two zones for the southern part.

In the practical field use of state plane coordinates, the engineer needs only the plane coordinates of the triangulation stations and the plane or grid azimuth to an azimuth mark within the area covered by his survey, and need not concern himself with their conversion from geographic coordinates. These data are available to him in the Coast Survey, and are sufficient for him to run and adjust his traverse using the ordinary methods of plane surveying.

While scale errors exist in the state systems, the fact that they are based on definite projections with determinable scale factors makes it possible to bring the computations to geodetic accuracy—if such refinement should be necessary or desired—by applying corrections for scale errors and for elevation above sea level. This is not possible with a system of plane coordinates based on a tangent plane. With the limitation of error of 1 part in 10,000 imposed on the state systems, corrections for scale error can usually be ignored for ordinary surveying purposes.[15]

## 212. Vertical Control Data

The second major constituent of geodetic control data is the vertical control or leveling data, that is, the elevations of numerous marked points (known as bench marks) in the country which provide starting points for all surveying and engineering operations where elevation is a significant factor.[16]

To define completely the location of any point on the surface of the earth, it is necessary to determine not only its geographic coordinates (*see* 2113 A)

15. As of April 1963, the following 26 states had adopted legislation legalizing the use of State Coordinate Systems for boundary descriptions and other purposes (the date following the name of the state is the year of adoption): Alabama (1945), California (1947), Connecticut (1945), Delaware (1945), Georgia (1945), Indiana (1951), Louisiana (1944), Maine (1947), Maryland (1939), Massachusetts (1941), Minnesota (1945), Nevada (1945), New Jersey (1935), New Mexico (1957), New York (1938), North Carolina (1939), Ohio (1945), Oregon (1945), Pennsylvania (1937), Rhode Island (1945), South Dakota (1947), Tennessee (1947), Texas (1943), Vermont (1945), Virginia (1946), Washington (1945), Mitchell and Simmons (1957), *op. cit. supra* note 12, at II, 53.

16. Leveling, in general, may be defined as the operation of determining differences of elevation between points on the surface of the earth. It may also be considered as the determination of the elevations of such points relative to some arbitrary or natural level surface called a datum. Control Leveling 1, Special Publication No. 226, U.S. Coast and Geodetic Survey (1961).

but its elevation as well. However, it is seldom that the latitude and longitude *and* the elevation of a particular point are known. This is the result of the entirely different methods used in determining geographic positions and elevations. Triangulation stations are located on the highest and most commanding points in order that they may be visible from other similar points, whereas bench marks for which elevations are determined are usually placed adjacent to well-established transportation routes and are seldom located on summits.

In providing for the vertical control of the country, the Coast and Geodetic Survey followed a program starting with widely spaced first-order lines 100 miles apart, later supplemented by second-order lines spaced at approximately 50- and 25-mile intervals. In some regions, area leveling was established which consisted of second-order lines spaced about 6 miles apart and connected to the wider-spaced lines in a consistent network of levels. However, the Bureau's main responsibilty is to keep the 25-mile spacing net up to date, and a releveling of these lines which are 25 years or more of age is planned. Bench marks are set at 1-mile intervals along each line, except in cities and towns and in areas of vertical change studies, where the spacing averages about one-half mile. There are now (in May 1963) 187,374 miles of first-order leveling and 285,461 miles of second-order leveling in the United States and 422,619 bench marks leveled over (*see* fig. 15).

First-order leveling represents the most exact method of determining elevations. Lines are run in both directions and the two runnings must be such that in a 100-mile circuit the error of closure is on an average about 2 inches.[17] Second-order leveling is run in one direction, except where lines are 25 miles or more in length, when they are double-run. For a 25-mile circuit, the error of closure is on an average about 2 inches.

The accuracy of the leveling executed by the Coast Survey is well within the specifications adopted by the Bureau of the Budget. Its first-order work satisfies the requirements of the International Union of Geodesy and Geophysics for "leveling of high precision," while the second-order work is equivalent to that classified as "leveling of precision." [18]

17. In the Coast Survey, elevations are measured in meters above the mean sea-level surface. Afterward, when the data have been computed and adjusted, the metric elevations are converted to feet for general use. *Id.* at 1.

18. *Id.* at 4–5. Until 1922, control leveling in the Coast Survey was all first order. In 1923 and 1927, a small amount of second-order work was done. Since 1932 it has been standard practice to subdivide the areas within the loops of first-order leveling with leveling of second-order accuracy. *Id.* at 2. The classification of leveling in the Bureau and the specifications that must be met in each class are given in *id.* at 20.

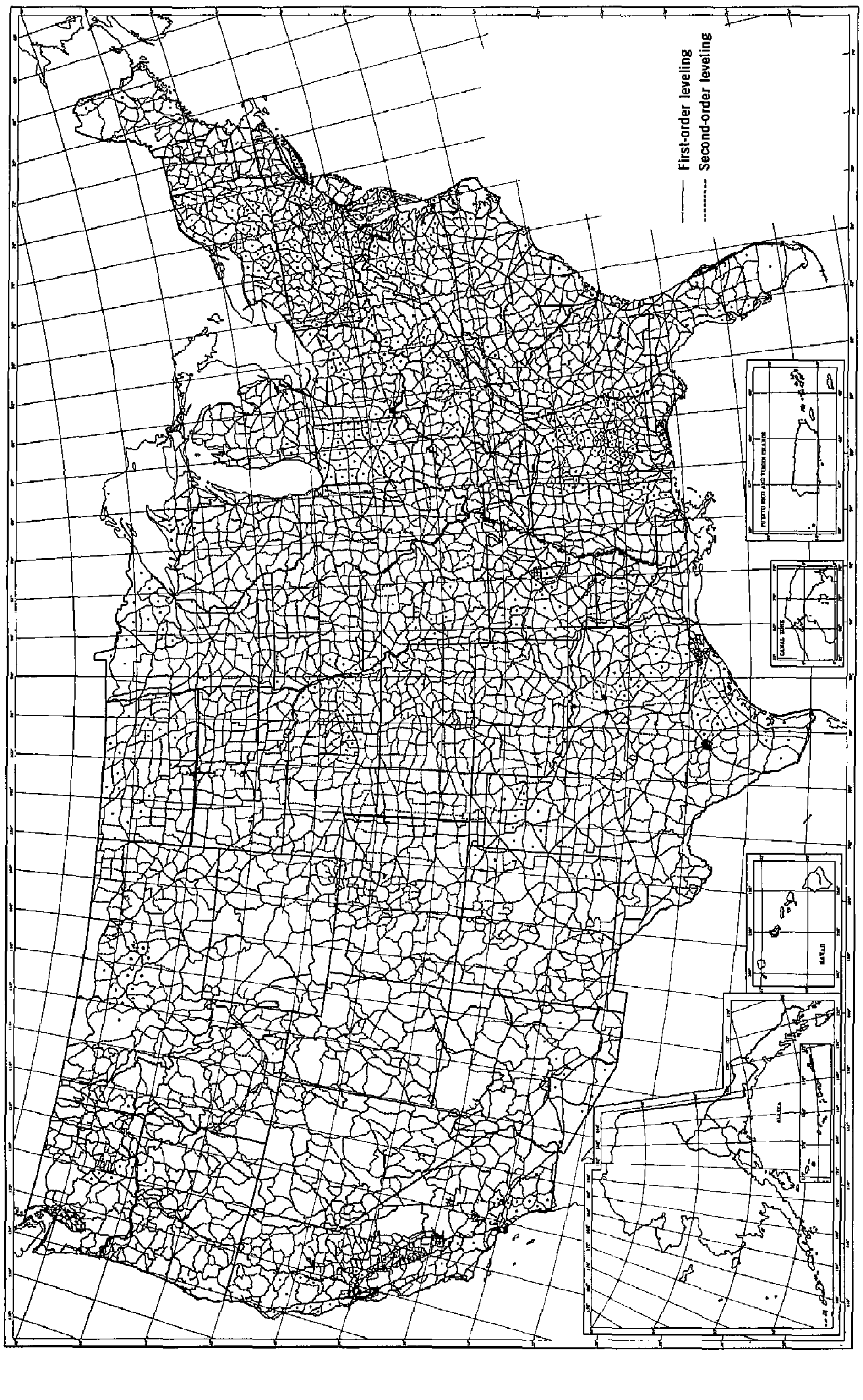


FIGURE 15.—Leveling network of the United States. As of May 1963, there were close to a half million miles of lines leveled over, and over 400,000 bench-mark elevations for use in topographic mapping and engineering projects.

## 2121. *Brief History of the Level Net*

First-order leveling was first undertaken by the Survey in 1878 when field work was begun on the line of precise levels which was to follow the transcontinental arc of triangulation extending from Chesapeake Bay to the Golden Gate, approximately along the 39th parallel of latitude.[19] The primary purpose of this first line of levels was to furnish accurate spirit level control for the vertical-angle leveling done in connection with the triangulation for use in reducing the observed horizontal directions to sea level. However, during the course of this leveling, bench marks were established at intervals of several miles and at most of the important towns along the route for the use of engineers and surveyors in initiating additional leveling on a sea-level datum. By 1899, the net had developed a total of 25 circuits, either all spirit leveling or spirit leveling between sea-level connections at tide stations. Closing errors were becoming troublesome to such an extent that an adjustment of the net was decided upon.[20]

About 1900, a new type of leveling instrument—the Fischer level—was designed in the Survey. The introduction of this instrument permitted levels of even greater accuracy to be run at much greater speed and stimulated the leveling work of the Bureau. With but comparatively slight changes, this has continued to be the standard instrument used for geodetic leveling since that time (*see* fig. 16).

During the years 1903, 1907, and 1912, adjustments in the level net became necessary in order to absorb the new leveling that had accumulated and the connections to sea level that had been made at Seattle, Wash., and at San Diego, Calif. The 1907 and 1912 adjustments were not strictly general adjustments because, after the rigid adjustments had been completed, certain areas showed such small changes from the former results that it was decided to hold fixed a considerable portion of the net as previously adjusted in order to avoid a large number of very small corrections to the elevations of the bench marks.[21]

Additional leveling was added to the net at a fairly steady rate in the decade and a half following the adjustment of 1912, but most of the new leveling fitted

19. The leveling was extended from a tide station at Sandy Hook, N.J., and elevations were published for a considerable time as "above mean tide level at Sandy Hook." RAPPLEYE, MANUAL OF LEVELING COMPUTATION AND ADJUSTMENT 1, SPECIAL PUBLICATION NO. 240, U.S. COAST AND GEODETIC SURVEY (1948).

20. The adjustment was made and the results published in the Annual Report (Appendix 8), U.S. Coast and Geodetic Survey (1899), under the title "Precise Leveling in the United States." This contained, in addition to the details of the various studies and the adjustment, the descriptions and resulting metric elevations of all bench marks established along the lines in the net. CONTROL LEVELING (1961), *op. cit. supra* note 16, at 7.

21. *Id.* at 7–8. References may be found here to the publications in which the results of the several adjustments are published.

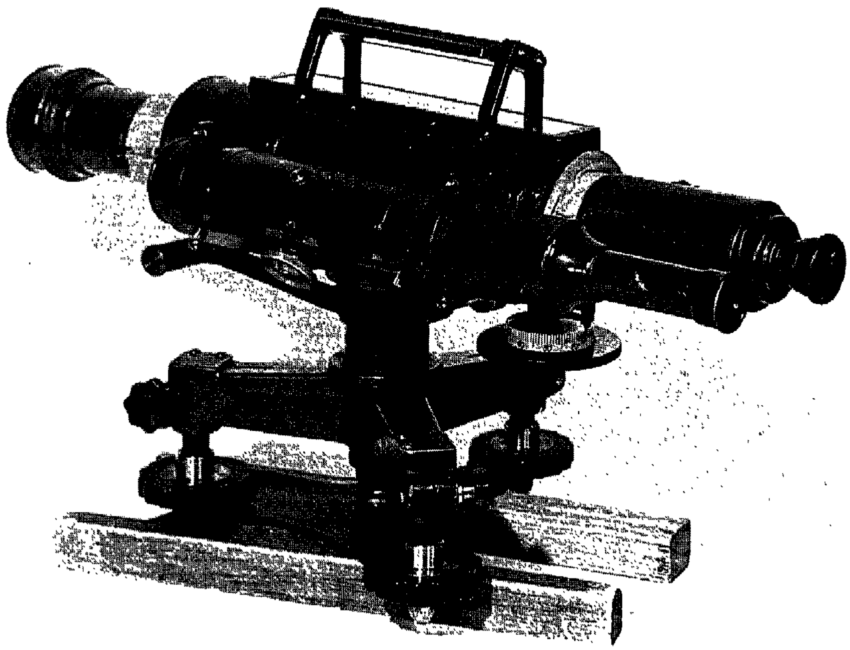

FIGURE 16.—Geodetic level used in first- and second-order leveling work. The observer is able to see the extremely sensitive bubble with his left eye and read the rod with his right eye without moving about the instrument.

into the net as adjusted without great difficulty, and it was not until 1927 that the need of an additional adjustment was felt. During this 15-year period, the only marked change in instrumental equipment was the introduction in 1916 of a new and improved type of leveling rod in which the fine graduations were placed on a strip of invar. This greatly reduced the difficulties experienced due to temperature changes and resulted in a further increase in the accuracy of the work.[22]

(*a*) *The 1927 Special Adjustment.*—In 1927, a special adjustment of the level net was undertaken. This resulted in an adjustment (for theoretical purposes) which is known as the 1927 Special Adjustment. Only the closed circuits of spirit leveling, including water leveling in the Great Lakes region, were adjusted, no sea-level connections being held fixed. After the net had been made

22. The orthometric correction to elevations, which takes into account the spheroidal shape of the earth and brings the elevations to their true heights above mean sea level, was not applied prior to about 1910. In the 1912 adjustment, it was applied only to the leveling lines west of the Mississippi River. It is now taken into account in all first- and second-order leveling. *Id.* at 9. For a complete explanation of this correction, *see* RAPPLEYE (1948), *op. cit. supra* note 19, at 43.

consistent internally by the adjustment, the difference of elevation between mean sea level at Galveston and the junction bench mark at Houston was used to determine the elevation of the latter. From that starting point the elevations of all other junction points were computed.

Using differences of elevation between the mean sea-level planes at the various tide stations and the nearest junction points, elevations were computed for the mean sea-level planes at the other tide stations. These elevations were independent of the local tide observations but were based on the mean sea-level surface at Galveston as carried to the other tide stations through the adjusted network.

The results indicated that the actual mean sea-level surface as defined by the tide observations tends to slope upward to the north along the Atlantic and Pacific coasts and upward to the west along the Gulf coast (*see* note 25 *infra*). The investigation also disclosed that sea level on the Pacific coast stood appreciably higher than that on the Atlantic coast.[23]

### A. THE 1929 GENERAL ADJUSTMENT

By 1929, the level net had been extended until it included approximately 45,000 miles of first-order leveling. Many additional tide stations had been connected to the net and a number of connections had been made to the leveling net of the Dominion of Canada. A general adjustment was therefore undertaken in order to produce the best available elevations for all bench marks and to permit the adjustment of a large amount of leveling added since 1912 without the excessive rates of correction which were sometimes necessary in fitting the new work to that already adjusted.

The adjustment was completed in 1929 and included the combined level nets of the United States and Canada. Sea level was held fixed as observed at 26 tide stations—21 in the United States and 5 in Canada. The total length of the lines of levels actually used in the adjustment was about 60,000 miles—40,000 in the United States and 20,000 in Canada. This is identified as the 1929 General Adjustment.[24]

To make a further test of the variation of mean sea level from a level surface, all closed land circuits in the combined nets and the water leveling in the Great

23. CONTROL LEVELING (1961), *op. cit. supra* note 16, at 9–10. The results of the study are found in BOWIE, GEODETIC OPERATIONS IN THE UNITED STATES 29, SPECIAL PUBLICATION NO. 134, U.S. COAST AND GEODETIC SURVEY (1927).

24. The results of this adjustment have not been and probably never will be published in a single publication. Descriptions of bench marks with their elevations based on this adjustment are published in lithographed lists by lines. The present policy is to republish all leveling data by 30-minute quadrangles. This conversion is now taking place. CONTROL LEVELING (1961), *op. cit. supra* note 16, at 10.

Lakes area were adjusted without holding any sea-level connections. Then, as in the 1927 Special Adjustment (*see* 2121(*a*)), elevations based on Galveston, Tex., were computed for the mean sea-level planes at the other tide stations. This adjustment is identified as the 1929 Special Adjustment. The results verified and extended the findings of the 1927 adjustment.[25]

### B. SEA LEVEL DATUM OF 1929

A sea level datum, as used in the Coast Survey, is a determination of mean sea level that has been adopted as a standard datum for heights. Sea level is subject to some variations from year to year, but because the permanency of a datum is of prime importance in engineering work, once a sea level datum is adopted it is generally maintained even though it may differ slightly from later determinations of mean sea level based upon longer series of observations. The sea level datum now used in the Coast and Geodetic Survey level net is officially known as "Sea Level Datum of 1929," the year referring to the last general adjustment of the net (*see* 2121 A).

As a result of the rapid expansion of the net during the years 1934 and 1935 and thereafter, together with the fact that some releveling disclosed areas where movements of marks had taken place either as a result of earthquakes or the removal of underground water, oil, and gas, or other factors, many supplementary adjustments became necessary in order to fit the new work to the old. These elevations were characterized as "Standard elevations based on the 1929 General Adjustment through the medium of the ______ Supplementary Adjustment." This caused confusion and resulted in a change of characterization for all elevations, whether based on the 1929 General Adjustment or the supplementary adjustments, and the establishment of a policy with regard to the readjustment of the net, as follows:

> Elevations based on the 1929 General Adjustment be held fixed, with some possible exceptions, and that the datum be officially designated as "Sea Level Datum of 1929." [26]

25. *Ibid.* The results of this adjustment are found in Bowie, Geodetic Operations in the United States 23, Special Publication No. 166, U.S. Coast and Geodetic Survey (1929). Both the 1927 and the 1929 Special Adjustments were based upon the best available values for sea level at the different tide stations. These were not always for the same tidal epoch. Recent theoretical studies (in 1963) using the same epoch for all the tide stations indicate a more uniform slope for sea level than was revealed by the earlier studies.

26. Control Leveling (1961), *op. cit. supra* note 16, at 11. Exceptions to this policy are (1) where releveling discloses different results from the previous leveling, and (2) where repeated relevelings are made in areas of vertical change. In the first case, a limited portion of the net is readjusted in order to avoid an undue burden being placed on the new leveling; in the second case, readjustments are made based on "anchor" marks that are indicated by the releveling as stable, and the data are published in tabular form showing the bench-mark elevations at the date of each leveling.

A special problem is presented where new tidal stations and connections have been introduced into the net. In such cases, local mean sea level is not held at zero unless the newly determined tidal plane is considered properly consistent with values held in the 1929 General Adjustment. The alternatives are either to keep readjusting the net, especially along its edges, or else to admit that an actual difference exists between the geodetic datum and the local tidal planes. The latter seems to be the only practical approach and represents the present procedure in the Bureau.

The Sea Level Datum of 1929 must not be confused with local mean sea level. While both are of tidal definition, the first is an adjusted datum arrived at by holding sea level fixed as observed at a selected number of tide stations (*see* 2121 A), whereas the second is derived entirely from observations made at the local tide station. The difference between the two may be of significance under certain conditions of foreshore slope. In the demarcation of tidal boundaries, whether it be a high-water boundary or a low-water boundary, it is the intersection of the local datum with the shore that delimits the boundary. Hence, where only a geodetic bench mark (one that is part of the national level net) is available in an area where a tidal boundary is to be established, a correction must be applied to the geodetic elevation to bring it into harmony with the local datum plane.[27]

### 2122. *Bench Marks—Descriptions and Elevations*

In the early days of the Bureau's activity in control leveling, the bench marks established along the lines of levels were of various types. Many were chiseled squares and chiseled crosses, often flanked or surrounded by lettering cut in the masonry on which the mark was established. In the period prior to 1905, small copper or bronze bolts were often leaded or cemented into masonry structures to serve as bench marks.

The first bench-mark disks or tablets of a character at all similar to those now in use were cast of bronze.[28] Bench-mark tablets have been gradually improved, the type used at present in first- and second-order leveling being a

27. This was pointed up in a case that came to the Bureau's notice where the mean high-water line was established in one of the Texas bays from a geodetic bench mark whose elevation was 2.8 feet above the Sea Level Datum of 1929. No tides had been observed at that particular place, but from tide observations and geodetic leveling determinations in a nearby bay, it was determined that local mean sea level was 0.3 foot higher than the Sea Level Datum of 1929. When this difference was applied to the elevation of the first geodetic bench mark, an entirely different mean high-water line was obtained. Neither the attorney who was handling the case nor the engineer who established the original line was aware of this.

28. At one time the Bureau used bronze caps fastened on the tops of iron pipes set in the ground, but this was soon discontinued because of the difficulty encountered from rusting at or near the surface of the ground.

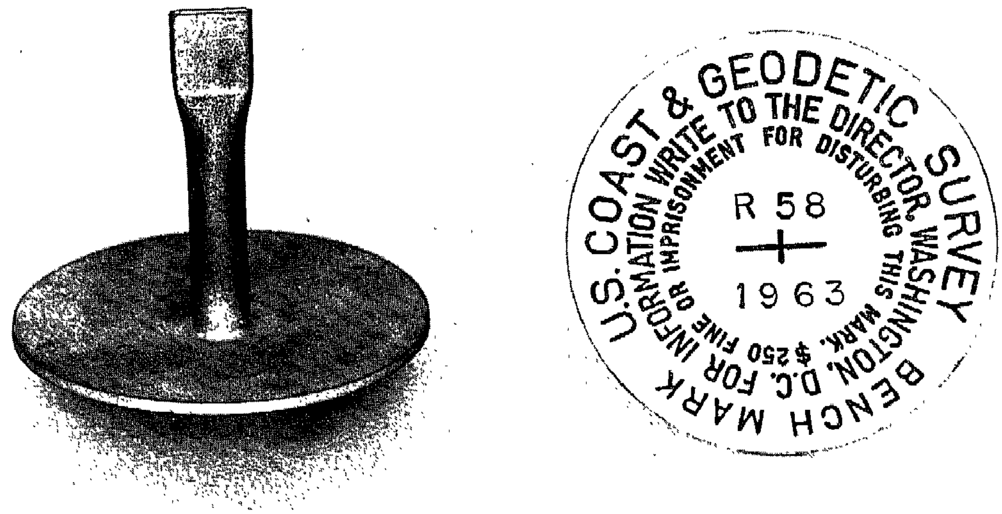


FIGURE 17.—A standard bench-mark tablet, set in masonry structures, rock outcrops, boulders, or concrete posts so that only the inscribed disk is visible.

tablet 3⅜ inches in diameter and a 3-inch shank, with the surface of the tablet slightly rounded so as to give a definite high point in the center to which the elevation is referred (*see* fig. 17). When these marks are set vertically (shank horizontal) in walls, the elevation refers to the center of the horizontal line in the center of the disk.[29]

Bench marks of the metal-tablet type have their designations stamped on them with dies. The system in use for numbering bench marks is as follows: The first mark established in a state is designated "A," the next "B," the next "C," and so on through the alphabet, to and including "Z." The next marks are stamped "A1," "B1," "C1," etc., to and including "Z1." The number is increased by one each time the alphabet is used. At first the letters "I" and "O" were used but they were so often confused with the numerals one and zero that later these letters were omitted from the bench-mark designations. In addition to these designations, the year of establishment is also stamped on the disk.

29. It was formerly the practice to stamp elevations on bench marks, but this was discontinued in Nov. 1956, except in Kentucky where the stamping of elevations was well advanced. The decision to discontinue was based upon a number of reasons among which were: changes in elevations due to earth movement, changes due to readjustments, and the difficulty of changing the stamping. *Discontinuance of Stamping Elevations on Bench Marks*, 7 JOURNAL, COAST AND GEODETIC SURVEY 120 (1957).

### 213. Index Maps and Control Survey Data

In the past, separate horizontal and vertical control index maps, indicating the locations of triangulation stations and the routes of level lines, were published by states mostly on a scale of about 1: 667,000, with large-scale insets where necessary. Beginning in 1960, these separate state maps were being replaced by a new series covering 1° of latitude and 2° of longitude on a 1: 250,000 scale, showing both horizontal and vertical control.[30] These index maps contain all the necessary information for identifying specific horizontal or vertical control data in an area, and for requesting particular control data from the Bureau. Horizontal control data available on request are the geographic positions (latitudes and longitudes) of triangulation and traverse stations, with azimuths and distances to nearby observed stations; the corresponding State Plane Coordinates in feet with plane azimuth to azimuth marks; and the descriptions for actually finding the control stations on the ground. Vertical control data available on request are the descriptions for finding the bench marks on the ground and their elevations above Sea Level Datum of 1929.

## 22. TOPOGRAPHIC AND HYDROGRAPHIC DATA

Topographic surveys of the Bureau have been used in the study of beach evolution, in the study of coastal erosion and protection, and frequently in the courts in the investigation of original land titles. Hydrographic surveys are basic tools for the geologist in his study of the origin and formation of the continental shelves and slopes.[31]

Topographic surveys of the coastal area and hydrographic surveys of the adjacent waters have been in progress since 1834 (*see* Part 2, 43, 52). In many areas, periodic surveys have been made in order to reflect the changeable nature of the coastline and the underwater topography. These represent a unique and comprehensive record of conditions as they existed at particular dates and of the changes that have occurred from both natural and man-made

30. This is a cooperative undertaking with the U.S. Geological Survey, and in most areas will show control surveys by both agencies. All Coast Survey work is shown in black and data are furnished by this Bureau. All Geological Survey control is shown in red and data are furnished by that agency.

31. A significant contribution to the study of submarine geology was made a few years ago by the Geological Society of America, when it prepared a series of submarine contour charts of the Atlantic continental shelf. These were based on detailed surveys of the Bureau and brought to light for the first time the highly dissected submarine topography of the northeast continental margin and the many submarine canyons that indent the continental slope. Veatch and Smith, Atlantic Submarine Valleys of the United States and the Congo Submarine Valley (1939).

causes. Besides their use in the production and maintenance of the nautical charts of the Bureau, these records find application in a variety of other uses by the public and by agencies of government.

Topographic and hydrographic surveys are made separately and are indexed in two parallel numbering systems (*see* Part 2, 1241). For studies of the shoreline and adjacent land areas, topographic surveys should be used; for studies of water depths, hydrographic surveys are appropriate. Scales of topographic surveys and the corresponding inshore hydrographic surveys are nearly always at either 1:10,000 or 1:20,000. Offshore hydrographic surveys are at smaller scales. A limited number in harbor areas are at 1:5,000 scale.

This section deals primarily with the general character of such surveys and the form in which the data are available; their interpretation is discussed in Part 2, chapters 4 and 5.

### 221. Topographic Surveys

Topographic surveys, as the name implies, are surveys of the topography or the land features of an area. They may vary both in coverage and in content. The area of coverage generally follows the chart needs at the time of the survey. On the early planetable surveys this varied from 1 to 10 miles. On photogrammetric surveys made from aerial photographs, coverage may extend from the shoreline inland for as much as 5 or more miles, or up to the 7½-minute quadrangle limit. Many show only the shoreline and planimetric features immediately adjacent thereto; others are complete planimetric maps; and still others are complete topographic maps.[32] From 1835 to 1927, practically all the topographic surveys were made by planetable. Since 1927, aerial photographs and photogrammetric methods have been utilized increasingly to provide the required topographic information along the coast. In recent years, most of the topographic surveys are recorded in the form of manuscript maps compiled from aerial photographs and ground survey data.

From the standpoint of waterfront boundaries, the most significant feature on a topographic survey is the mean high-water line (the dividing line between

32. Under a Memorandum of Understanding, dated Mar. 25, 1947, between the Coast and Geodetic Survey and the U.S. Geological Survey, a procedure was established whereby the activities of the two agencies would be more closely integrated so as to avoid overlapping and duplication in survey operations, but without any change in the responsibilities of either agency. To this end, it was agreed that a line be established around the coastal area of the United States, which shall, in general include the 7½-minute quadrangles touching the coastal waters. Where topographic information adequate for use in preparing nautical charts does not already exist within the area outlined, and it is determined that the Geological Survey will not be able to supply the needed information in time, the Coast Survey will make the required surveys to the inland borders of the 7½-minute quadrangles concerned. The results of such mapping are furnished the Geological Survey in a form mutually agreed upon for each particular project.

land and sea) which the topographer delineates without recourse to the running of levels (*see* Part 2, 4421). On some surveys the low-water line is also fully delineated but generally it merely represents the topographer's estimate of its location without waiting for low tide (*see* Part 2, 4461).

### 222. Hydrographic Surveys

Hydrographic surveys are surveys of the water area. They show principally the depths of water (in feet or fathoms) taken during the field survey but referred to a particular plane of reference or sounding datum (mean low water along the Atlantic and Gulf coasts, and mean lower low water along the Pacific coast). Besides the water depths or soundings, a completed hydrographic survey contains other data necessary for a proper interpretation of the survey, such as depth curves or depth contours, bottom characteristics, submerged and exposed rocks, and control stations.[33] Many of the surveys show a delineation of the zero depth curve, which corresponds to the sounding datum of the area, although surf conditions and the range of tide usually control the inclusion of such information.

Until the advent of echo sounding following World War I, inshore hydrographic surveys were made with the handlead and line or with a graduated sounding pole (*see* Part 2, 541). Since that time, some form of echo sounder (visual or graphic recorder) has been used. Today, nearly all sounding is done with a graphic recording type of instrument which traces a continuous profile of the sea bottom from which the depths to be shown on the survey sheet are scaled. Modern hydrographic surveys therefore exhibit a far more intensive development of the submarine relief than are found on the earlier surveys.

### 223. Copies of Field Surveys

Photographic copies of field topographic (planetable) and hydrographic surveys, and of topographic surveys compiled from aerial photographs, are

33. The full extent of a complete hydrographic survey may be described as consisting of a systematic coverage of the area with depth measurements (soundings) sufficient to ensure that all dangers to navigation have been found; a development of all underwater features of special significance to navigators, such as channels, reefs, banks, shoals, and characteristic submarine features; a determination of the least depths on all dangers to navigation; the location of the soundings, dangers, and submarine features so that they can be charted correctly with reference to the adjacent land features, or by latitude and longitude; contemporary tide observations from which the soundings may be reduced to a reference plane, and often for the determination of this plane; and supplemental operations to locate and obtain the descriptions of numerous features, such as rocks, reefs, wrecks, aids to navigation, and landmarks, that must be charted and described in the *Coast Pilots* published by the Bureau. Adams, Hydrographic Manual 191, Special Publication No. 143, U.S. Coast and Geodetic Survey (1942).

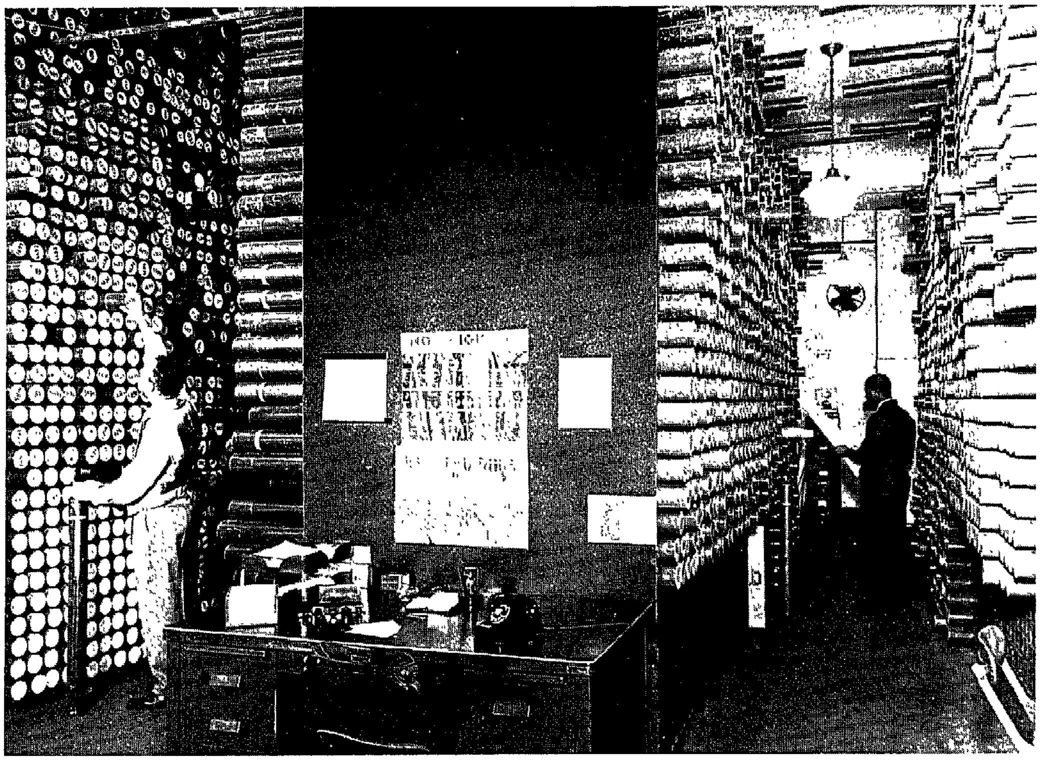

FIGURE 18.—A fireproof vault houses more than 18,000 topographic and hydrographic surveys that are used for keeping nautical charts of the Coast Survey current, and for other purposes. The earliest survey dates back to 1834.

available at the nominal cost of reproduction.[34] Photostatic copies are limited to 18 by 24 inches in size and can include only a section of a planetable or a hydrographic survey. Not more than two adjacent photostats of one survey will be made. When a copy of the entire survey is desired and it cannot be included in two photostats a bromide copy is made in one sheet.[35] A few surveys might require more than one bromide, depending on size and available negative.

A photostat is normally a negative in that the background is black and the detail is white, but the copy is otherwise correct. Positive photostats may be made from the negatives and have white backgrounds, but this is a double

34. As of May 1963, there were 5,400 planetable surveys, 8,800 hydrographic surveys, and 4,400 surveys compiled from aerial photographs on file in the Bureau archives (*see* fig. 18).

35. Photostating is a direct photographic process and no intervening film or plate is required. The bromide process requires the original to be first photographed at a reduced scale on a film or glass negative, and then making an enlargement on bromide paper to the scale desired but usually at approximately the same scale as the original. The bromide paper does not come in contact with the negative.

process. Bromides are always positive with black lines and figures on a white background. Upon request, a survey will be enlarged photographically to any scale up to twice the scale of the original or will be reduced to any scale no smaller than one-half the scale of the original.

Photographic copies of topographic surveys compiled from aerial photographs by photogrammetric methods are furnished as ozalid prints,[36] unless enlargements are requested in which case a film negative is first made and a photographic print furnished from the negative. Contact prints, reductions, and enlargements can also be furnished on materials such as the plastics to meet special needs.

Where required, certified photographic copies of original surveys for use in judicial proceedings may be obtained at a small additional cost.

### 2231. *Survey Indexes*

Two series of index sheets, which show the date, area covered, and scale of each survey, are available for the planetable and the hydrographic surveys along the Atlantic, Gulf, and Pacific coasts (exclusive of Alaska and Hawaii). An independent index series is available for the photogrammetric surveys which differentiates by color the classification of the surveys (planimetric maps, shoreline surveys, topographic maps) and furnishes information on area covered, scale, and date of aerial photographs upon which the surveys are based. Index sheets are published letter size and are available on request.

### 2232. *Aerial Photographs*

Original aerial photographs, from which the photogrammetric maps are prepared, form a valuable source of information for use in many fields of investigation. The wealth of information and fullness of detail embraced in good quality aerial photographs cannot be matched by any practical method of mapping from the ground. But aerial photographs are not maps in that they are perspectives and not orthographic projections of the ground on the spheroid of reference. To convert them to map form requires not only the use of special instruments and methods but extensive ground control as well in order to correlate the photographs with geographic position, elevation, scale, and orientation. Also, an aerial photograph never fits those on either side exactly, except over perfectly flat ground and after rectification.

36. Ozalid prints are photographic contact prints prepared in much the same manner as blueprints. The developed print shows a colored line on a white background. These prints are developed by a dry process and have a low distortion percentage.

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When used with an understanding of these limitations, they provide documentary evidence of existing conditions that would be difficult to controvert. Practically all of the coastline has been photographed several times in connection with keeping the nautical charts of the Bureau up to date.

The Coast and Geodetic Survey uses several single-lens mapping cameras and until recently made extensive use of a nine-lens camera specially designed for coastal photography. Prints of nearly all of the Bureau's aerial photography are available to the public and prices are furnished on request. Prints of nine-lens photographs are approximately 36 by 36 inches in size and have to be prepared in accordance with the scale of the aerial negatives. Ratio prints (enlargements or reductions) cannot be furnished for nine-lens photographs.

Most of the single-lens photography available at present is panchromatic photography. However, both infrared and color photography have been used in recent years and the use of color is increasing rapidly. Either contact prints or ratio prints (enlargements or reductions) can be furnished for single-lens panchromatic and infrared photography. Only contact prints can be furnished for color photography.

Aerial photography is usually indexed on 1:250,000 scale base maps, photographic copies of which are also available at a nominal cost.

## 23. TIDAL DATA

To a maritime nation like the United States with its extensive coastline, a knowledge of tidal phenomena is essential. Concentrated in the coastal areas tributary to tidal waters is a vast wealth of resources and facilities, intimately associated with and influenced by the ceaseless action of the tide. In order that these tidal movements may be better understood and utilized, the Coast and Geodetic Survey has been engaged for many years in a continuing program of tidal study and investigation. This program had its origin in the need for reducing to a common level, or datum plane, soundings taken at different stages of the tide during hydrographic surveying operations so that nautical charts will show all depths referred to a common datum. The further needs of the mariner were met with the publication of *Tide Tables* giving the predicted times and heights of the tide annually in advance. In recent years, greater emphasis has been placed on the needs of the land surveyor engaged in the demarcation of waterfront boundaries determined by tidal definition. It is with this last category that this section primarily deals, but only insofar as the data available to him in the Bureau are concerned.

## 231. The Tidal Program of the Bureau

The Coast and Geodetic Survey, as the federal agency most concerned with tidal studies, is being called upon with increasing frequency for special tidal investigations. Its tidal program must therefore be sufficiently comprehensive to serve the dual purpose of providing the tide observations and processed results for conducting its own survey operations and for meeting the additional demands for special data. This program includes the operation of a system of control tide stations at which continuous records of the rise and fall of the tide are maintained; the determination of tidal datum planes for surveying and other engineering purposes; the prediction of tides and the preparation and publication of annual *Tide Tables* in advance; the study of mean sea level and its long-period variation; the study of methods of observing tides and reducing tidal observations; and the study of tidal phenomena in general.

### 2311. *Control Tide Stations*

Any place where continuous tide observations have been taken or are expected to be taken over a number of years has been designated a *control tide station* (formerly called a primary tide station), and it is from this source that most of the basic tide data are obtained.[37] Control tide stations serve a number of purposes. They furnish data on the height of the tide at any particular time, thus permitting the determinations of mean sea level at these stations, which are then used as starting and tie-in points for the precise level net of the country (*see* 2121 A); they permit the precise determination of other tidal datum planes at these stations and make possible the correction to mean values of short-series tide observations at subsidiary stations; furnish data on the slow changes taking place in the relative elevations of land and sea; and provide the basic data for the study and advancement of the subject of tides generally.[38] The number and distribution of control tide stations depend on several factors, the more important of which are the tidal characteristics involved (type, range, interval, annual variation, etc.), the particular needs of the area for tidal data,

37. The first control tide station in the United States was established at Governor's Island, N.Y., in 1844. The tide station in longest operation is at the Presidio at the entrance to San Francisco Bay, and has continuously recorded the rise and fall of the tide since July 1897 (*see* Part 2, 543 note 36).

38. This is accomplished through the operation of an automatic tide gage that records on a roll of paper the rise and fall of the tide in the form of a curve, the abscissas of which represent the time and the ordinates the height. The Bureau is in the process of converting the majority of the tide stations so that the record will be a punched tape with readings every 5 minutes. This will take between 5 and 10 years to complete.

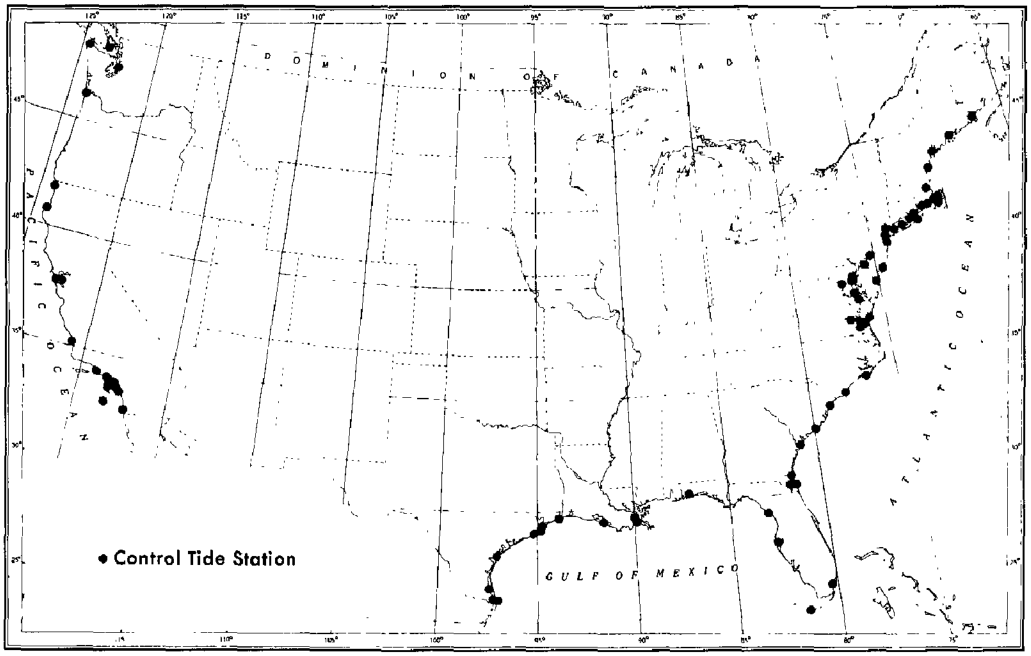


FIGURE 19.—Control tide stations in the United States (1963). These stations house automatic gage equipment that records a continuous record of the rise and fall of the tide from which most of the basic tide data are obtained.

and the facilities available for station installation and operation.[39] The principal ports and developed areas are the favored locations for the control tide stations of the Coast and Geodetic Survey, as it is here that the necessary facilities can be most readily found and the resulting tide data used to best advantage. The number of control tide stations has been gradually increased until it now (in June 1963) includes more than 100 within the United States and possessions (*see* fig. 19).

### A. THE 19-YEAR CYCLE

Although tidal constants and tidal datum planes may be established (within certain limits of accuracy) from observations extending over a month or a year, for the demarcation of valuable tidelands or for scientific purposes continuous observations extending over a period of 19 years are required. This period is generally reckoned as constituting a full tidal cycle because the more important of the periodic tidal variations due to astronomic causes will have gone through

39. The selection of sites for control tide stations on the basis of tidal characteristics alone, while an excellent procedure from one standpoint, would frequently result in locations that would be impracticable when the other two factors are taken into consideration.

complete cycles, and because the variations of a nonperiodic character resulting from meterological causes may be assumed to balance out during this epoch.[40] It is therefore customary to regard results derived from 19 years of tide observations as constituting mean values.

This, however, is not the whole answer. If the mean level of the sea remained constant over long periods of time and if the coast were absolutely stable, then sea level determined at any place from one 19-year series would be the same as that derived from another such series, even if separated by a number of years. But long-period observations indicate slow, secular changes in the relation of land and sea.[41] While averages obtained from two overlapping 19-year epochs, for example, 1924–1942 and 1925–1943, exhibit an inconsequential difference, those obtained from two independent 19-year epochs, for example, 1903–1921 and 1930–1948, may show a difference great enough to be of significance where precise determinations are required.[42] Therefore, in defining tidal datums it is necessary to identify them with a particular 19-year series. To make datums comparable at all localities the same group of years must be used. Beginning with 1943, it was in general the practice of the Coast Survey to refer tidal datum planes to the 19-year period encompassing the years 1924–1942. The 19-year period used at the present time covers the years 1941–1959.

### 2312. *Short-Series Tide Stations*

In addition to the long-series control tide stations operated by the Bureau, tidal observations are made at short-series tide stations established as a necessary part of its hydrographic survey operations in order to provide the data required both for the determination of the reference datum and for the reduction of the soundings to that datum. In planning for these surveys, the locations of the tide stations are so selected as to also provide data of general utility for other pur-

40. The 19-year cycle reflects the full effect on the time and range of the tide due to the variation in the longitude of the moon's node which has a period of 18.6 years.

41. Systematic tide observations have provided quantitative data for the study of such changes. Along the Atlantic coast, investigations indicate that in the last 40 years the relative rise of sea level has been 0.011 foot per year; along the Pacific coast, it has been 0.005 foot per year; and along the Gulf coast, based on three stations in Florida, it has been 0.011 foot per year (at Galveston, the rate of rise has been 0.021 foot per year, due probably to land subsidence in the area). On the other hand, in Southeast Alaska, a 1959 special tidal survey indicates land emergence rather than a falling of sea level, the average change being of the order of 0.05 to 0.09 foot per year (*see* Part 2, 5654 note 81).

42. At New York, sea level from the 1930–1948 series is 0.29 foot higher than from the 1893–1911 series; at Baltimore, the 1930–1948 series gives a value 0.26 foot higher than the 1903–1921 series; and at Galveston, the 1930–1948 series shows a value 0.39 foot higher than the 1909–1927 series. MARMER, TIDAL DATUM PLANES 63–64, 104–105, SPECIAL PUBLICATION NO. 135, U.S. COAST AND GEODETIC SURVEY (1951).

poses.[43] The lengths of these series depend upon the time it takes to complete the hydrographic operations in a given area. The results from such stations are brought to the equivalent of 19-year means by comparisons with simultaneous observations at suitable control stations where mean values are available from long-series records. In their corrected form they can be utilized in *Tide Tables,* tidal notes for nautical charts, and in the determination of tidal datum planes.[44]

### 2313. *Special Area Tide Surveys*

In some areas a need has developed for more detailed tidal information than is provided by the nearest control stations and by the short-series stations. To supplement these sources, special tide surveys have been made in selected areas. Originally, these surveys were limited to ports and harbors and consisted mainly of short series of observations for the verification and improvement of existing data. Later, they evolved into comprehensive regional surveys through which tide-gage records were obtained simultaneously at 10 to 20 stations for periods of a year or more. This provided data to determine the varying times and heights of high and low water at critical points. Equipment, installation, and operation were the same as at the control station. Also, the usual leveling operations at the individual stations were extended to include connection with the first-order level net, thus providing a common reference datum for correlating tidal heights and planes throughout the area of the survey. The first of such systematic surveys was begun in New York Harbor in 1922. This was the pilot project by which all others were patterned.[45] This program was discontinued just prior to World War II, and as of June 1963 had not been resumed.

### 2314. *Establishment of Bench Marks*

All along the coast, wherever tides are observed, the Coast Survey establishes tidal bench marks, the elevations of which are determined with reference

43. During the years 1954–1958, the average number of short-series tide stations established each year was 73.

44. Two methods are available for establishing tidal datum planes from short-series observations: (1) comparison of simultaneous observations, and (2) correction by tabular values. The accuracy attainable depends upon the length of the series used. The second method is used when tides are observed at a place remote from a suitable control station. However, the present network of stations assures a suitable one for use with the first method. An explanation of the methods for determining the datum of mean high water is given in MARMER (1951), *op. cit. supra* note 42, at 87–95.

45. MARMER, TIDES AND CURRENTS IN NEW YORK HARBOR, SPECIAL PUBLICATION NO. 111, U.S. COAST AND GEODETIC SURVEY (1935). The following area surveys have been completed and the results included in special publications: Portsmouth Harbor; Boston Harbor; Narragansett and Buzzards Bays, and Nantucket and Vineyard Sounds; Long Island and Block Island Sounds; Hudson River; Delaware Bay and River; Chesapeake Bay; San Francisco Bay; and Southeast Alaska.

to the planes of local high water, mean sea level, low water, and other tidal planes. The practice is to establish three or more such marks for any series of observations, no matter how short. The zero of the tide staff is connected by spirit levels to these marks. This makes it possible to replace the staff at the same elevation during the progress of the observations, should it become destroyed or should its elevation be changed by accident. The bench marks also serve the further purpose of preserving for future use the datum planes that are determined from the tidal observations.[46] The standard tidal bench mark of the Bureau consists of a brass disk, about 3 inches in diameter, with a shank about 2½ inches long for insertion into a building or other substantial support.[47] Since bench marks are subject to disturbance and destruction through construction or building activities and the operation of natural forces, the Bureau conducts a bench-mark recovery program for periodic inspection of these marks. Where necessary, new bench marks are established and descriptions of existing bench marks revised.[48]

A complete record is kept of each tidal bench mark, including its original and revised descriptions, dates of establishment and recoveries, and its elevations referred to the tide staff for each successive leveling connection. For the control stations, where leveling connections between staff and bench marks are checked periodically, compilations are prepared showing the relative elevations of the different bench marks for each leveling operation. These compilations provide information on the relative stability of individual bench marks, indicating those that are most suitable for long-period reference and others that must be replaced as too unstable to fulfill their function. To permit datum correlation of surveys of different dates, a record is kept that shows for each hydrographic survey the relation of the reference datum to the tide staff and specified bench marks.

## 232. Engineering Aspects of Tides

The rise and fall of the tide is a continuing phenomenon and varies from day to day and from place to place. Thus, at New York the mean range is about 4.5 feet while the maximum range may be 7 feet. At the Atlantic entrance to the Panama Canal the range is less than a foot while at the Pacific

46. The bench marks and zero of the tide staff are connected by a double line of levels run in opposite directions. Coast Survey instructions prescribe that the forward and backward differences in the elevations of two tidal bench marks must not differ by more than 0.035 $\sqrt{K}$ feet, $K$ being the distance in statute miles leveled between the two bench marks. MARMER (1951), *op. cit. supra* note 42, at 25.

47. The same type of disk is used for the tidal bench marks as is used in the vertical control network (*see* fig. 17). The year of establishment is stamped on the disk, as is the identifying number, but the latter follows a different numbering system from that used in the vertical control.

48. Many of the earlier tidal bench marks were of such temporary nature that they were not long recoverable and the planes that they originally referenced can no longer be positively identified.

entrance it averages 12.5 feet. On the other hand, at Anchorage, Alaska, a rise and fall of approximately 35 feet may be encountered on certain days.

Tides also differ in the character of the rise and fall. At New York, for example, there are two tides a day of approximately equal range; at San Francisco, there are two tides a day of unequal range; and at Pensacola, there is but one tide a day.

These and other aspects of the tidal phenomenon are matters which the engineer must take into account in planning or designing waterfront structures or in establishing waterfront boundaries based on tidal definition.

### 2321. *Establishment of Datum Planes*

The simplicity of its definition, the accuracy of its determination, and the certainty with which it may be reproduced at some future time, give value to the tidal datum as a plane of reference. There is no one natural or basic tidal datum, although the datum of mean sea level is frequently so designated because it is the plane about which the tide oscillates. There are a number of datums which may be derived from tidal observations, the selection of the most satisfactory one being dependent upon the specialized purpose which the datum is to serve and the type of tide existing in a particular locality.

In its work along the coasts of the United States and in the interior of the country, the Coast Survey utilizes the following principal tidal datums: mean sea level, mean high water, mean low water, and mean lower low water. In addition, it recognizes the tidal datums of mean higher high water, and half tide level, or mean tide level, as of value to the engineer and foı which the relationship to the other datums is determined (*see* 2332).

#### A. MEAN SEA LEVEL—A BASIS FOR THE LEVEL NET

Sea level as a basis for the level net of the country has been previously discussed. It was pointed out that the Sea Level Datum of 1929, on which the elevations in the interior are based, is an adjusted datum and may differ from local mean sea level (*see* 2121 B).

Mean sea level at any place is the mean level of the sea at that place. It is the primary tidal datum plane and may be defined as the average height of the surface of the sea for all stages of the tide for a 19-year period, usually determined from hourly height readings.[49] Sea level is the level of the sea from which the tide rises and falls, that is, it is the level of the sea freed from the rise and fall

49. Mean sea level is generally assumed to constitute an equipotential surface, but as derived from tide observations at different places it deviates somewhat from such a surface because of the effects of winds and variations in barometric pressure. A wind blowing from the sea—an onshore wind—tends

of the tide. Or stating this in another way, the daily rise and fall of the tide, which is of astronomic origin, is superimposed upon the daily variation in sea level brought about primarily by changing meteorological conditions. It is important that this concept be kept in mind (*see* fig. 20).[50]

In order to distinguish the average level to which the sea rises during various periods from *mean sea level,* sea level derived from observations extending over a period of 1 day, 1 month, 1 year, is referred to as daily, monthly, and annual sea level, respectively. At any point on the coast, sea level varies from day to day, from month to month, and from year to year. From one day to the next, sea level may vary by a foot or more, and within the same year two values of daily sea level may differ by 5 feet or more. Monthly sea level is subject to variations of both periodic and nonperiodic character so that within a year, sea level for two different months may differ by as much as a foot. Yearly values may differ by as much as one-tenth or two-tenths of a foot from one year to the next and in addition may be subject to a slow progressive rise or fall. The term *mean sea level* is reserved for the value obtained from averaging the hourly height values of the tide over a period of 19 years, this being considered as constituting a full tidal cycle and is regarded as a primary determination (*see* 2311 A).[51]

Observations covering a period of 19 years are obtained at but relatively few places along the coast. At all other places where mean sea level is required, satisfactory secondary determinations can be made by means of observations covering much shorter periods, if the results are corrected to a mean value by comparison with the determination at some suitably located control tide station. The precision with which mean sea level can be derived by this method depends upon the length of the series used in the comparison. In general, it may be taken that mean sea level determined from 1 day of observations will give a value correct to within 0.25 foot; 1 month, to within 0.1 foot; and 1 year, to within 0.05 foot.[52]

to raise the level of the sea along the coast; while a wind blowing from the land—an offshore wind—tends to lower it. This wind effect is brought about not by any effect on the tide-producing forces, but by the effect of the wind on the level of the sea; the amount of tidal rise or fall is changed by the wind only as this rise or fall takes place from a higher or lower level of the sea. The effect of variations in barometric pressure is to depress the level of the sea with a rising barometer and to raise the level with a falling barometer, the water thus behaving approximately as an inverted water barometer.

50. From this it follows that changes in sea level are independent of the range of tide. It is sometimes assumed that at stations having a large range of tide greater variations in sea level are to be expected than at stations having a small range. That there is no basis for this assumption is brought out by the fact that at Boston the range of tide is more than twice that at Atlantic City, yet the magnitude of the changes in daily sea level is much the same at both places. MARMER (1951), *op. cit. supra* note 42, at 49.

51. *Id.* at 63. For a detailed discussion of mean sea level in general, and daily, monthly, and annual sea level at various points along the coasts of continental United States, *see id.* at 45–63.

52. *Id.* at 65–67. A 3-year period has been found to give a value correct to within 0.03 foot, and 9 years to within 0.016 foot.

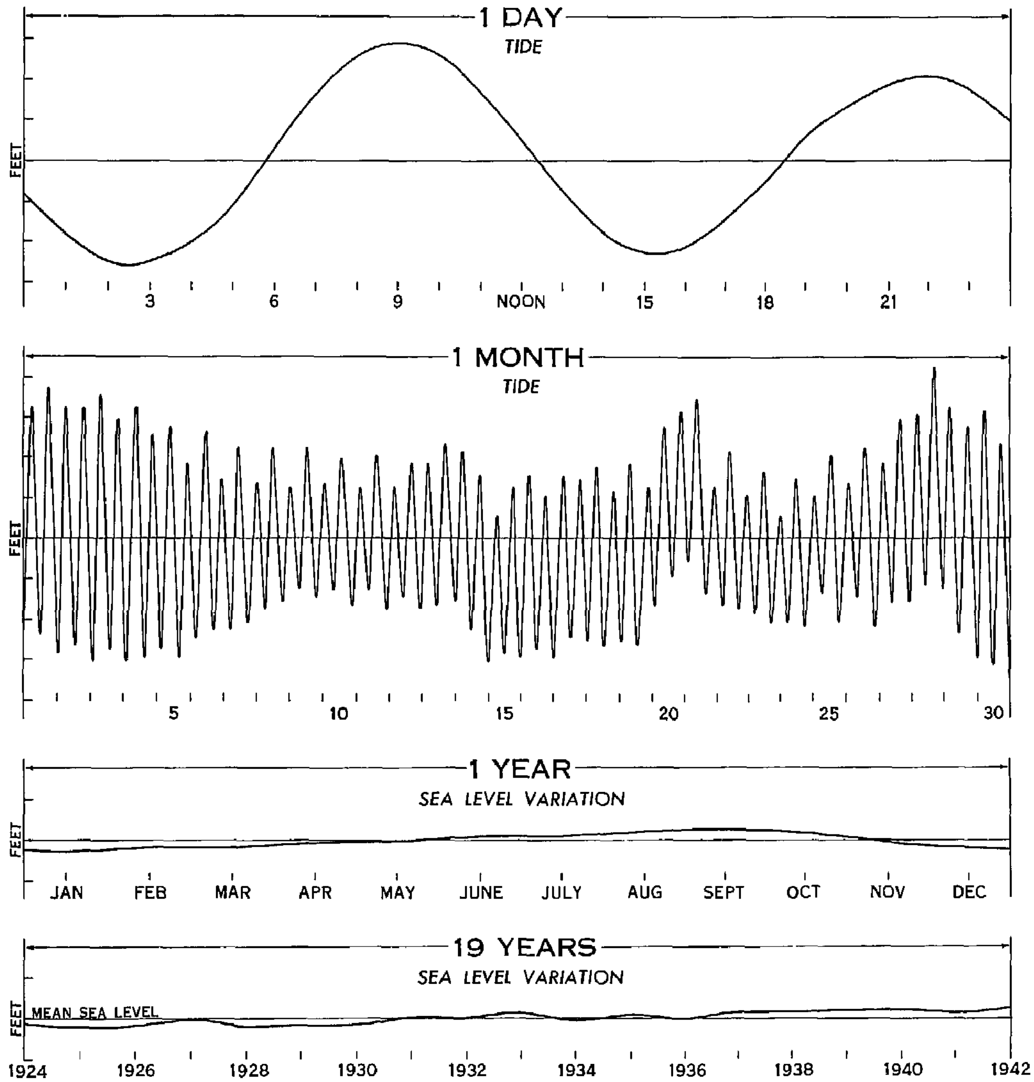


FIGURE 20.—Sea surface variation from Coast and Geodetic Survey tide station at Atlantic City, N.J.

### B. OTHER DATUM PLANES

Besides the datum of mean sea level, other datum planes are established from tide observations for use on the surveys and nautical charts of the Coast and Geodetic Survey, and for boundary purposes.

(*a*) *For Shoreline and Alongshore Features.*—Along all coasts, the datum of mean high water is used as the plane of reference for the shoreline—the dividing line between land and sea—and for elevations of alongshore features on the topographic surveys and nautical charts of the Coast Survey.

(*b*) *For Soundings on Surveys and Charts.*—As a reference plane for soundings on the hydrographic surveys and nautical charts of the Bureau a low-water datum is used because of its practical utility to the navigator. The aim is to provide him with a margin of safety consistent with prevailing conditions. From the standpoint of navigation, the critical part of the tidal cycle is at the time of low water. At such time, depths in a channel or over a shoal area are at a minimum. If a datum higher than low water were to be used as a reference plane, depths shown on the nautical charts would be greater than actually exist at the time of low water. This might result in giving the mariner a false sense of security, particularly in areas where the controlling depth approaches the draft of his vessel. Another practical advantage of a low-water datum is that tidal corrections given in the *Tide Tables,* which the mariner uses in conjunction with the chart to find the depth at a specified time and place, will be mostly additive values. It is for these reasons that low-water datums have been adopted for the nautical charts of the Coast Survey.

But even low-water datums differ on the different coasts of the United States, depending upon the prevailing type of tide. Along the Atlantic coast, where the tide is of the semidiurnal type with two tides a day of approximately equal range and successive low waters differ but slightly, the adopted datum is mean low water, which is the mean of all the low waters in a given area. This also applies to the Gulf coast where the tide is predominantly of the diurnal type with but one high and one low water in a tidal day. On the Pacific coast, where the tide is of the mixed type with two tides a day of unequal range and successive low waters exhibit a marked inequality, the adopted datum is mean lower low water, which is the mean of the lower of the two low waters each day.

The advantages of using a mean lower-low-water datum over a mean low-water datum for Pacific coast charts are similar to those described above for low-water datums. The important point to keep in mind is that the selection is dictated by the practical needs of navigation. Its use should be so appraised.[53]

(*c*) *For Riparian Boundaries.*—Boundaries determined by the course of the tides involve two engineering aspects: a vertical one, predicated on the height reached by the tide during its vertical rise and fall, and constituting a tidal plane or datum; and a horizontal one, related to the line where the tidal plane

53. The datum of mean low water along the Pacific coast and in Alaska is not to be confused with the datum of mean lower low water. The first is the mean of all the low waters (higher lows and lower lows) occurring each tidal day over a period of 19 years; the second is the mean of only the lower lows over the same period. The two are technically distinct datums and cannot be equated any more than mean high water can be equated with mean higher high water.

intersects the shore to form the tidal boundary desired. In this section only the vertical aspect will be considered.

As a basis for riparian boundaries determined by tidal definition, the datums of mean high water and mean low water are the ones generally encountered.[54] High water and low water are subject to periodic variations from day to day, from month to month, and from year to year. In addition, they are subject to the nonperiodic variations found in sea level (*see* 2321 A).

In view of these variations, the datum of mean high water at any place may be defined simply as the average height of the high waters at that place over a period of 19 years; and the datum of mean low water as the average height of the low waters for the same period. In tides of the semidiurnal and mixed types no problem arises in determining either of these datums from the definition stated. But in applying the definition to tides which are predominantly diurnal—as is the case with tides in the Gulf of Mexico—the question arises whether to include or exclude from the tabulations the secondary tides which occur every fortnight and the tide curve exhibits two high and two low waters during a tidal day. These secondary tides have small ranges and are frequently difficult to detect on the tide record because of the disturbing effects of wind and weather. Therefore in tabulating tides of the diurnal type the secondary tides are completely disregarded in determining the datums of mean high water and mean low water, and on the days when two tides occur only the higher high water and the lower low water are used.[55]

## 2322. *Prediction of Tides*

In the days of shallow-draft vessels advance knowledge of the state of the tide was of little importance. With the increased size and draft of modern vessels, operating on exacting schedules, such advance information became of considerable interest to the navigator, for the state of the tide determines when certain harbors may be entered, when bars may be safely crossed, and when short cuts over shoal places may be attempted. It was in recognition of these needs that the Coast Survey undertook to provide such data in the form of *Tide Tables*.[56]

54. In almost all the states the boundary between the privately owned upland and the state owned tidelands is the high-water line. In a few states, the general rule has been modified and the boundary is the low-water line.

55. MARMER (1951), *op. cit. supra* note 42, at 86–87, 104. For a further discussion of this phase of riparian boundaries set in the context of the Submerged Lands Act (67 Stat. 29 (1953)), *see* Volume One, Part 2, 1613.

56. The procedure of publishing *Tide Tables* was initiated by the Bureau in 1853. These were first published in the annual reports in an abbreviated form without the daily predicted values that are given today. Prior to 1853, charts of the Coast Survey included tide notes which gave limited information for

Besides their use in navigation, tide predictions find application in a variety of activities connected with a modern port. The engineer engaged in harbor improvements, in the building of wharf structures, or in the placing of bridge spans, must be cognizant of the tidal conditions likely to be encountered. And the surveyor may utilize predicted tides for establishing an approximate high- or low-water boundary line that may be adequate for certain purposes and under certain conditions.

### A. THE TIDE TABLES

The *Tide Tables* are published a year in advance and furnish information on the times and heights of high and low water for every day of the year for the more important ports of the world. By means of *tidal differences,* derived from a comparison of tide observations at a reference port and at a subsidiary station, the approximate times and heights of high and low water for a large number of other ports may be obtained. Each tide table includes a table of tidal differences with full explanation for its use.[57] In such a table it is the usual practice to refer the tides at a number of places to the tides at the nearest principal port for which daily predictions are given. This is based on the fact that, as a rule, the tides at nearby places are of the same type, this being one of the principal considerations in using a table of differences.[58] The tidal datum from which the predicted heights are reckoned is the same as that used for the largest-scale charts of the locality. In the United States, these datums are mean low water for the Atlantic and Gulf coasts and mean lower low water for the Pacific coast.

The table of differences also gives the *mean range,* the *spring range,* and the *diurnal range* of the tide at the various places listed, as well as the value of *mean tide level.* Mean range is the difference in height between mean high water and mean low water. Spring range is the average semidiurnal range occurring semimonthly as a result of the moon being new or full; it is larger than the mean range where the type of tide is either semidiurnal or mixed, and is of no

determining the height of mean high water and the time with reference to the moon's meridian transit. In 1867, the annual report tables were discontinued and separate tables of predictions published (*see* note 57 *infra*).

57. High water is the maximum height reached by each rising tide, and low water is the minimum height reached by each falling tide. The first tables to include predictions for each day were for the year 1867, and gave the times and heights of high waters only for 19 reference stations and tidal differences for 124 subsidiary stations. A few years later predictions for the low waters were also included, and for the year 1896 the tables were extended to include the entire maritime world, with full predictions for 70 ports and tidal differences for about 3,000 stations. The present tables contain daily predictions for 195 reference ports and tidal differences for about 6,000 stations. TIDE TABLES 1964, EAST COAST OF NORTH AND SOUTH AMERICA 4, U.S. COAST AND GEODETIC SURVEY.

58. Where differences in type of tide occur at nearby stations it becomes necessary to use a distant port as a reference station which has a similar type of tide. The tides at a number of islands in the Bering Sea are referenced to the tide at San Diego, rather than to the tide at nearer stations, such as Sitka or Kodiak.

practical value where the type of tide is diurnal. The diurnal range is the difference in height between mean higher high water and mean lower low water. Mean tide level (half tide level) is a plane midway between mean low water and mean high water.

In addition to the table of differences, the *Tide Tables* contain information for determining the height of the tide at any time. This applies to both the reference stations and the subsidiary stations. Two methods are available—a numerical one which makes use of a published table of corrections, and a graphical one which involves the construction of a predicted tide curve for the day in question.[59] The numerical method is fully explained in the tables and can be easily followed. The graphical method is also described but not illustrated. It is therefore included here.

(*a*) *Graphical Method of Finding Height of Tide at Any Time.*—This method of finding the height of the tide at any time is known as the *one-quarter, one-tenth rule,* so named because of the method of construction. The procedure is as follows:

(1) On cross-section paper (*see* fig. 21) plot the low- and high-water points—for example, *A* and *E* in the figure—in the order of their occurrence for the day, measuring time horizontally and height vertically. These are the basic points for the curve.

(2) Draw straight lines connecting the points representing successive high and low waters.

(3) Divide the connecting lines into four equal parts (points *B, C,* and *D* in the figure). The halfway point of each line gives another point for the curve.

(4) At the quarter points adjacent to low water and to high water (*B* and *D* in the figure) draw vertical lines below and above the respective quarter points at a distance equal to one-tenth the range of the tide (*B′* and *D′* in the figure).

(5) Draw a smooth curve through the high- and low-water points and the intermediate points (*A, B′, C, D′, E* in the figure), making the curve well rounded near high and low water. This curve will closely approximate the actual tide curve, and heights for any time of the day may be readily scaled from it.

### B. THE TIDE PREDICTING MACHINE

The tide at any place is the direct result of the tide-producing forces of the moon and the sun, which are known. Its time of occurrence and magnitude, however, are greatly affected by the hydrographic features of an area, so that, strictly speaking, the tides as they occur in nature are the result of the varying responses of the different ocean basins to the tide-producing forces, as modified by local terrestrial features. This accounts for the variation in the tide from place to place (*see* 232). It is therefore necessary, as a first step in

59. Both methods are based on the assumption that the rise and fall of the tide conform to simple cosine curves. The heights obtained will therefore be approximate, the roughness of approximation varying as the tide curve departs from a cosine curve.

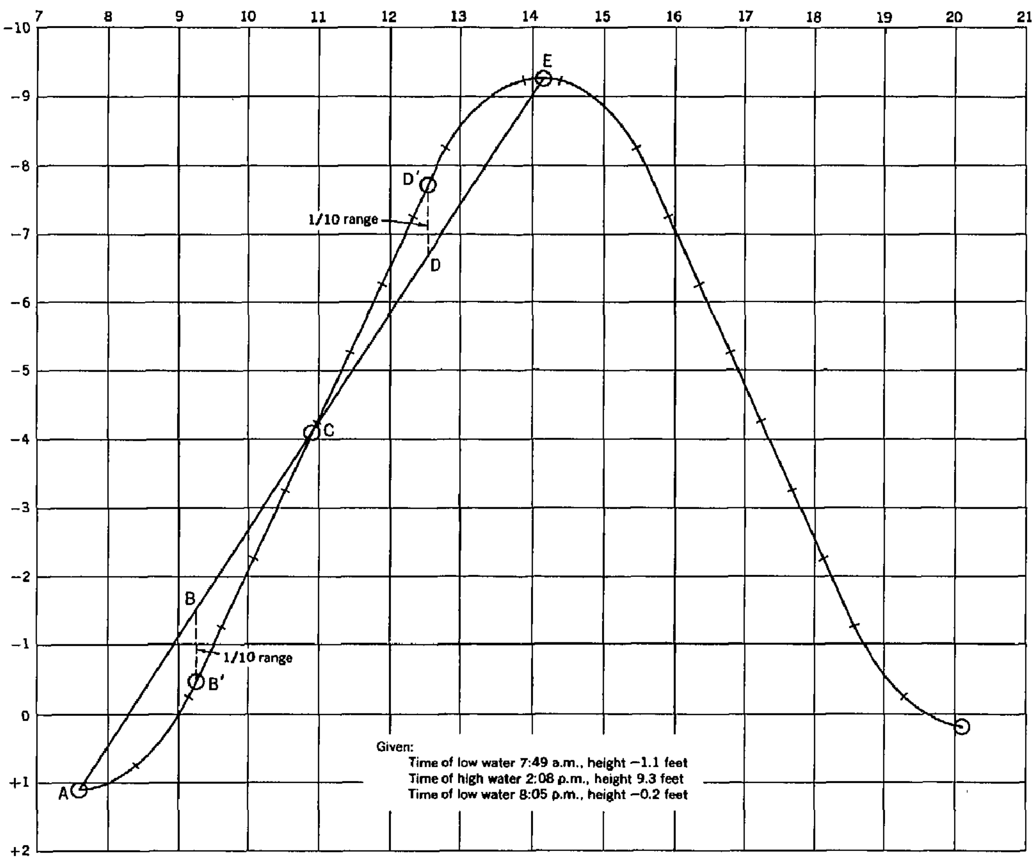


FIGURE 21.—Graphical method of finding the height of the tide at any time from the *Tide Tables* by the *one-quarter, one-tenth rule.*

tide prediction for a given place, to have a series of tide observations to learn the characteristics of the tide at that place—the longer the series the better, but it usually extends over a period of at least a year. Without such preliminary series, tide prediction would be impossible. But once a series has been observed and tidal constants determined, predictions can be made for any future time.

For predicting the times and heights of high and low water for use in the *Tide Tables,* two different methods have been employed—a nonharmonic one and a harmonic one. The latter came into use after the introduction of the harmonic analysis and is the method used today.[60]

60. The nonharmonic method is an approximate method. It is based on the principle that "the tide follows the moon" and makes use of the close relationship that exists between the time of tide at most places and the moon's meridian passage. For a full description of this method, *see* MARMER, THE TIDE 173–178 (1926).

In the harmonic method, the observed tide is subjected to a harmonic analysis, that is, the complicated motions of the moon and sun are replaced by a number of hypothetical moons and suns, which with respect to the earth as center have circular orbits in the plane of the equator. Each of these hypothetical bodies is regarded as generating a tide of its own. The actual tide at any place is thus regarded as made up of a number of simple tides, each of which is due to a hypothetical tide-producing body. Their combined tide must be the same as the actual tide of moon and sun.

The harmonic analysis separates the observed tide curve into cosine curves called constituents. Each constituent is represented by an amplitude which takes account of the height of the constituent and is one-half its range, and an epoch which takes account of the time element (time of occurrence reckoned from a fixed origin). These constituents, once determined, are used to predict the tidal curve for any future time. The resultant predicted curve represents a summation of all the constituent curves. The tide predicting machine (*see* fig. 22) performs this summation mechanically.[61]

Before beginning the predictions for any port, the constants, representing the different components of each constituent tide, are set on the proper cranks and dials of the machine which are so arranged that when the machine is set in motion by means of a crank and gears it will sum up the effects of all these constituent tides and produce the tide in nature. It provides for summing 37 constituents.[62]

### C. ACCURACY OF TIDE TABLES

To test the accuracy of the *Tide Tables,* comparisons have been made for different ports between predicted tides and observed tides. These tests indicate that, under normal weather conditions, the predicted tides closely approximate the actual tides in both time of occurrence and height. At Los Angeles, for example, where the tide is of the mixed type with a mean range of 3.8 feet, a full year of comparisons showed that 90 percent of the predicted times of high and low water agreed within 5 minutes of the observed times; 98 percent of

61. Up to and including the *Tide Tables* for the year 1884, all the tide predictions were laboriously computed by means of auxiliary tables and curves constructed from the results of tide observations at the different ports. From 1885 to 1911, inclusive, the predictions were generally made by the Ferrell Tide Predicting Machine. From 1912 to the present time, the Coast and Geodetic Survey Tide Predicting Machine No. 2 has been used. TIDE TABLES (1964), *op. cit. supra* note 57, at 4. For a note on the development of tide predictions in the Bureau, *see* Finnegan, *Historical Note on Tide Predictions,* 5 JOURNAL, COAST AND GEODETIC SURVEY 100 (1953).

62. The machine not only traces a continuous curve showing the variation of the tide hour by hour throughout the year, but also indicates by dials the time and height of each high and low water. A recent addition to the machine is an attachment which automatically types the predictions in the format of the *Tide Tables,* thus permitting direct reproduction by offset printing. Including the time for setting the machine, daily predictions for a year can be made in about 7 hours.

FIGURE 22.—Tide Predicting Machine, designed in the Coast Survey, for predicting the times and heights of the tide for any port in the world and for any year. Astronomical equations involving as many as thirty-seven factors are solved mechanically to produce the tide in nature. Not shown in the view is a recent attachment which automatically types the predictions in the format of the *Tide Tables*.

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the predicted heights agreed within half a foot of the observed heights; and 59 percent agreed within one-tenth foot. Exact agreement cannot be expected between predictions and actual times of occurrence, since the times and heights of the tide will be modified by the prevailing meteorological conditions, which may not be normal. This is particularly true of the upper reaches of rivers subject to freshet conditions, and also of comparatively shallow bays with a small range of tide.

### 233. Types of Tidal Data Available

Besides the published tables and the tide predictions that are included with the Small-Craft charts, there are other types of tidal data that are available to the public on request. Those which are used frequently by many people are furnished in the form of processed material—state index maps; tidal bench-mark data; relation between sea level datum and hydrographic datums; and tables of mean and diurnal ranges and highest and lowest tides—while those required for a special purpose covering a specific period of time are furnished in the form of photostats of the original records—hourly heights; high and low waters; and monthly, yearly, and cumulative means.

#### 2331. *State Index Maps*

Special index maps are available for each coastal state showing by symbol and numbered position the localities for which tidal bench-mark data may be obtained (*see* fig. 23). On the reverse side of these maps more specific information is given as to where the bench marks are located for each numbered position on the index map, both of which are to be used in requesting bench-mark data.

#### 2332. *Tidal Bench-Mark Data*

It has been previously noted that Coast Survey practice is to establish at least three bench marks for any series of observations (*see* 2314). Data for such bench marks are published separately for each station in loose-leaf form that permits ready expansion and revision. These compilations include the descriptions of all bench marks at each tide station (for ready identification on the ground), and their elevations above the basic hydrographic or chart datum for the area—mean low water on the Atlantic and Gulf coasts and mean lower low water on the Pacific coast, or some special low-water datum. The date and length of the tidal series on which the bench-mark elevations are based are also given. An accompanying table shows the relations between the basic datum

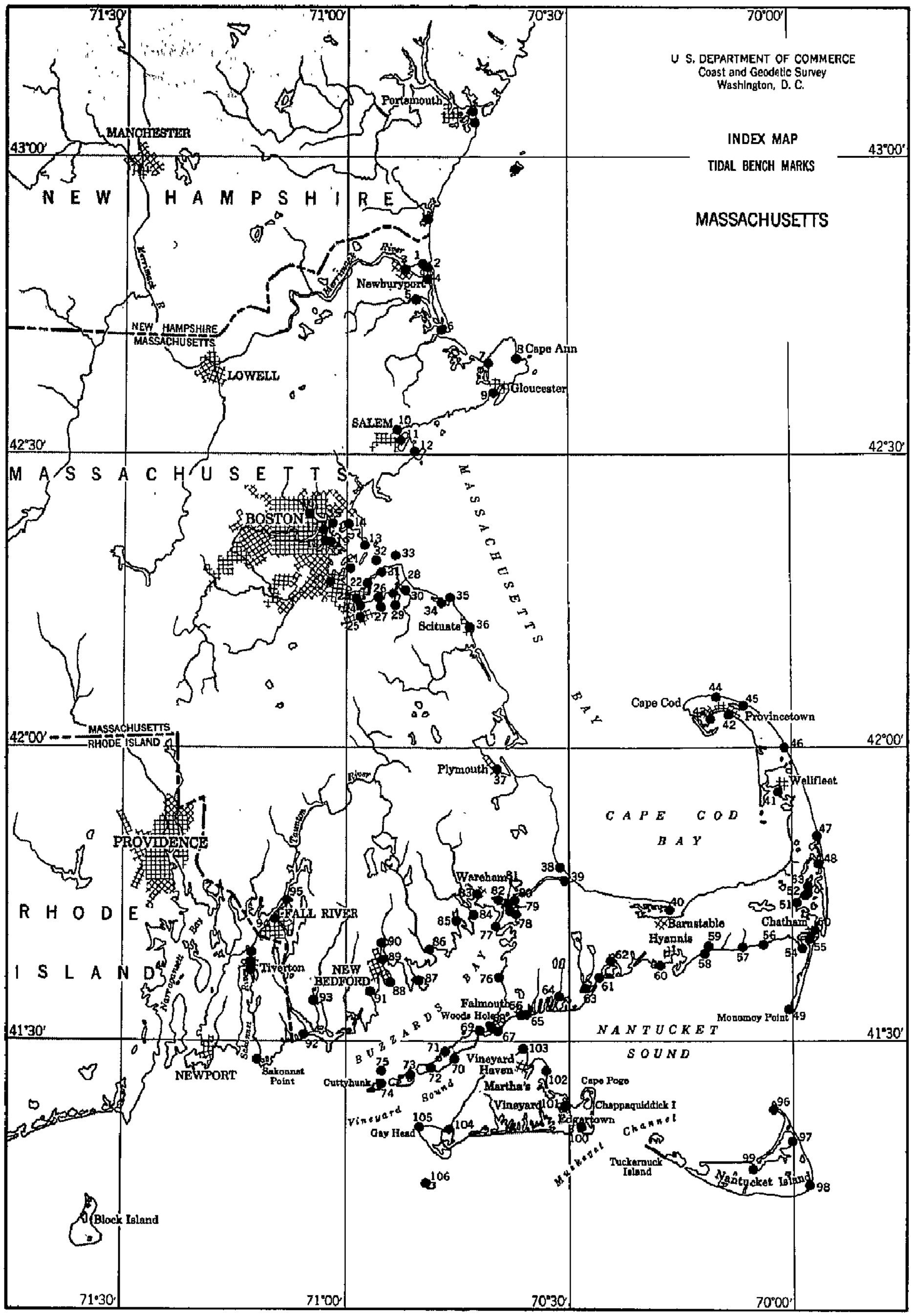


FIGURE 23.—Index map of tidal bench marks in Massachusetts. The dots and numbers indicate the localities for which tidal bench-mark data are available. On the reverse side are the place names corresponding to the numbers.

and other tidal datums in general use—mean higher high water, mean high water, half tide level, mean low water, and mean lower low water. In addition, heights of observed or estimated highest and lowest water levels in relation to the basic datum are also included with the dates of occurrence of these abnormalities (*see* 2334).

### 2333. *Relation Between Sea Level Datum and Hydrographic Datum*

In the process of its extension, the precise level net of the country has come to include tidal bench marks at many localities in addition to those where tide observations originally established the Sea Level Datum of 1929 (*see* 2121 B). However, there are still about 900 stations out of a total of about 1,700 in conterminous United States where there are no spirit-level ties between the geodetic bench marks and the tidal bench marks, and consequently the elevations of the tidal bench marks referred to the Sea Level Datum of 1929 have not been established.

For each coastal state where spirit-level connections have been made, a table is available showing the relation between Sea Level Datum of 1929 and the hydrographic datum. By subtracting the tabular value at each station from the published elevation above mean low water (or mean lower low water), the bench-mark elevation above the Sea Level Datum of 1929 is obtained. From this the vertical relationship between a geodetic bench mark and a tidal bench mark can be derived (*see* 2121 B note 27).

### 2334. *Mean and Diurnal Ranges and Highest and Lowest Tides*

Also available to the public on request is a leaflet consisting of two tables (Table 1 and Table 2). Table 1 applies to the Atlantic coast and gives the mean range of the tide, together with the height of the highest tide above mean high water and the lowest tide below mean low water, as recorded at the various control stations through the year 1961. Table 2 applies to the Pacific coast and Alaska and furnishes similar information as Table 1, except that the diurnal range is given and the highest and lowest tides are referenced to mean higher high water and mean lower low water, respectively. Both tables also give the average yearly highest and lowest tides for each station.

### 2335. *Hourly Heights and High and Low Waters*

Initial processing of tide records from control tide stations consists of a complete and systematic scaling of the hourly heights and the times and heights of high and low waters. The hourly height records have three distinct and basic applications. They provide data for the computation of the basic tidal plane of mean sea level, from which is derived the datum for the level net of the country; for the computation of the harmonic constants used in the prediction and classification of tides; and for a compact and condensed file record for future reference and reproduction. From the high- and low-water records are obtained basic data on time and height relationships, including lunitidal intervals, ranges, diurnal inequalities, high- and low-water datum planes, half-tide level or mean tide level, and mean and extreme heights.

### 2336. *Monthly, Yearly, and Cumulative Averages*

For each control tide station, compilations are prepared of monthly averages obtained from the hourly height and high- and low-water records (*see* 2335). These compilations are further processed to show yearly averages, cumulative averages, and averages by successive and overlapping 19-year periods, each new year as available becoming the last year of a 19-year group. Included in these summarized compilations are also the dates and heights of the highest and lowest tides recorded each month. These extreme heights are generally the result of meteorological disturbances superimposed on the normal periodic tide, and are of particular value to the navigator and to the coastal engineer. During periods of extreme low water, the actual depths of water may be noticeably less than shown on nautical charts. The lowest tide to be expected, as referred to the chart datum, is therefore a necessary part of the tidal information included on the nautical charts of the Survey (*see* Part 2, 658 and 6581). Knowledge of the heights of extreme tides—high and low—that have occurred or that may be expected to occur in any locality is an indispensable factor in planning and designing waterfront structures, and the long-period tide records of the Bureau are in constant demand for this purpose.

Photostat copies of the hourly heights and high and low waters and of the monthly, yearly, and cumulative averages are available for public distribution at the cost of reproduction.

## CHAPTER 1

# Introductory

Although much of the material in this part of the publication deals primarily with the surveys that were made during the formative period of the Coast Survey, it also covers the years to and including World War I and the years immediately following. It does not, except very generally, cover the echo-sounding surveys nor any of the hydrographic surveys executed by electronic methods. This also applies to topographic surveys utilizing photogrammetric methods. These modern surveys can be adequately interpreted for legal and engineering use by reference to existing manuals and other published material.

### 11. GENERAL ACCURACY OF THE EARLY SURVEYS

In evaluating the early surveys of the Bureau, certain factors regarding their specific accuracy should be given consideration. These will be described in subsequent chapters. In this chapter, some observations will be made relative to their general accuracy.

There is probably little doubt but that the earliest records of changes in our coastline that are on a large enough scale and in sufficient detail to justify their use for quantitative study are those made by the Coast Survey. These surveys were executed by competent and careful engineers and were practically all based on a geodetic network which minimized the possibility of large errors being introduced. They therefore represent the best evidence available of the condition of our coastline a hundred or more years ago, and the courts have repeatedly recognized their competency in this respect (*see* Part 3, 412).[1]

But this is not to impute infallibility to them, especially as to minute details. While remarkably few errors have crept into its work during the long history of the Survey, so much so that the work of the Bureau is known and respected

1. In *City of Oakland* v. *Wheeler*, 168 Pac. 23, 28 (1917), the competency of a hydrographic survey of the Coast Survey made in 1855 was objected to, but the Supreme Court of California said: "This map is a record of the United States Coast and Geodetic Survey, made in the performance of their duties by federal officers . . . . Whatever the rule may be elsewhere than in California, in this state these sections of the code cited [sections 1920 and 1926 of the Code of Civil Procedure] settle the competency of these maps and their character as prima facie evidence of the facts sought to be established by them."

throughout the world for its integrity and reliability, it must nevertheless be recognized that in any process involving human equations there is always present an element of possible error. However, the only consideration which would justify weight being given to such a possibility would be the production of concrete evidence, of approximately the same date, that showed a contrary condition.[2]

In appraising the surveys of the Bureau, particularly the early ones, and their general accuracy, several circumstances should be given consideration.

The first is the purpose for which the survey was made. In the Coast Survey, the primary purpose of making topographic and hydrographic surveys is to provide data for the construction of nautical charts. This purpose is reflected in the method and scale used. They are not the methods that the Bureau would use in the demarcation on the ground of waterfront boundaries based on tidal definition, but they are adequate for the purpose intended. In applying such surveys to other needs, such as the location of the high- or low-water line as of a given date, the limitations inherent in them should be properly appreciated.[3]

Other circumstances of a general nature that should be considered in evaluating surveys are the nature of the area surveyed and the date of the survey. In the early days of the Coast Survey, when so much surveying was to be done and there was pressure to get out charts of the country's uncharted shores, it was only natural that some of the relatively unimportant areas would be surveyed with what today would be considered no more than reconnaissance accuracy (*see* 121). To have surveyed every then unimportant creek or slough with the same degree of detail as was included in surveys of an important river or harbor area could not have been justified administratively or otherwise.[4] The date of a survey has a bearing on its general accuracy and may be

2. In the above case, the court also held that if "any inaccuracies existed in the maps themselves these experts [for the defendants who attacked the introduction of the Coast Survey maps], if qualified to do so, could have been permitted to point them out, and they were permitted to do exactly this; but they could not be permitted to give their general opinions as to the value of these maps for the purpose of defining boundaries, nor as to the weight to be given them as evidence." *Ibid.*

3. The Bureau has made occasional special-purpose surveys in which special methods were used and the surveys were made on scales large enough to serve the purposes intended. An example of this is the planimetric survey of the District of Columbia-Virginia boundary line in 1946–1948, made pursuant to an act of Congress, in which the mean high-water mark on the Virginia shore was tied horizontally to triangulation markers on shore and vertically to tidal bench marks. A more extensive special-purpose survey was made in 1957–1961, under a cooperative arrangement with the State of Louisiana and the U.S. Bureau of Land Management, to establish an accurate map location of the entire Louisiana low-water line for delineating the "coast line" under the Submerged Lands Act, from which the seaward boundary of the state could be determined. The mapping was accomplished by photogrammetric procedures in which the aerial photography was closely coordinated with an accurate tidal datum (*see* Volume One, Part 2, 17).

4. A case in point is the 1852 topographic survey (Register No. T–360) and the 1853 hydrographic survey (Register No. H–464) of San Antonio Creek, Calif. (the Oakland Estuary). These surveys were made shortly after the first officers of the Coast Survey went to the West Coast. Oakland in those days had not acquired the importance that it did later. The 1852 survey showed only one dock and about two

considered an offshoot of the nature of the area surveyed. In the early days of the Survey, land was in abundance and was cheap when measured by present values. The standard of survey work then, while high for its period, was not as high as it is today with practices and procedures fully standardized.[5] This latter fact accounted for the difference sometimes encountered in early surveys in the representation of detail on adjoining surveys executed by different topographers (*see* 43).

In summary, the degree of accuracy of the early surveys depends on many factors, among which are the purpose of the survey, the scale and date of the survey, the standards for survey work then in use, the relative importance of the area surveyed, and the ability and care which the individual surveyor brought to his task. The surveys and charts of the Bureau are highly technical documents. In their proper interpretation, particularly for purposes other than navigation, recourse must frequently be had to information that does not appear on the face of the survey or chart. Such interpretation can best be made by those familiar with the Bureau's historical development and with its field and office methods and procedures, and who have had an opportunity of comparing surveys executed at different periods along various sections of our coasts.

## 12. SURVEYS, MAPS, AND CHARTS

Many features and types of information are shown on the surveys, maps, and charts of the Bureau, the significance and import of which are not always apparent. In order that they may be of maximum value in the many specialized contexts that may arise, both legal and technical, they will be interpreted in the light of the various inquiries that have been received and dealt with over the years.

dozen buildings in the hinterland. The area was therefore relatively unimportant in the light of the need for surveys along the entire coast. This is reflected in the generality of the shoreline on the topographic survey and the absence of fixes for the sounding lines on the hydrographic survey. That these were considered in the nature of preliminary or reconnaissance surveys is evidenced also by the fact that 4 years later, with the growth of Oakland, new topographic (Register No. T–592) and hydrographic (Register No. H–573) surveys were made of the creek.

5. In more recent years, especially the years following the experimental period in aerial photogrammetry, the value of topographic surveys for engineering and other uses has been given greater recognition, and the instructions regarding the delineation of the high- and low-water lines have reflected this broader use. Swanson, Topographic Manual (Part II) 397–399, Special Publication No. 249, U.S. Coast and Geodetic Survey (1949). In modern hydrographic surveys, stricter attention is paid to the accurate location of inshore soundings by the requirement for recording a position fix at the beginning and ending of every line, when the sounding boat has attained sounding speed at the beginning of a line or is slowed down near the end of a line, and when the speed is changed appreciably. Adams, Hydrographic Manual 213, Special Publication No. 143, U.S. Coast and Geodetic Survey (1942). *See also* Jeffers, Hydrographic Manual 10, Publication 20–2, U.S. Coast and Geodetic Survey (1960, 3d ed.).

References to surveys, maps, and charts are frequently made as though they are the same or similar types of documents. Technically they are distinctly different, and it is important to those having occasion to use them to understand these technical differences. Even in legal decisions a confusion in terminology is sometimes noted and reference is made to a "chart" when clearly a "survey" is meant, and vice versa. In this section, these terms will be defined and significant features emphasized. They will be more fully considered in subsequent chapters on interpretation.

A *survey,* as used in this publication, can be of two kinds—topographic or hydrographic. A topographic survey is the actual, original, field survey made with the planetable (*see* 124); a hydrographic survey is an original office plotting of the recorded sounding data taken during the field survey using the boat sheet as a guide (*see* 125). In either case, it is the result of the field operation. Original surveys are sometimes also referred to as topographic sheets and hydrographic sheets.

A *map* is a printed reproduction of a compilation resulting from one or more topographic surveys drawn to the scale of the original survey or smaller and on a definite projection. While a map may include some water area, basically it furnishes information relative to the land area.

A *chart* (nautical) is a printed reproduction of a compilation resulting from topographic and hydrographic surveys of the Bureau and from other sources (*see* 127).[6] In the early history of the Survey, the term "chart" was used where the water formed a considerable part of the whole, whereas if the land formed the dominant part it was classed as a "map."[7] Today the distinction between charts and maps is based on use rather than on the relation of land to water area, the major difference being that a chart is constructed for use in navigation.

### 121. Reconnaissance and Preliminary Surveys

A reconnaissance survey is a hasty, preliminary survey of a region made to provide advance information regarding the area, which may be useful pending the execution of more complete surveys. Such a survey is made in a rapid manner, usually covers an extensive area on a comparatively small scale, and may or may not be controlled by triangulation. The resulting survey is fre-

6. Aeronautical charts are not dealt with in this publication because the smallness of scale precludes their use for shoreline studies, or for the determination of shore boundaries except in a very general way.

7. Based on letter of Mar. 17, 1856, from Superintendent A. D. Bache to W. R. Palmer, Assistant in Charge of Coast Survey Office, relative to the classification of surveys, maps, and charts. The 1845 edition of New-York Bay and Harbor and the Environs (corresponding approximately to present chart 1215) was labeled "Map."

quently no more than a sketch of the area, and if soundings are made they sparsely cover the area and give only the most general idea of hydrographic conditions.[8] Such surveys are usually appropriately identified on the face of the survey. Hydrographic survey Register No. H–289 (1851) is a "Reconnaissance of West Coast" and covers the area from San Francisco to San Diego at a scale of 1:380,000.

A topographic reconnaissance was defined by the Bureau in 1865 as one where "there is any deviation from the closest attainable accuracy in a finished plane-table sheet" or where "the rudest sketch of a country in which the features are delineated in rough approximation, which for certain temporary purposes is all that is needed." [9]

A reconnaissance survey was the lowest order of surveys and could only furnish a "reconnaissance chart" (*see* 122) or a "sketch" (*see* 123). A preliminary survey was of higher order than reconnaissance, but did not have the detail of a complete survey. It could be the basis for a "sketch" or a "preliminary chart" (*see* 123), but not for a complete map or chart.[10]

### 122. Reconnaissance Charts

Reconnaissance charts are charts based upon reconnaissance surveys (*see* 121). Such charts were published in the early years for exploratory purposes and as a preliminary to the making of detailed surveys. A noteworthy example is the 1853 chart entitled, "Reconnaissance of the Western Coast of the United States," and covers the coastline from San Diego to San Francisco at a scale of 1: 1,200,000.

### 123. Sketches and Preliminary Charts

The publication of "sketches" and "preliminary charts" was inaugurated in 1845 in order to make available to the navigator the results of the surveys as soon as possible after they were made.[11] They were marked "sketches" when only a very limited area was included; otherwise they were labeled "charts."

8. Adams (1942), *op. cit. supra* note 5, at 309.

9. Annual Report, U.S. Coast Survey 229 (1865). The Topographical Conference of 1892 defined it as "a determination of the topographical features of a region or locality that, if plotted, would represent on a map only a partial development of the salient features of the region." Annual Report, U.S. Coast and Geodetic Survey 577 (1891).

10. Letter (1856), *supra* note 7. Reconnaissance and preliminary surveys usually contained topography and hydrography and were registered as hydrographic surveys. *See* Registers Nos. H–289 (1851) and H–502 (1855).

11. Annual Report, U.S. Coast Survey 3 (1845).

This practice, however, was not consistent and the terms sketches and charts appear to have been used interchangeably.[12]

Sketches were based upon reconnaissance or upon regular surveys, and presented the details of the hydrography with generally a true outline of the shore. For the most part, they were engraved by the apprentices in the Survey and served as subjects for practice.[13]

"Preliminary charts" were drawn and engraved as each season's work was submitted by the hydrographic parties. A clue to the distinction between the "preliminary" chart and the "finished" chart is contained in the chart catalog of 1863 where it is stated: "The preliminary charts are those which are issued as soon after the several surveys as is consistent with accuracy of general delineation; and are designed to supply the immediate and pressing demands of navigation. The finished charts embody *all* the information furnished by the survey, including the minutest details; and embrace not only the hydrography, but the topography likewise. The two classes of charts differ in regard to the *amount* of the information which they furnish; but not in regard to the correctness of that which is given." The shoreline and soundings only were usually engraved on preliminary charts.[14]

During World War II, the classification "preliminary" was again introduced but the designation applied to those charts constructed from unverified hydrographic surveys.[15] This was made necessary by the large backlog of unverified surveys. This is still the practice in 1963.

## 124. Topographic Surveys

A topographic survey is a graphic representation by means of conventional symbols of the land features (natural and artificial), *as they existed on a given date,* of a portion of the earth's surface on a reduced scale. It may and may not show the ground relief. As used in this publication it is the *original field survey sheet* on which the topographic features are delineated. The topo-

12. *See* sketches included in Annual Report for 1851.

13. Originally, sketches of newly discovered dangers, small detached surveys, and reconnaissance surveys were gratuitously distributed to navigators, underwriters, and other interested parties. Annual Report, U.S. Coast Survey 16 (1849). By 1863, this distinction was not so finely drawn, and some sketches were listed in the chart catalog for that year on a sales basis. The catalog of 1880 was the last to use the classification "sketches."

14. Letter (1856), *supra* note 7. The classification "preliminary" was used in the chart catalog through 1900.

15. Edmonston, Nautical Chart Manual 12, U.S. Coast and Geodetic Survey (1956). Another classification occasionally used is "provisional." This applies to charts for which there is an urgent need and which are smooth-drafted for direct reproduction. Chart 6159 (1961 ed.) of the Columbia River is an example of such a chart. It is so labeled because the depths shown will change when a dam is built in the area. *Ibid.*

graphic survey is the authority for the high-water line and for all information inshore of that line, including the names of topographic features, as well as all alongshore features that the topographer was able to see, such as bare rocks and rocks awash.

Since this publication deals primarily with the early surveys of the Bureau, the topographic surveys here defined are those surveyed with the planetable (*see* 41). In this method, the topographer constructed his map as he surveyed. Delineating the high-water line, sketching the contours, locating the roads and other culture were accomplished in the field with the terrain in full view. All measurements were immediately applied to the survey sheet, thus *eliminating the necessity of retaining field notes* for later plotting in the office. This is an important characteristic of planetable surveying which is frequently overlooked.

### 1241. *Registry Numbers*

Topographic surveys and hydrographic surveys (*see* 125) are identified by *registry numbers* which are assigned to them when received in the Washington Office. "Register No. 52" would mean that 51 surveys were registered before it. It is customary in referring to surveys to annex the letter "T" to the registry number of a topographic survey and the letter "H" to a hydrographic survey, although these do not appear on the survey sheets. It is also customary in written matter to give the date of the survey in parentheses. Thus, "Register No. T–52 (1838)" would be a complete identification of the survey.[16] Separate but parallel systems of numbering are used for both classes of surveys. Generally, but not always, the chronology of execution of surveys would be indicated by the registry numbers. They have no geographic significance.

The more recent surveys carry the identification "Topographic Survey No. ——" or "Hydrographic Survey No. ——" in the title.

### 1242. *Descriptive Reports*

A *Descriptive Report,* as the name implies, is a written report to accompany each topographic and hydrographic survey and becomes part of the official record of the survey. It is prepared by the field engineer for the purpose of supplementing the survey with information that cannot be shown graphically thereon and to direct attention to important results. It outlines the conditions

16. The 1942 Hydrographic Manual required only the designation H–6381 (1939) as the complete identification of that survey. Adams (1942), *op. cit. supra* note 5, at 40. But that was for intra-Bureau use. For outside use in all correspondence with the Bureau it is better to give the complete identification of the survey. This is the form followed throughout this publication.

under which the survey was made and sometimes throws important light on the interpretation of a particular stretch of shoreline (*see* 4433).

Descriptive Reports were not a standard requirement in the Coast Survey until April 11, 1887, when instructions for their submission were first published,[17] but some reports are available for topographic surveys beginning with 1863 (Register No. T–979). Descriptive Reports carry the same identification numbers as the survey sheets.

### 1243. *"Bis" Sheets and Revision Surveys*

A number of the early topographic surveys that have become dilapidated through continued use have been redrawn in the Washington Office. These are identified by the word "bis" placed after the registry number. They are in every respect identical with the original. Inadvertently, the term has sometimes been used to designate a revision survey (*see,* for example, Registers Nos. T–441 (1851–53) and T–441*bis* (1873)), but strictly the designation should have been T–441*a*, the usual designation for such a survey (*see* Registers Nos. T–795 (1859) and T–795*a* (1909) and T–795*b* (1909)).[18]

### 1244. *"a" and "b" Sheets*

On some of the early topographic surveys, an "a" and "b" designation was used for adjoining contemporary surveys where one was in the nature of an extension of the other (*see* Registers Nos. T–1482*a* and T–1482*b* (1878)). This practice was later followed on aluminum-mounted sheets where both sides of the sheet were used (*see* Registers Nos. T–6532*a* and T–6532*b* (1936)).

### 1245. *Tracings of Surveys*

A number of the early topographic surveys have tracings filed with the original planetable sheets which show the topography in considerable detail. The reason for this is that in the instructions for hydrographic work the following requirement was included: "The shore-line should be obtained from the Office, or from the topographical party acting in the vicinity, and entered upon

17. Instructions and Memoranda for Descriptive Reports to Accompany Original Sheets 3, U.S. Coast and Geodetic Survey (1887). The instructions state that "those points which come under the notice and observation of the officer charged with a particular survey and which are characteristic of the locality surveyed are to be reported on. On all such distinguishing features, especially all such as are likely to be useful and valuable in future years, *the fullest information should be sought for and given.*"

18. For present practice in the handling of revision surveys, *see* Swanson (1949), *op. cit. supra* note 5, at 517–518.

the sounding-sheets. In some cases, the shore-parties furnish tracings; in others, lend their maps to be copied."[19] This also accounts for the fact that tracings do not always accompany the sheets. In some cases, a tracing was made to cover several adjoining topographic surveys, but the tracing was assigned the register number of only one of the surveys (*see,* for example, the tracing accompanying Register No. T–1552 (1884) which includes Registers Nos. T–1681 (1884–85), and T–1682 (1885)).[20]

During the early surveys on the West Coast, it was also the practice, as a safety measure (although not rigidly so), to make tracings of all the original survey sheets before they were forwarded to the Washington Office, in the event of possible loss in transit. Many of these tracings were retained in the San Francisco office of the Survey.

### 125. Hydrographic Surveys

As used in the Coast and Geodetic Survey, a hydrographic survey is a representation of the water area of a portion of the earth's surface by means of soundings (depths) taken at various locations throughout the area, and in sufficient numbers to enable the hydrographer to delineate on the survey sheet all underwater features of special significance to the navigator, such as channels, reefs, banks, shoals, rocks, and characteristic submarine features, *as they existed on a given date.* Where practical, the low-water line is also delineated. The hydrographic survey is the authority for all data below the plane of high water, including the names of hydrographic features.

A hydrographic survey differs from a topographic survey (planetable) in one essential respect. The topographer makes his map as he surveys, whereas the hydrographer records the information he obtains in a "sounding volume" and is later plotted in the office as a "smooth sheet" which becomes the official record of the survey (*see* 552).[21] The original sounding volumes are filed in the Bureau's archives or in the National Archives and Records Service and are available for nearly all of the early surveys.

The numbering of hydrographic surveys is discussed in 1241. It need only be added that all records pertaining to a particular survey—sounding

19. General Instructions for Hydrographic Work 48, U.S. Coast and Geodetic Survey (1883).

20. Blueprints of such tracings have often been interpreted by users of our surveys as representing a new survey, particularly if the date when the tracing was made differed from the date of the survey (*see,* for example, tracing accompanying Register No. T–591 (1856)).

21. A complete smooth sheet is a record of the soundings taken during the field survey together with other data necessary for a proper interpretation of the survey, such as depth curves, bottom characteristics, names of geographic features, and control stations. Adams (1942), *op. cit. supra* note 5, at 657.

volumes, Descriptive Report, fathograms (on more recent surveys)—are identified by the same number.

### 1251. *"A" and "a" Sheets*

On some of the early hydrographic surveys, an "A" sheet was used to designate an extension of the original survey but made at a later date (*see* Registers Nos. H–790 (1861) and H–790*A* (1871)). Other treatments were to designate as an "a" sheet an extension of the original survey but which could not include everything because of the size of the sheet (*see* 1244). These were contemporary surveys (*see* Registers Nos. H–3297 (1911) and H–3297*a* (1911)). The modern practice is to avoid the use of "a" sheets and to assign a new number to each survey sheet.[22]

### 1252. *Field Examinations*

In 1934, a new file was begun in the Chart Division, titled "Field Examinations." This consists of reports furnished by the field parties of the Bureau of examinations of small details (hydrographic or topographic) for which control is available and which can be correlated with the charts. Such examinations were formerly filed as "Chart Letters." Each field examination is submitted on either a section of a chart or a section of a planimetric map of the area, and is assigned a consecutive number in the Washington Office, each calendar year beginning a new series. They are identified thus: F.E. No. 5 (1959), indicating the fifth field examination in 1959, and are indexed on the hydrographic and topographic indexes but are not registered as original survey sheets.[23]

## 126. Combination Hydrographic and Topographic Surveys

In addition to the combined reconnaissance and preliminary surveys noted in 121, surveys sometimes included both topography and hydrography (Registers Nos. H–1737 (1886) and H–1930 (1889)). These were relatively infrequent, and were made only pursuant to special instructions, or to serve some special purpose. Thus, Register No. T–2196 (1895), which is a large-scale (1:1,000) combination survey of Port Orchard, Wash., was made for the

22. *Id.* at 749.

23. Letter of Sept. 21, 1934, from Chief, Division of Charts to Chief, Section of Field Records, and Adams (1942), *op. cit. supra* note 5, at 57. The 1960 Hydrographic Manual provides that where the boat sheet (*see* 551) is clearly legible and soundings have been corrected to show true depths, the sheet may be cut or folded and filed, after verification and review, with the report of the examination in the "Field Examinations" file. Jeffers (1960), *op. cit. supra* note 5, at 228.

Navy Department to serve as a guide for laying out the grounds, locating residences and other buildings, and estimating the amount of dredging necessary for access to the dry dock.

### 127. Nautical Charts

A nautical chart is a printed reproduction, on a reduced scale, of some portion of the navigable part of the earth's surface. It is constructed primarily to serve the needs of the mariner, and shows the nature and form of the coast; the depths of the water and character of the sea bottom near it; the locations of reefs, shoals, and other dangers to navigation; the rise and fall of the tides; the locations of artificial aids to navigation; the direction and strength of sea currents; and the behavior of the earth's magnetism in areas which must be navigated.

Coast and Geodetic Survey charts are compiled primarily from the topographic and hydrographic surveys of the Bureau and from the best available data from various other sources. For example, information on aids to navigation is obtained from the U.S. Coast Guard (formerly such information was furnished by the Bureau of Lighthouses); controlling depths in dredged channels and depths in other areas where improvements are projected, and bridge and overhead cable clearances are obtained from the Corps of Engineers. In addition, charts frequently contain reported information, such as a shoal, a bank, an obstruction, etc., which, though possibly of doubtful accuracy, must be charted as a precautionary measure until such time as it can be disproved or verified. It is important to keep this in mind when using nautical charts for engineering and legal purposes. Compilation is a process of evaluation and selection from the material available to the cartographic engineer. Those features that are of little interest to the mariner are generalized or omitted if they interfere with, or obscure data of navigational value. By contrast, those features of greatest navigational importance are accentuated so as not to be overlooked.

The first published chart of the Coast Survey of which there is a present record is that of Bridgeport Harbor, Conn., and is dated 1835.[24] This chart was probably engraved commercially on contract, since no engravers had been employed at this time. Neither the plate nor a copy of the chart is available in the Bureau at the present time.[25]

24. Catalogues of Charts 1, U.S. Coast Survey (1843–53).

25. Adams, *Engraved Charts*, 10 Field Engineers Bulletin 93, U.S. Coast and Geodetic Survey (1936).

## 1271. *Numbering of Charts*

The nautical charts of the Coast Survey are identifiable by number or by title. This practice was established in late 1866 or early 1867,[26] but the present system of numbering charts according to geographic location and classification dates back to 1898.

### A. PAST PRACTICE

When charts were first published they were not given individual exclusive numbers. When used as inserts in reports, *Coast Pilots,* or other publications they were numbered as illustrations or by reference numbers used in the text. These numbers were usually engraved on the copper plates. Charts were designated, listed, and sold by title.

In 1856, the first project for a complete series of contiguous charts was adopted. It was to cover the Atlantic and Gulf coasts on a scale of 1:80,000.[27] This was known and referred to as Coast Charts Nos. 1 to 113. The plan was rearranged in 1866 so the numbers before and after that date do not agree. In 1867, when chart numbers were assigned, 100 was added to the Coast chart number to form the chart catalog number.[28]

The 1867 assignment of chart numbers was as follows:

*Atlantic and Gulf Coasts.* Sailing, General, and Preliminary coast charts—1 to 31; Coast charts—101 to 213; Harbor charts—300 to 528.

*Pacific Coast.* All classes of charts—601 to 657.

Gaps were left in the numbering to take care of future charts in the different groups. The new numbers were placed on the existing stock by hand stamp and later engraved on the plates as new printings were made, in many cases without other change. This could lead to the erroneous conclusion that the numbers were assigned at an earlier date than 1867.[29] As far as is known, a new chart was never assigned a number that was previously used.

26. Unpublished ledger entitled "Compilation of Nautical Charts and Miscellaneous Maps Assigned Permanent Identifying Numbers Published by United States Coast and Geodetic Survey Subsequent to 1866." This ledger is on file in the Nautical Chart Division of the Survey, and is referred to in the Nautical Chart Manual as "Catalog of Chart Numbers." EDMONSTON (1956), *op. cit. supra* note 15, at 15.

27. This series superseded the "Preliminary Coast Charts" series, some of which were begun and never finished. They were listed and often entitled "Seacoast Charts of the United States." *See* unpublished 1936 compilation in Nautical Chart Division of the Survey entitled "Catalog of All Charts Published Prior to 1867." This compilation gives the 1867 chart number and the comparable 1936 number.

28. *Ibid.* In the chart catalog of 1866, the charts were arranged in geographical order and then numbered consecutively as item numbers. These were often taken to be chart numbers and caused confusion. As a result, the present practice of assigning each chart a permanent identifying number was established and first published in the chart catalog of 1867.

29. The first Alaska charts were dated 1868 and were assigned numbers beginning with 700.

The first major change in the 1867 assignment of numbers was made in 1891 when the Pacific coast charts were numbered from 5000 and the Alaska charts from 8000. This is reflected in the chart catalog of 1892.

### B. PRESENT PRACTICE

The present assignment of chart numbers, based on the Catalog of Nautical Charts (corrected to May 1963) and subsequent information, is as follows:

*Atlantic and Gulf Coasts.* Sailing charts—1000 series (begun in 1900) and chart 70; General charts—1100 series (begun in 1912) and charts 71, 77, 78, 1350, and 1351; Coast charts—1200 series (begun in 1911); Intracoastal Waterway charts—800 series (begun in 1936) (*see* 625(*e*));[30] Harbor charts—200 to 700 series; Small-Craft charts—100 to 199 series (begun in 1959), 600–SC to 699–SC series and any conventional chart adapted to small-craft use (begun in 1961); Special charts—3000 series.

*Puerto Rico and Virgin Islands.* All charts—900 series (begun in 1898).[31]

*Pacific Coast.* Sailing charts—5000 series (begun in 1892); General charts—Series ending in "02" beginning with 5202 (begun in 1912) and including charts 5101, 6300, and 6401; Coast charts—6300 and 6400 series; Harbor charts—generally in 5100 to 6400 series inclusive; Small-Craft charts—100–SC to 199–SC series (begun in 1959 along Atlantic coast), 600–SC to 699–SC series and any conventional chart adapted to small-craft use (begun in 1963).

*Hawaiian Islands.* Sailing charts—4000 and 4100 series (begun in 1898); all other charts—4100 series.

*Alaska.* No uniform pattern prevails. Generally, the charts eastward of Unimak Pass are in the 8000 series and those to the northward and westward in the 9000 series, except the General charts of the Aleutian and the Pribilof Islands which are in the 8000 series.

Whenever possible, consecutive numbers for adjacent charts of the same scale are used, such as the 1100 and 1200 series of the Atlantic and Gulf coasts. This is not, however, generally possible in the case of large-scale harbor charts where an established sequence of numbers is frequently interrupted by the

30. These superseded the 3200 series charts of the Atlantic Intracoastal Waterway which were first published in 1924.

31. This series was also used for the charts of the Canal Zone until September 1949 when their publication was transferred to the jurisdiction of the Hydrographic Office of the Navy Department. "Catalog of Chart Numbers," *supra* note 26.

cancellation or rearrangement of charts, or by the changing of scales necessitated by the development of ports and the consequent change in the mariner's needs.[32]

As to the use of previously assigned numbers for new charts, the present practice is to use such numbers if the charts have been canceled for 20 years or more.[33]

The use of the suffix "SC" with the chart number in all cases except the 100 series will designate a folded conventional chart with additional information for the use of small craft (*see* chart 246–SC of Boston Harbor). These charts do not replace the conventional charts. The 600 series includes charts in the small-craft category not published as conventional charts (*see* chart 690–SC of Lake Washington), and conventional charts not in the small-craft category. The 800 series with the designation "SC" replaces the corresponding conventional charts in that series.

### 1272. *Dates on Charts*

Users of nautical charts should not be misled by the several dates appearing on them. Since a chart is a compilation, the information on it may have been obtained at different times. One portion, comprising an unchangeable area, may be based on surveys made many years ago, while another portion, subject to natural or artificial changes, may reflect the results of recent surveys. Therefore, from the dates alone, no indication can be had as to when any particular information was applied to a chart. For this, recourse must be had to the "History Sheets" in the Bureau files (*see* 1275). Nevertheless, the user of charts should be familiar with the meaning and significance of chart dates. On the most recent charts, three such dates appear—The *correction date,* the *edition date,* and the *new print date.* At one time, dates were included in the Publication Note of the chart (*see* 1273) and in the Authority Note (*see* 1274).

(*a*) *Correction Date.*—The most important date on a chart, from the standpoint of the navigator, is the date as printed in the lower left-hand margin on

32. In numerical order, the plan of assignment of chart numbers in 1963 (including aeronautical charts and miscellaneous maps and charts) is as follows: 1 to 9—Symbols and Abbreviations, etc.; 10 to 99—Sailing and General charts, Atlantic and Gulf coasts; 100–SC to 199–SC—Small-Craft folios consisting of 3 or 4 folded sheets, for all coasts; 200 to 799—Harbor charts, Atlantic and Gulf coasts; 600–SC to 699–SC—Small-craft route charts for rivers and narrow waterways consisting of a single folded sheet, for all coasts; 800 to 899—Intracoastal Waterway charts; 900 to 999—Puerto Rico and Virgin Islands charts; 1000 to 1999—Sailing, General, and Coast charts; 2000 to 3999—Aeronautical charts and Miscellaneous Maps and Charts; 4000 to 4199—Hawaiian, Samoa, and Guam Islands charts; 4200 to 4999—Open (formerly for Philippine Islands charts); 5000 to 6999—Pacific coast charts; 7000 to 7999—Open; 8000 to 9999—Alaska charts.

33. EDMONSTON (1956), *op. cit. supra* note 15, at 15. This does not apply to the Intracoastal Waterway charts in the new folded format with limits changed and suffix letters added. Although they cancel one or more of the previous charts in the flat format, they retain the old numbers.

Intracoastal Waterway and Small-Craft charts, thus: Corr. thru NM 3—1/21/61; or as hand-stamped in the lower right-hand margin on standard charts, thus:

CORRECTED THROUGH
NOTICE TO MARINERS
NO. 28 JULY 12 '58
U.S.C. & G.S.
WASHINGTON, D.C.

This is referred to as *correction date* or *hand-correction date.* It gives the number and date of the *Notice to Mariners* through which the chart has been corrected by hand for changes in aids to navigation, newly discovered dangers, and important changes in channel depths.[34] For changes subsequent to the stamped date, the mariner must consult the *Notice to Mariners* in order to ensure that his chart reflects the latest condition in the area to be navigated. This tie-in of the correction date of the chart with the *Notice to Mariners* is the current form used and was adopted October 5, 1954.[35]

(*b*) *Edition Date.*—When a new chart is published, the month and year of first publication is printed in the center of the upper margin of the chart as the first edition date, thus: 1st Ed., June 1957. This note never changes and is carried in this location for the life of the chart. The note also appears in the lower left-hand margin of the chart with the day of the month, but only the last two digits

34. *Notice to Mariners* is a pamphlet issued weekly by the U.S. Naval Oceanographic Office (formerly Navy Hydrographic Office) and contains material affecting the safety of navigation, such as changes in aids to navigation and channel depths, newly discovered dangers, and the like, with which the mariner can bring his charts up to date. It is published jointly by the U.S. Coast Guard and the Oceanographic Office. The Coast Survey and the Corps of Engineers contribute material to this publication. In addition to keeping mariners advised of changes, it also announces new charts, new editions of charts, and new publications. Prior to 1869, the Bureau issued notices in the form of a press release. The first serially numbered notice was published on Jan. 14, 1875. Notices were issued on a monthly basis from that time to Jan. 1, 1908, when it was discontinued as a publication of the Survey and was, by direction of the Secretary of Commerce and Labor, consolidated with and made a part of the weekly *Notice to Mariners* issued by the Light-House Board. BURCHARD, LIST AND CATALOGUE OF THE PUBLICATIONS ISSUED BY THE U.S. COAST AND GEODETIC SURVEY 95 (1902), 21 (1908 Supplement). Under the Reorganization Plan, effective July 1, 1939, the Bureau of Lighthouses was transferred from the Department of Commerce and consolidated with and administered as part of the Coast Guard. The latter then assumed the responsibility, together with the Oceanographic Office, for preparing the *Notice to Mariners.* This is the arrangement in 1963. Changes and deficiencies in aids to navigation, and other information of navigational importance, are published in Local Notice to Mariners. These are issued at frequent intervals by the commander of the Coast Guard for the district in which the aids are located. All such information of a continuing nature is inserted in the weekly *Notice to Mariners.*

35. *New Format for Nautical Charts,* 6 JOURNAL, COAST AND GEODETIC SURVEY 151 (1955). Prior to this date, the correction note was printed in the lower right-hand margin and read as follows: "Lights, beacons, buoys, and dangers corrected for information received to the following date." It was followed by a hand-stamp giving the date of issue of the chart. This note was used in substantially the same form from about 1915 (*see* chart 369). Prior to this no such detailed information was included on the chart. Conventional Intracoastal Waterway charts carry the following caution note regarding hand corrections: "This chart has been corrected only to the print date shown in the lower left-hand corner. Corrections subsequent to this date should be made from the Weekly Notice to Mariners."

of the year are given, thus: 1st Ed., June 24/57.[36] In the case of folded charts, the date is shown thus: 1st Ed., corr. thru NM 45-Nov. 10, 1962.

A *new edition* of an existing chart is printed when corrections are so extensive or of such importance to navigation as to render all previous printings obsolete. It includes all chart corrections published in the *Notice to Mariners,* and all other corrections too extensive to be applied by hand and which are not ordinarily published in the *Notice to Mariners.* New editions are also issued when there is an accumulation of hand corrections of the order of 80 or more. A new edition does not necessarily indicate that the chart has been reconstructed, nor does the date necessarily have any reference to the dates of the surveys. The frequency of new editions varies with the chart.

When a new edition is printed, all dates in the lower left-hand margin of the chart are removed and the new edition note substituted, thus: 2nd Ed., June 3/58.

(*c*) *New Print Date.*—When changes or corrections of a relatively minor character are made to a chart, the new issue is known as a *new print.* Such prints do not render the previous printings of the current edition obsolete for use in navigation. The corrections are applied to the negatives and a new printing plate is made and the date (month, day, and year) of the new print is added to the right of the edition date in the lower left-hand corner of the chart, thus: 1st Ed., June 24/57; Revised 1/7/58. Additional revisions of the chart in the form of new prints cancel the previous revision dates and the latest new print date is substituted, thus: 1st Ed., June 24/57; Revised 12/10/58.[37]

Charts are sometimes reprinted for the sole purpose of replenishing stock, without any corrections being made. Such issue is an exact duplicate of the current issue and no changes in printing or publication dates are made. But if one letter or one sounding is changed, the issue is classed as a *new print* and a revision date is added in the lower left-hand corner.

In summary, the essential point to bear in mind with regard to dates on charts is that they represent the dates of publication and bear no relationship necessarily to the date when a particular area was surveyed or when certain

36. This practice of indicating the 1st edition of a chart became operative on Oct. 5, 1954. *Ibid.* Formerly, beginning with Apr. 10, 1945, the 1st edition note was located in the Publication Note (*see* 1273). Prior to this, the date of first publication, if shown at all, was usually placed in the title. (*See* Coast Chart No. 120, New York Bay and Harbor, Dec. 1885 ed., which gives the date of first publication as 1866.)

37. Prior to 1915, the only dates, other than dates in the Authority Note (*see* 1274), that appeared on the chart were the date of publication and the date of first publication, both of which appeared in the title. After this date, the practice of showing new print dates on the chart in the lower left-hand corner was begun (*see* chart 369). (This may not be a firm date as far as other charts are concerned.) All the print dates after a new edition was issued were left on the chart and were removed only when the next edition was issued. This practice continued generally until 1954 (*see* note 36 *supra*).

information was obtained. The fact that a new edition was issued does not mean that the entire area of the chart was revised. The necessity for the new edition may be due to revision surveys far removed from the area of interest. It is obviously impossible to cover the entire area of most charts in one progressive field survey. The data used in the original compilation are therefore of different dates, even before any amendments have been applied. In fact, two adjacent soundings may sometimes be from surveys years apart. If the precise date of origin of a particular section of a chart is required, the original data from which the chart was compiled must be consulted (*see* 1275).

### 1273. *Publication Note*

When a new chart is published, a *publication note* is added in the lower center margin, thus:

Compiled and printed at Washington, D.C. by
U. S. DEPARTMENT OF COMMERCE
*Luther H. Hodges, Secretary*
COAST AND GEODETIC SURVEY
*H. Arnold Karo, Director*

When space is insufficient for the five-line note, the names of the Secretary and the Director are omitted.

Formerly, the publication note included the month and year of publication,[38] and between 1945 and 1954 the date of the 1st edition of the chart was also included (*see* note 36 *supra*). The present form of publication note shown above dates from February 1959. Before that only the Bureau name and the name of the Director were included.

### 1274. *Authority Note*

Every chart now published contains an *authority note,* similar to the following, which gives the federal agencies that have contributed to the information used in the compilation:

AUTHORITIES

Hydrography and topography by the Coast and Geodetic Survey with additions and revisions from the Geological Survey, Naval Oceanographic Office, and Corps of Engineers.

38. This practice was followed since about 1915. Prior to that time the date of publication was given in the title of the chart.

When most of the information is from sources other than the Coast and Geodetic Survey, a note similar to the following is used:

AUTHORITIES

Surveys by the Coast and Geodetic Survey and Corps of Engineers.[39]

The present form of generalized note, excluding all reference to dates of surveys, is of comparatively recent origin, dating back to 1947.

### A. EARLY PRACTICE

Authority notes have undergone many changes in both form and content. The Map of New York Bay and Harbor, published in 1845, gave detailed information relative to the dates of surveys of the shoreline and soundings in various parts of the map. For example, with regard to Sandy Hook the note states: "The shore line of Sandy Hook as established in 1844, is distinguished from that of 1836, by an exterior line, and the Soundings of the same date are marked thus $\underline{2}$, $\underline{4}$, $\underline{5}$, $\underline{40}$." For elaborateness, a high point was reached in 1883 in the note on chart 369, Bay and Harbor of New York (*see* fig. 24). It gave the dates and locations of the basic surveys and resurveys, including the names of the surveyors. The surveys were confined to triangulation, topography, and hydrography. (Later, the dates of magnetic and astronomical observations were added but without specifically limiting the applicable areas.)

### B. INTERMEDIATE PRACTICE

Since 1883 there has been a gradual tendency toward simplification and generalization, climaxed in the form of note used in the 1924 edition of the same chart, thus:

AUTHORITIES

Surveys to 1920
Surveys by U.S. Engineers to 1924 and other sources

### C. LATER PRACTICE

There was an obvious deficiency in the latter type of note because it gave the user of the chart no indication of the obsolescence or recency of the material

39. Edmonston (1956), *op. cit. supra* note 15, at 25.

**AUTHORITIES**

*This chart is reduced from a survey made in 1855,'56&'57 under the direction of A.D.BACHE Superintendent of the Coast Survey for the New York Harbor Commissioners, and refers to that period, but the channels and aids to navigation, the water fronts and railroad lines have been generally brought up to 1873*

*The* **Triangulation**, *based upon the primary triangulation of the coast executed by F.R.Hassler Superintendent in 1837 & '38, was made partly by J.Ferguson Assistant in 1836, but mainly by E.Blunt Assistant, between 1833 & '35 and subsequently between 1852 & '57.*

*The* **Topography** *of both shores of the Hudson and East Rivers except the cities of New York and Brooklyn was surveyed by H.L.Whiting Assist. aided by F.W.Dorr, C.Rockwell and J.Mechan in 1857 & '58; Staten Island by H.L.Whiting aided by F.W.Dorr in 1856 & '57; South-shore of Raritan Bay by A.M.Harrison Assist. in 1855 & '56; from Perth Amboy to Newark by F.W.Dorr Sub-Assist. in 1858; Long Island south and east of Brooklyn by S.A.Gilbert Assist. in 1855 & '56; the interior between Brooklyn, Flushing and Jamaica by F.W.Dorr Sub-Asst. in 1859 and H.L.Whiting Assist. in 1862. The Wharf front of the cities of New York and Brooklyn was surveyed by A.Boschke Assist. in 1857. The compilation of the interior of the cities of New York and Brooklyn, the re-survey of the shores of Newark Bay and Passaic River and of new wharves and docks are by F.H.Gerdes Asst.*

*The* **Hydrography** *of the approaches of the Lower and Upper Bays and of East River was surveyed by Lieut.Comdg. T.A.Craven U.S.N.Assistant in 1855; that of Hudson River and Staten Island passages by Lieut.Comdg.R.Wainwright U.S.N.Assistant in 1855; changes in the Sandy Hook and Swash Channels and on the Jersey Flats by H.Mitchell and F.F.Nes Assistants up to 1872; Newark Bay and Passaic River by F.H.Gerdes Assistant in 1872.*

**Edition of 1883**

*This edition shows the resurvey of Coney Island, Rockaway Beach and the shores and Islands of Jamaica Bay by J.W.Donn, Assistant, in 1877 and '78. The Hydrography of Jamaica Bay by Lieut. W.Maynard U.S.N.Assistant, in 1877, and the resurvey of Rockaway Inlet and the channels between Sandy Hook and Coney Island by Lieut. Comdr. E.B.Thomas U.S.N.Assistant, in 1881 and 1882. Resurvey of Gedney's and the Swash Channel by Ensign J.M.Orchard, U.S.N. Assistant, in 1884. And important corrections from resurveys in 1885 and 1888, by Engineers U.S.A.*

FIGURE 24.—Facsimile of *Authority Note* used on the nautical charts in 1883.

used. Nor was any distinction made between hydrography and topography. To remedy these defects, a note was designed in 1938 that combined terseness with utility of purpose. Its general form was as follows:

AUTHORITIES

Topography by the U.S.C. & G.S. in 1933 and 1934
Supplemented by topography by the U.S. Geological Survey in 1892

Hydrography by the U.S.C. & G.S. in 1934
Supplemented by surveys in dredged channels by the U.S. Engineers to 1937

This form of note was used on charts on which almost the entire area was surveyed recently and within a short period. This applied to almost all new charts of scale larger than 1:80,000 and to some of the latter scale.[40]

Inextensive corrections to the chart, however recent, were not reflected in the authority note, but changes in the latter were made dependent upon the extent to which the chart had been amended. If new surveys covered the main portion of the chart, their dates were included, otherwise they were given only under special circumstances, as where they completely covered the changeable area of the chart. Another change effected in this form of note was the specific inclusion of the name U.S.C. & G.S. In all previous forms this was omitted, but Coast Survey sources were assumed unless otherwise stated.

But even this form of note was inadequate because it gave only a general idea with regard to the dates of surveys on which the chart was based. To avoid possible misinterpretations, it was decided to eliminate all dates from the authority note and adopt the form shown at the beginning of this section. A contributing factor to adoption of the present form was the fact that very complete history records are now kept of each chart and it is a relatively simple matter to trace the authority for all the information found on a modern chart (*see* 1275).

### 1275. *History Sheets*

An important innovation in the preservation of chart records was the establishment in 1900 of a "history sheet" file.[41] On these sheets are preserved, in compact form, every detail and authority used on the charts together with the date when a correction was applied. Through this file the history of every chart can be traced should this become of consequence. This file is still maintained. The present form of record is known as a "History of Cartographic Work" and is more elaborate in scope than the early records, one reason being that there are now many more sources of information used in the compilation of a chart than was the case formerly.[42] Also the Bureau has become more

40. On charts of very small scale, it was almost impossible to adopt an all-inclusive authority note. The extent of the area covered by a single such chart necessitated the use of data extending over a considerable period of time and to attempt to classify such information on the chart would have resulted in a note so cumbersome as to be of little practical value. It was therefore customary in such cases to omit the note altogether, or to insert a generalized statement regarding sources.

41. Annual Report, U.S. Coast and Geodetic Survey 90 (1900).

42. Edmonston (1956), *op. cit. supra* note 15, at 28–30. Prior to 1900 and dating back to 1851, there was maintained a series of "Chart Correction Books" in which corrections to the various charts were entered.

C & GS 925
Rev. 2 62

HISTORY OF CARTOGRAPHIC WORK – NAUTICAL CHART DIVISION FILES

| | | | | |
|---|---|---|---|---|
| CHART 566<br>DRAWING #18<br>SHEET 1<br>PROJECT 50150 | NC REC CORR FUTURE<br><br>DATE | TO REPRODUCTION<br>NC (NE) NP RP TO<br>DATE | X LITH Rec'd<br>LITH Ver<br>PRINT DATE | REMARKS (over)<br>Changed to NE-95 hand corr. - 12-12-62 |

| Applied Part | Applied Full | Item | Source of Information: File No | Date | Authority | Type of Information | Locality | Information Applied |
|---|---|---|---|---|---|---|---|---|
| | ✓ | 1 | H-8522 | 1961 | C&GS | Hydro | W. of Kent I. | Applied entire base survey |
| | ✓ | 2 | H-8523WD | 1961 | C&GS | Hydro | W. of Kent I. | 50 and 21 soundings carried forward |
| | ✓ | 3 | L-964 | 1962 | C of E | Topo | Cedar Pt. | Added pier |
| | ✓ | 4 | L-362 | 1962 | C of E | Clearance | Ches. Bay Bridge | Lowered vert. clear. (for construction gondola) |
| | ✓ | 5 | L-89 | 1962 | C&GS | Landmark | Entire chart | No corr. |
| | ✓ | 6 | L-340 | 1962 | C&GS | Landmark | Entire chart | Added "O Standpipe" at Round Bay and deleted "O CLOCK" at Crystal Beach |
| | ✓ | 7 | L-1285 | 1961 | C&GS | Misc. | Entire chart | 3 ft. sounding added at chan. into Lake Ogleton. Added shoaling note on chan. into Spa Creek. Deleted cupola at Annapolis. Added foot bridge at Annapolis |
| | ✓ | 8 | L-1217<br>BP-60369 | 1961<br>4-61 | USN | Hydro | Annapolis | Revised soundings and depth curves (thru cht 385) |
| | ✓ | 9 | BP-61203-05 | 12-61<br>4-62 | C of E | Hydro | Craighill Chan. | Revised soundings (2) along edge of channel |
| | ✓ | 10 | Aid Proof #23 | | | | | Corrections made thru 10-1-62 |
| | ✓ | 11 | New print cht. 566 | | | | | Applied to drawing |

| Items | Compiled by | Started | Completed | Time (hrs) | Items | Verified by | Started | Completed | Time (hrs) |
|---|---|---|---|---|---|---|---|---|---|
| 1-2 | John Jones | 9-24-62 | 9-26-62 | 11 | 1-2 | John Doe | | 10-1-62 | 2 |
| 3-11 | W. Smith | 9-27-62 | 9-28-62 | 16 | 3-11 | John Doe | | 10-2-62 | 4½ |

FIGURE 25.—Sample of history record of a nautical chart compiled in 1962.

conscious of the collateral uses of charts and the importance of being able to trace sources of information and dates of application. The history sheet represents a complete and detailed record of all available information used or consulted in the compilation. This may come from various types of surveys and records (*see* 127). A sample of the history record of a chart compiled in 1962 is shown in figure 25.

## 1276. *Special Files of Charts*

There are several special files of charts maintained in the Bureau for keeping track of chartable material received between successive editions or prints of charts, and for other purposes in connection with furnishing information on the navigational conditions existing at a given date. The more important of these will be described in succeeding paragraphs.

A. STANDARDS FILE

This file is one of the most important in the Bureau pertaining to nautical charts. It is the means by which a record is kept of incoming charting information, be it a survey of the Bureau, a Corps of Engineers blueprint, or a survey from a miscellaneous source. It was begun about February 1908. Prior to that time a record was kept in book form of all information as received and the charts affected. This was transcribed into a set of 12 volumes arranged according to charts. It is possible that in conjunction with these volumes some charts were also kept on which the information received was entered, but which were probably destroyed as soon as the information was applied to the chart. This system was abandoned with the beginning of the "Standards File" in 1908.[43]

The Standards File consists of a complete set of the published charts. When chartable information is received, the area affected is circled in color on the chart and a leader run to a stamp in the margin giving the authority for the information, the date when applied to the drawing, and the date when applied to the printing plate. Ordinarily, standards are only changed when a new edition is issued; however, if a standard becomes overcrowded with material that has been applied to new prints, a new standard may be made before a new edition is called for. As will be seen, this procedure differs from the aid proofs (*see* B, below). Information shown on the current standard is incorporated in the new edition and the latter becomes the new standard. The former becomes the "Preceding Standard." A stamp at the bottom of the chart gives the chronological sequence of the standards, thus:

| | |
|---|---|
| STANDARD | July 1961 |
| Preceding Standard | May 1960 |
| Following Standard | Aug. 1962 |

In addition to the chronological stamp, each standard has a consecutive number to assist in keeping track of the successive standards.

When a current standard is replaced by a new standard, the date of the latter is entered opposite "Following Standard" in the stamp, and at the same time the date of the earlier standard is entered on the new standard. All standards from their beginning in 1908 to the present time are available, and it is the intention (in 1963) to retain them as a permanent file.

43. A standard is usually a copy of a new edition (*see* 1272) or a new chart on which is indicated in outline form all new information, except aids to navigation, to be applied to the chart before printing. *Id.* at 2.

### B. AID PROOF FILE

The "Aid Proof File" consists of a complete set of the published charts on which a record is kept of all changes in aids to navigation and all hand corrections applied to the chart since the last new print (*see* 1272) was issued.[44] Just when such file was begun is somewhat uncertain, since it was never kept as a permanent file. Some form must have existed even at a very early time, but due to the relatively few corrections required in those days, the complete file in use today (in 1963) was not needed. However, the more important corrections were entered in a set of 12 volumes (*see* A, above).

Originally, hand corrections to the charts (dangers and changes in aids) were accurately shown on the aid proof and on the standard, but beginning with February 1931 such corrections were plotted only on the aid proofs and these formed the bases for the corrections applied.

Aid proofs are changed with every new print of a chart, thus differing from standards in this respect which are changed generally only with every new edition (*see* A, above). Information shown on the current aid proof is incorporated in the new print of the chart and the latter becomes the new aid proof. The former then becomes the "Preceding Aid Proof." A stamp at the bottom of the chart gives the chronological sequence of the aid proofs, thus:

| | |
|---|---|
| AID PROOF | Mar. 1962 |
| Preceding Aid Proof | Dec. 1961 |
| Following Aid Proof | July 1962 |

In addition to the chronological stamp, each aid proof has a consecutive number to assist in keeping track of successive aid proofs.

When a current aid proof is replaced by a new aid proof, the date of the latter is entered opposite "Following Aid Proof" in the stamp, and at the same time the date of the earlier aid proof is entered on the new aid proof.

Aid proofs do not constitute a permanent file. As filing space becomes scarce, the aid proofs are microfilmed and then destroyed. It is the present plan (in 1963) to retain this file from 5 to 10 years which should satisfy the needs of the legal profession insofar as litigations arising from wrecks and collisions are concerned (*see also* E, below). However, even though the aid proofs are eventually destroyed the microfilms will always be available and the

44. An aid proof is a copy of the latest new print of a chart on which are indicated all changes in aids to navigation and important corrections that must be applied to the printing plate before the next printing of the chart. The majority of these changes are applied, by hand, to the existing stock of charts before issue to the public. Information regarding changes in aids is derived principally from the *Notice to Mariners* (*see* 1272). *Id.* at 3.

information will also be available in the daily entry book (on cards since 1942) kept in the Bureau.

#### C. RECORD FILE

A file of each edition of all nautical charts is maintained in the National Archives Building and is known as "Record File." It was established in 1956 and was formed from what was then known as the "Permanent File." It is as complete as it was possible to make it at that time. Since then, one copy of each new edition has been added to it. The remaining old charts in the Bureau, after the Record File was established, was set up as a "Reference File." This file was only about 75 percent complete and is not being expanded. Distribution is not made from these files.

#### D. DISTRIBUTION FILE

The "Distribution File" consists of copies of new editions of all nautical charts. Five copies of each new edition are placed in this file for sale or issue, after the regular sales stock is exhausted. Should the need arise for a chart of a certain date after the Distribution File is exhausted a photographic copy of the chart in the Record File (*see* c, above) could be furnished.

#### E. MARINE ACCIDENT FILE

In 1954, a special file of nautical charts was established for use in connection with the marine accident cases or wreck investigations, identified as the "Marine Accident File." Upon receipt of information of an accident, three copies of the appropriate charts in force at the time are placed in this file. These are retained for a period of 5 years.

### 13. ENGINEERING USE OF SURVEYS AND CHARTS

Those who use surveys and charts for engineering or legal purposes must understand certain of the basic elements associated with them in order to guard against the introduction of errors resulting from the medium on which surveys and charts are prepared, and from other sources. If these limitations are properly recognized, it is usually possible to make a comparison of two or more successive surveys with an accuracy equal to that inherent in the original surveys themselves.

## 131. The Scale of a Survey or Chart

Scale is the relation that a measured distance on a "survey, map, or chart" (referred to hereinafter for convenience by the generalized expression "map") bears to the corresponding actual distance on the earth. It is a system of proportion by which definite selected magnitudes on the map represent definite given magnitudes on the earth, and can be expressed by the fundamental relationship

$$\text{Scale} = \frac{\text{Distance on map}}{\text{Distance on earth}}.$$

Thus, a scale of 1 inch = 1,000 feet means that a distance of 1 inch on the map represents a distance of 1,000 feet on the earth. Scale determines the amount of detail that it is possible to show in a given area. Its selection therefore depends upon two factors—the character of the area to be mapped, and the use which the map is to serve. The larger the scale the more detail can be shown, and, conversely, the smaller the scale the more generalization will be required (*see* 1313).

The matter of scale is important to the user of maps. We are all familiar with the map of the world on which Greenland appears larger than the whole of South America. It is only when account is taken of the projection base of the map and its properties (*see* 613) that we realize that actually South America is nine times larger than Greenland. The same is true with surveys of different scales. A visual comparison of two surveys, without regard to scale, may often result in erroneous impressions of the amount of change having taken place in a given locality. Small differences may become overly magnified unless we are conscious of the difference in scale.

### 1311. *Fractional Scale*

On Coast Survey charts and surveys, the scale is indicated by a fraction in which the numerator is unity and the denominator is the number that the unit distance must be multiplied by in order to obtain its distance on the ground in the same units. Thus, the scale of 1 inch = 1,000 feet would be designated as $\frac{1}{12{,}000}$ (read "one to twelve thousand"), there being 12,000 inches in 1,000 feet. In other words, the unit distance of 1 inch in this case must be multiplied by 12,000 in order to obtain its distance on the ground, which is 12,000 inches. Similarly, any other unit—1 foot, 1 yard, 1 centimeter, etc.—represents 12,000 of the same unit on the ground. Such a scale is termed a "fractional scale," and

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the fraction is commonly called the "representative fraction" or "R.F." of the map. It is sometimes also referred to as the natural scale (*see* 6412(*a*)) and appears variously as 1: 12,000, 1/12,000, or 1–12,000. On the more recent topographic and hydrographic surveys, and on the nautical charts, the form 1: 12,000 is used, and this is the form followed in this publication.[45]

Most of the topographic surveys of the Coast Survey are on scales of 1 : 10,000 and 1 : 20,000. This is also true of the hydrographic surveys adjacent to the coast, the scales being smaller for surveys of offshore areas.

The scales of nautical charts vary from large scales for harbor charts to small scales for charts used in offshore navigation (*see* 1313).

### 1312. *Graphic or Linear Scale*

On nautical charts of scales 1 : 80,000 or larger, graphic or linear scales are usually shown in addition to the fractional scale (*see* fig. 26). These consist of lines subdivided into units representing nautical miles, statute miles, and yards. Such scales have the great advantage of remaining true after the chart has been enlarged or reduced photographically, or has undergone changes in scale due to the printing process or to changes in the hygrometric conditions of the atmosphere, because any variation from true scale in the body of the chart is also reflected in the graphic scale and distances may still be measured with accuracy.[46]

When reproduction copies of original surveys are requested from the Washington Office, a graphic scale is attached to the survey prior to photographing.

### 1313. *Large and Small Scales*

Confusion often exists regarding the true meaning of the terms "large" and "small" as applied to the scale of a map or chart—so much so that they are frequently used in exactly the reverse sense. There is no absolute definition for

45. Where the metric system of measure is used (as in the Coast Survey), the denominator of the fractional scale is usually a round number because units in the metric system are related decimally, e.g., kilometer, meter, decimeter, centimeter, millimeter (meaning 1,000 meters, 1 meter, 0.1 meter, 0.01 meter, 0.001 meter, respectively). A survey on a scale of 1 centimeter to 500 meters is represented by the fraction $\frac{1}{50{,}000}$, since there are 50,000 centimeters in 500 meters. If the English system of measure is used, awkward fractions result because of the absence of a decimal relationship. Thus, a scale of 1 inch to the mile is indicated as $\frac{1}{63{,}360}$ and ½ inch to the mile as $\frac{1}{126{,}720}$.

46. In northern latitudes, such as Alaska, the 1 : 80,000 scale charts do not carry the graphic scale because of the rapid change in scale of Mercator charts (*see* charts 8302, 8520). For information regarding scales on nautical charts smaller than 1 : 80,000, *see* 6412.

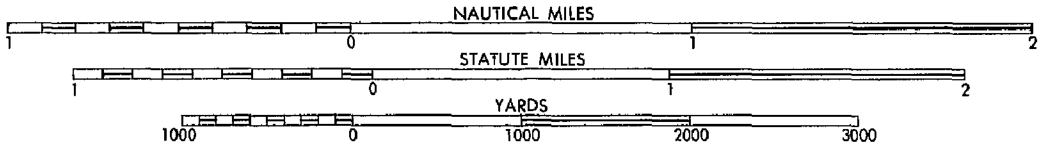


FIGURE 26.—Graphic scales used on Coast and Geodetic Survey charts.

these terms; they are necessarily relative. We cannot say that a 1: 40,000 scale chart is of small-scale, because in relation to a 1: 120,000 scale it is a large scale. On the other hand, it is a small scale in relation to a 1: 5,000 scale. Whether one chart is larger or smaller in scale than another is determined by the relative length that a distance on the ground has on the two charts, and not by the ground area covered, as is sometimes thought. The chart on which the ground distance spans a greater length is the larger scale. Thus, a ground distance of 10,000 inches would span a distance of 1 inch on a 1:10,000 scale chart, but would only span ½ inch on a 1:20,000 scale. Therefore 1:10,000 is a larger scale than 1:20,000, although for the same size chart the latter would cover four times the area of the former. A simple rule with fractional scales is that the larger the denominator the smaller the scale, or, stating it differently, the smaller the value of the R.F. of the map or chart, the smaller is the scale. Thus, $\frac{1}{20,000}$ is a smaller scale than $\frac{1}{10,000}$.

Insofar as Coast Survey usage is concerned, scales up to and including 1:20,000 would be considered *large* scales, those between 1:20,000 and 1:80,000 would be classed as *intermediate* scales, and scales smaller than 1:80,000 would fall into the category of *small* scales.

## 1314. *Determining the Scale of a Survey*

It sometimes becomes desirable to determine the actual scale of a survey, as where distortion has crept in or where the scale has for some reason not been indicated. Problems of this kind are readily solved in the following manner by application of the fundamental relationship for scale (*see* 131):

Assume a survey, with a fractional scale of 1:10,000, extending from latitude 45°05′ to latitude 45°15′, the projection intervals being given for each minute of arc. Take 1 minute of latitude near the center of the survey (say between 45°10′ and 45°11′) and find its value in meters on a metric scale. (By using a 1:10,000 metric scale, the distance in meters can be read directly since each subdivision on the scale equals 1 centimeter or 0.01 meter.) Suppose this value is found to be 0.1865 meter. The corresponding distance on the earth's surface for 1′ of latitude at latitude 45° 10′ is then found from the published tables to be 1,852.24 meters.[47] The fractional scale of the survey is therefore $\frac{0.1865}{1,852.24}$ or $\frac{1}{9,932}$ (*see* 1311).[48]

If a metric scale is not available, the distance on the survey can be measured in inches and the tabular value of 1,852.24 meters converted to inches from the relationship 1 meter = 39.36990 inches.[49] The same fractional value for the scale will result.[50]

The scale of the survey can also be determined by measurement between meridians of longitude and comparing these measurements with the corresponding tabular values as taken from the left-hand pages of Special Publication No. 5 (*see* note 47 *supra*) marked "Arcs of the parallel in meters" for the particular latitude used. The mean of the determinations in the east-west and north-south directions should be taken as the scale of the survey.

Even where no projection is shown on the survey, the scale can be determined provided the work is based on a triangulation system. In such cases, the problem becomes one of measuring the distance on the survey between triangulation stations and comparing these values with the values given in the computational data.

Once the true scale of a survey has been determined, measurements made on the survey sheet, using a scale corresponding to the fractional scale of the survey, can be converted to true distances by the following simple proportion:

Measured distance times fractional scale = $X$ times true scale.

Thus, if the measured distance is 50 meters on the $\frac{1}{10,000}$ fractional scale, and the true scale of the survey is found to be $\frac{1}{9,932}$, then the true distance would be

$$50 \times \frac{1}{10,000} = X \times \frac{1}{9,932}, \text{ or } X = 49.66 \text{ meters.}$$

### 132. Errors Due to Distortion of Medium

In using successive surveys or charts for studying the rates of shore recession or advance, or for other purposes, the first consideration is that the surveys or charts must be brought to the same scale before any quantitative measurements can be made. Even though the scale may have been correct at the time the

47. *See* Tables for a Polyconic Projection of Maps and Lengths of Terrestrial Arcs of Meridian and Parallels 101, Special Publication No. 5, U.S. Coast and Geodetic Survey (1946).

48. One minute of latitude is used in the example for simplification. In practice, several minutes should be used in order to minimize the effect of an error in the original plotting of one of the projection lines.

49. *Id.* at 3. The legal value for the meter in the United States is 39.3700 inches. *Ibid.*

50. If it is desired to express the relationship in miles to the inch, the distance on the survey is measured in inches and the tabular value converted to miles. The computation of the scale is obvious.

survey or chart was drawn, it cannot be assumed that it has remained so, as the paper used is subject to changes in dimensions due to varying atmospheric conditions and in the case of charts due also to the printing process employed. These changes are usually unequal in the two directions (with and across the grain of the paper), with intermediate values in other directions. These changes are referred to as distortions.

### 1321. *Correction Factor to be Applied*

To measure distances accurately on a survey where no graphic scale is shown and the fractional scale no longer represents the true scale, a correction factor must be determined and applied to every measured distance. This factor can be computed from the following relationship:

$$\frac{\text{Tabular value} - \text{Survey value}}{\text{Survey value}} = \pm \text{ Correction factor.}$$

A procedure similar to that described for the determination of the scale of a survey can be followed (*see* 1314), the survey value in this case being obtained by measuring on a scale corresponding to the fractional scale shown on the survey.[51]

For precise measurements, a correction factor should be obtained for both a north-south and an east-west direction. A mean value can then be used or a graduated factor applied to a measurement depending on its direction.

### 133. Errors Inherent in Original Surveys

Inherent in the distances scaled from the surveys are not only the errors due to paper distortion, but also those that might be considered inherent in the original surveys themselves. This arises from the fact that no survey is a precise copy, in miniature, of the original features on the earth. Even the best survey is but an abstract of a part of the earth's surface showing the major features with a greater or less degree of accuracy according to the nature and purpose of the survey.

The general accuracy of the early surveys of the Bureau has been heretofore discussed (*see* 11). The limitations inherent in the method of survey is discussed in the chapter on "Analysis and Interpretation of Topographic Surveys"

51. If no such scale is available, the survey value can be measured in inches and the tabular value converted to inches on the indicated fractional scale. Thus, if the fractional scale is 1:10,000 and the tabular value for 1 minute of latitude is 1,824.24 meters, then this value multiplied by inches in a meter and divided by 10,000 will give the tabular value to be used in the above equation.

(*see* 442 and 443). Suffice it to say here that the degree of accuracy depends on a number of factors among which might be mentioned the purpose of the survey (*see* 4421) and the scale on which it is made.[52]

### 134. Transfer of Data

Under heading 1314 was discussed the matter of determining the true scale of a survey that was subject to distortion, in order that scaled distances may be in their correct values. In making comparative studies of successive surveys, some method of transfer must be utilized for either superimposing one survey on another if on the same scale, or for reducing one to the other if on different scales. There are several methods by which the shoreline or other detail can be transferred depending upon the respective scales of the two surveys, the degree of accuracy sought, and the instrumental equipment available. In this section will be considered the preparation of a composite drawing of several surveys on the same fractional scale (*see* 1311) but slightly different in actual scale (*see* 1341); and the transfer of detail from one scale to another (*see* 1342, 1343, and 1344).

#### 1341. *Tracing-Paper Method*

Where the surveys to be studied are on the same scale, the simplest method of transfer is by means of tracing paper. The procedure is to first construct a projection in its true dimensions from the published tables (*see* note 47 *supra*) on the same fractional scale as the surveys being studied and with the same subdivisions. This tracing is then superimposed on the survey to be studied and the detail traced, frequently shifting the tracing minute distances so as to distribute the error (distortion) throughout each rectangle. By this method, the field within which distances must be considered is limited initially to the smallest rectangle formed by adjacent meridians and parallels. This may be further reduced by subdivision of corresponding rectangles into any number of equal parts. By such subdivision even those maps on which the distortion is appreciable can be mechanically allowed for in preparing the composite drawing. If the subdivisions are made small enough, the amount by which the tracing is shifted each time can be so reduced that no part of the feature traced need be

52. Douglas Johnson in his "New England-Acadian Shoreline," states: "In legal proceedings involving shore changes I have heard it sincerely maintained by counsel, and apparently accepted by the court, that the accuracy of a chart surveyed on a small scale is equal to that of one surveyed on a large scale, so that photographic enlargement of the small scale chart to the same size as the larger one, must give an accurate basis for comparison of shore changes; the argument being based on the erroneous assumption that surveys are precise copies of the original features, reduced in various degrees." Johnson, The New England-Acadian Shoreline 419 (1925).

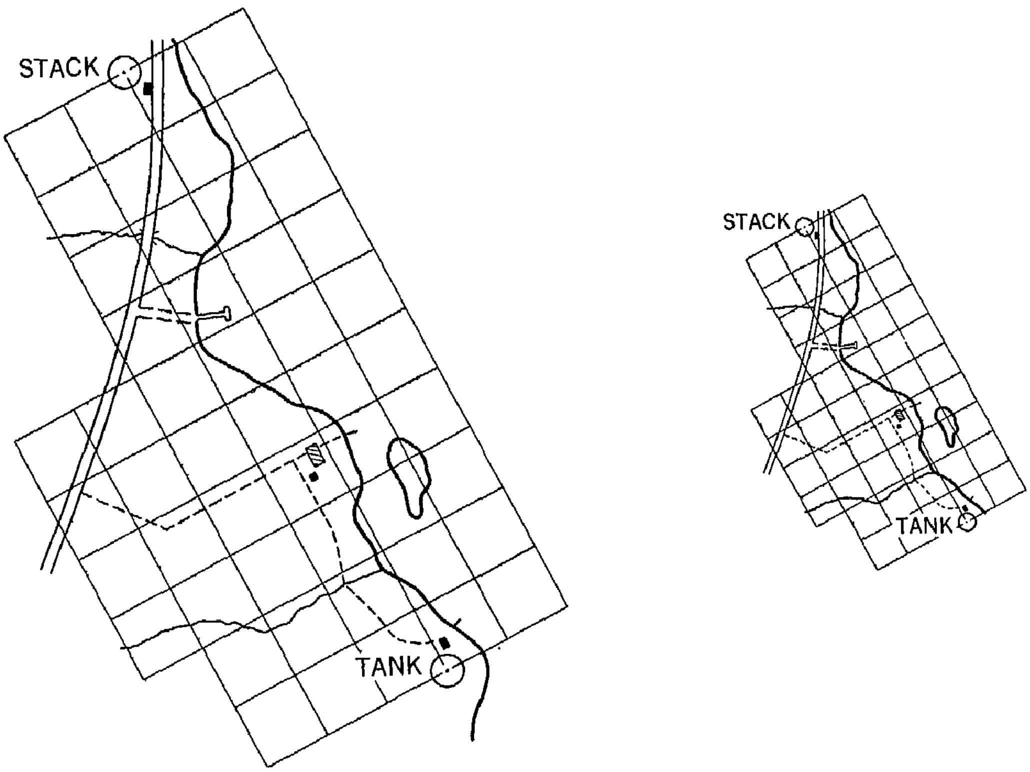


FIGURE 27.—Reduction of topography by method of squares.

in error by more than the width of the line drawn. The same procedure is followed with the other surveys.[53]

## 1342. *Method of Squares*

This method is useful for transferring detail from one survey to another where the scales are not the same. It was for many years one of the principal methods used in chart compilation for transferring hydrographic data from the survey sheet to the chart drawing (*see* 1344).

In this method (*see* fig. 27), common points on the two surveys are selected—usually intersections of meridians and parallels. Referred to these

53. If it is desired to transfer the detail from one survey to another, the same procedure is followed as outlined above with the exception that instead of constructing a new projection, a tracing is made of the projection on the survey *to which the transfer is to be made,* not of the survey to be transferred. All the adjustments are made on the survey being transferred and the detail traced. When this is completed it is merely necessary to fit the projection on the tracing paper to the projection on the survey and the transfer made by any of the methods ordinarily used.

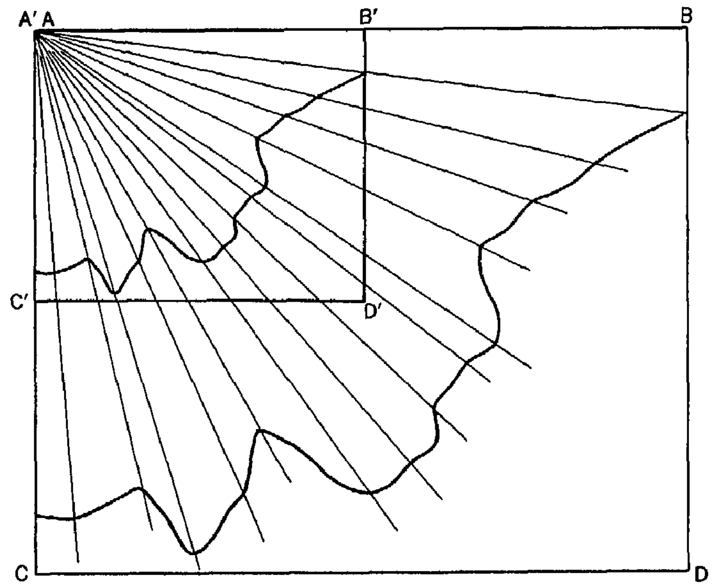


Figure 28.—Radial-line method of reducing topography.

common points, sets of corresponding squares or rectangles are constructed in pencil which are identical when referred to the actual ground detail, but differ in size on the two sheets.[54] To obtain reasonable accuracy, the squares on the smaller scale should be formed by lines not more than one-eighth inch apart. To facilitate identification, lines should be accentuated at intervals. The detail may then be transferred from one sheet to the other by reference to the positions within these small squares. The use of proportional dividers in the transfer of the detail will add to the accuracy of the results.

## 1343. *Radial-Line Method*

Another method of transferring detail from one survey to another, where the scales are not the same, is by means of "radial lines" (*see* fig. 28). A common point on the two surveys is selected from which radial lines can be drawn to intersect the general trend of the shoreline to be transferred at not too acute an angle. As in the method of squares, the radial lines are drawn on tracing paper which is placed over the source sheet. The lines are drawn to intersect the shoreline at all salient points and at enough intermediate points to permit fairly accurate sketching of the detail.

54. To avoid marking up the source sheet, the squares should be drawn on tracing paper and laid over the detail to be transferred.

In the simplest case, where it is desired to transfer to a scale half as large as the original, it is merely necessary to use dividers to halve the radial distances from the common point to the intersections with the shoreline and plot the new distances along the same lines. Subsequently, the intervening shoreline is sketched in pencil by eye through the new points so that it corresponds to the original. The shoreline at the new scale can then be transferred by any of the methods ordinarily used. The same method can be used to decrease the scale in any proportion by the use of proportional dividers.[55]

### 1344. *Photographic Method*

With the advent of stable-base photographic films and papers, the use of photography as a means of changing the scale of the material to be transferred was introduced. A stable-base film positive or a positive print on waterproof paper is used either with the tracing-paper method (*see* 1341) or with the transparent compilation drawing. This is the common method of transfer used in the Survey today.

55. Other methods of transferring detail from one survey to another include the use of a pantograph or a projector. For a description of these instruments and their use, *see* ADAMS, *op. cit. supra* note 5, at 434 and 435.

## CHAPTER 2

# Geographic Datums

A fundamental concept in the survey of a large area—for example, the United States—is the establishment of a single geographic datum in order that the survey may perform fully the function of accurately coordinating all surveys and charts within the area. This was recognized at an early period in the history of the Coast Survey. With few exceptions, all the horizontal control work of the Bureau is now referenced to a single geographic datum. This is a fact of great practical significance to the engineer who uses the control data or the surveys based on such control. It is important to remember, however, that this was not always the case but took many years to achieve. There are therefore many early topographic and hydrographic surveys in the Bureau archives that have never been converted to the latest datum. This chapter deals with some of the factors underlying the geodetic survey of a country, the development of the various geographic datums of the United States, and the final adoption of the North American 1927 Datum as the standard for all survey work of the Bureau.

A datum is any numerical or geometrical quantity or set of such quantities which may serve as a base for other quantities.[1]

A geographic datum—also called a horizontal or geodetic datum—is the adopted position in latitude and longitude of a single point to which the charted features of a region are referred. More specifically, it consists of five quantities: the latitude and longitude of an initial point, the azimuth of a line from this point to another point to which it is tied by the triangulation, and two constants necessary to define the terrestrial spheroid. It forms the basis for the computation of horizontal control surveys in which the curvature of the earth is considered.

Geographic datums are to cartography what tidal datums are to hydrography. Just as soundings must first be reduced to the same plane of reference

1. For a group of statistical references, the plural form is *data*, as geographic data for a list of latitudes and longitudes. Where the concept is geometrical, rather than statistical, the plural form is *datums*, as, for example, two geodetic datums. MITCHELL, DEFINITIONS OF TERMS USED IN GEODETIC AND OTHER SURVEYS 21, SPECIAL PUBLICATION NO. 242, U.S. COAST AND GEODETIC SURVEY (1948).

before studies of changes can be made, so must maps and charts be referred to the same geographic datum before features in the horizontal plane can be compared. This is particularly true in the case of comparisons between recent surveys and those of an early date, many of the latter having been based on independent datums. Unless datum corrections are applied, faulty conclusions as to changes will result. (*See also* Chap. 3.)

## 21. THE FIGURE OF THE EARTH

If the surface of the earth were a plane, as some ancient peoples supposed, the mapping of a large country like the United States, while still a tremendous undertaking, would nevertheless be a relatively simple one, and the science of geodesy could never have arisen. The elementary geometry of Euclid, which makes the three angles of a triangle equal 180 degrees, would suffice to measure and represent the earth's geographical features. But since the earth is not flat, the problem of mapping large areas is a complicated process. The geometry of Euclid is not applicable, and a body of principles which takes into account the size and shape of the earth must be applied, if accurate results are to be obtained. This constitutes the science of geodesy.

While it is customary to associate the concept of roundness of the earth with the period when Columbus attempted to reach Asia by a westward course, actually the notion of a spherical earth dates back many centuries before the beginning of the Christian Era. Just when the transition of thought from a flat to a round earth took place is somewhat doubtful; however, to Pythagoras, the Greek philosopher who lived about 540 B.C., appears to be due the first clear statement regarding the spherical shape of the earth. While various suggestions have been advanced as to the basis on which he reached this conclusion—one is the philosophical one that the sphere being the most perfect of solid figures, the earth should have that form—the important point is that he did so consider it, and this concept of a spherical earth flourished until blotted out during the Middle Ages.

The acceptance of the Pythagorean theory led to conjectures as to the earth's circumference. Many estimates were made, but the earliest of record was the one by Eratosthenes, the librarian of Alexandria, about 240 B.C. His method, though crude in measurement and based on several assumptions (none of which was exactly true, but the errors of which must have cancelled out), gave a re-

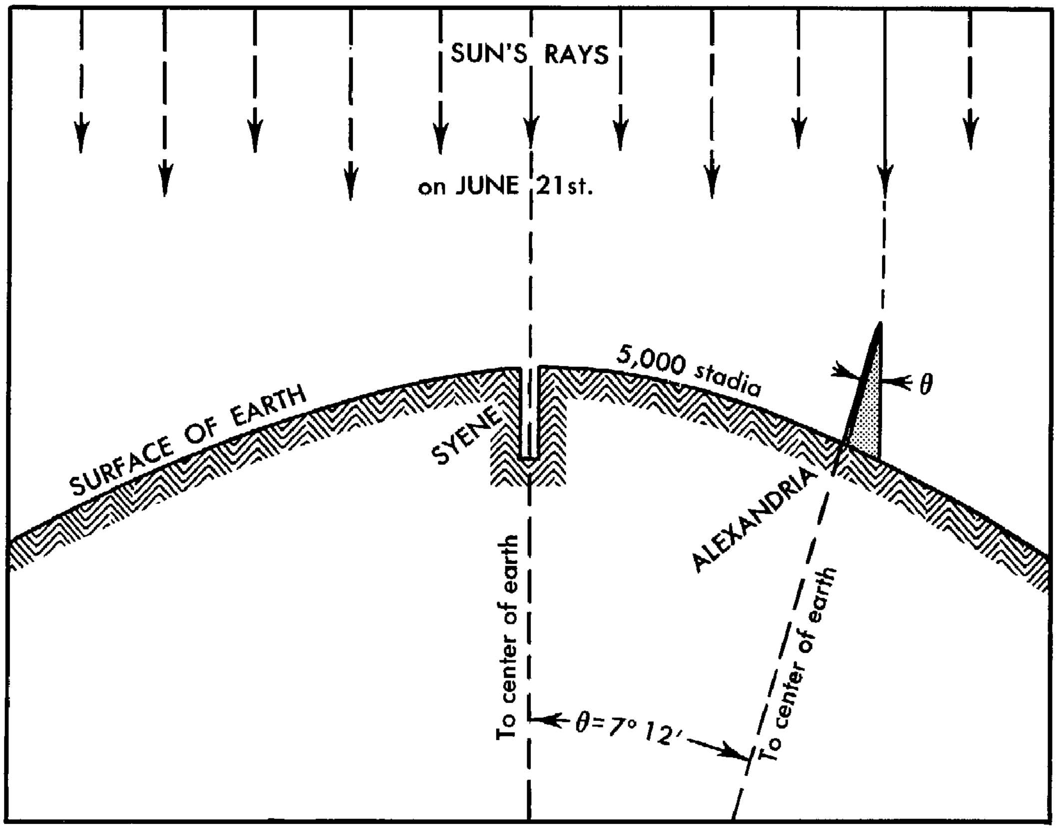


FIGURE 29.—Eratosthenes' method of calculating the earth's circumference in 240 B.C.

markably close approximation to present-day values, and was the forerunner of the modern method of meridian-arc measurement.[2]

As man began to extend his horizons through explorations on land and sea, there was increased demand for more accurate maps based on geographical locations by means of latitude and longitude, which necessitated a more accurate knowledge of the size and shape of the earth.

The numerous mountain ranges, valleys, and ocean deeps may give the impression that the earth is an irregular mass. While such irregularities are of

2. Tradition has it that there was a well in Syene in southern Egypt which the sun's rays penetrated only on June 21, the day of the summer solstice; that is, the sun at that time cast no shadow of a vertical object (*see* fig. 29). This would place Syene on the Tropic of Cancer. As its distance from Alexandria was known to be 5,000 stadia, assuming that Alexandria is directly north of Syene, all that was necessary was to measure the angle of the noonday sun on June 21. The inclination of the sun's rays to the vertical in Alexandria was found to be 1/50 of the circle, or 7° 12′. So a meridian of the earth must be 50 times 5,000, or 250,000 stadia—about 28,000 miles. This is remarkably accurate (within 12 percent) especially since neither Syene is on the Tropic of Cancer nor Alexandria on the same meridian with Syene, but 3° west of it; nor is the distance 5,000 stadia, but, rather, 4,530. RAISZ, GENERAL CARTOGRAPHY 17 (1938).

concern to the topographer and hydrographer in their surveys, they are insignificant for practical purposes when their relation to the size of the earth is considered. For example, while the highest known elevation (Mount Everest in the Himalayas) is 29,028 feet,[3] and the greatest known ocean depth (the Mariana Trench in the Western Pacific, about 200 miles southwest of Guam) is 36,198 feet,[4] on a globe 1 foot in diameter the irregularities would be represented by bulges or depressions of no more than one-hundredth of an inch. But even when these features are ignored, the shape of the earth cannot be considered spherical.

The true figure of the earth, as distinguished from its topographical surface, is taken to be the surface which coincides with the mean surface of the oceans, and which is everywhere perpendicular to the direction of the force of gravity. Under the islands and continents, this surface may be conceived to be that which would coincide with the water surface in narrow, sea-level canals if they were extended inland through the continents. It is tilted upward toward the high lands and has a reverse tilt under the oceans (*see* fig. 30). This figure is quite irregular and no geometric solid exactly fits its shape. Because of this it has been given the name *geoid,* meaning earth-shaped.

Obviously, we cannot use the geoid as a surface of reference for computing survey data, even if its exact shape were known, because it would lead to difficulties and complications in geodetic and cartographic work which would hardly be justified by the results obtained. One of the problems of geodesy has therefore been to find a geometric surface that closely approximates the true or geoidal surface on which the triangulation can be computed. This search for an accurate figure of the earth is not peculiar to any one country,

3. For a discussion of the height of Mt. Everest, including the 1952–1954 determination, *see* Gulatee, *Mount Everest—Highest Point on Earth,* 4 JOURNAL, COAST AND GEODETIC SURVEY 113 (1951), and *The Height of Mount Everest, A New Determination (1952–1954),* 7 JOURNAL, COAST AND GEODETIC SURVEY 154 (1957).

4. This value (an echo sounding of 11,034 meters) was reported to the International Oceanographic Congress in Sept. 1959 by the Academy of Sciences of the U.S.S.R. as having been obtained at position 11°21′8″ N., 142°12′6″ E. by the Soviet ship *Vityaz.* THE WORLD ALMANAC 582 (1962) from information furnished by the National Science Foundation and the U.S. Navy. *See also* Kort, *Scientific Research of Vityaz During IGY,* 37 INTERNATIONAL HYDROGRAPHIC REVIEW 137 (July 1960). Other recently recorded values for the greatest depth in the Mariana Trench are: 35,800 feet by the bathyscaph *Trieste* from a pressure-gage determination on Jan. 22, 1960, and 35,700 feet by the Scripps Institution of Oceanography from a sonic-sounding survey in July 1959. Lyman, *Trieste's Record Depth Recalculated,* 86 UNITED STATES NAVAL INSTITUTE PROCEEDINGS 99 (July 1960). Previously, a record depth of 5,940 fathoms (35,640 feet) was obtained by echo sounding in Oct. 1951 by H.M.S. *Challenger* at position 11°21′8″ N., 142°12′6″ E. by the Soviet ship *Vityaz.* THE WORLD ALMANAC 582 (1962) from in-feet) obtained by the same ship. *The Deepest Ocean Sounding,* 5 JOURNAL, COAST AND GEODETIC SURVEY 59 (1953). The greatest ocean depth was formerly believed to be in the Philippine Trench to the east of the island of Mindanao where the U.S.S. *Cape Johnson* found a depth of 5,740 fathoms (34,440 feet). *Id.* at 60. For a discussion of the great ocean depths and a table of the principal deeps discovered, *see Ocean Depths,* 49 THE MILITARY ENGINEER 213 (May–June 1957).

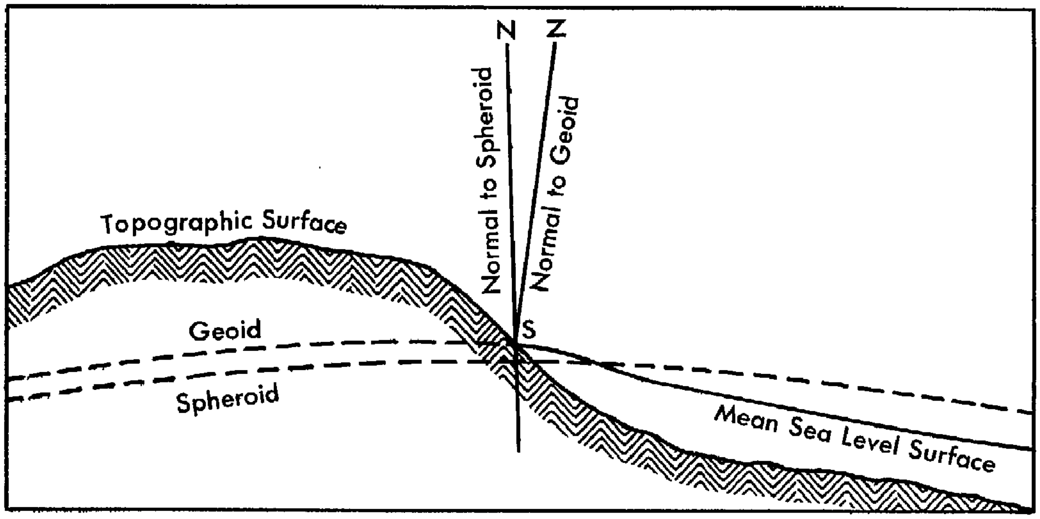


FIGURE 30.—Relationship of spheroid, geoid, and topographical surface. *NS* is the normal to the spheroid; *ZS* the normal to the geoid, or direction of the plumb line; and angle *ZSN* the deflection of the plumb line, or station error, at station *S*.

and scientists the world over have been identified with the problem at one time or another.

When the first measurements of arcs of the meridian were undertaken for the determination of the size and shape of the earth, it was, of course, supposed that the earth was a perfect sphere and computations of its size made accordingly. No one thought of it as flattened at the poles. It was Sir Isaac Newton who first propounded the revolutionary theory that the earth must have the form of an oblate spheroid (a sphere flattened at the poles) because of its axial rotation.[5]

Newton's theory was subject to much criticism and skepticism, particularly in France, where the Cassinis had extended the meridional arc through Paris for 8½° and concluded that the earth instead of being flattened at the poles took the opposite form and was actually elongated through the polar axis. In other words, their calculations showed the earth to be a prolate rather than an oblate spheroid.[6] We, of course, now know this was due to certain inaccuracies in their work. But the battle between the "earth flatteners" and the

5. Geometrically, the oblate spheroid may be considered as generated by revolving an ellipse about its minor axis; hence the name "ellipsoid of revolution," which is used interchangeably with "spheroid." From the nature of the figure, any section parallel to the equator is a circle, and any section through the poles is an ellipse.

6. A prolate spheroid is generated by an ellipse revolving about its major axis. In this spheroid, the lengths of the degrees of latitude decrease from the equator to the poles. (In the oblate spheroid the reverse is true.) It was this decrease in value that led the Cassinis to conclude that the earth was a prolate spheroid.

"earth elongators" was on, and was kept alive as additional measurements tended to confirm first one theory, then the other.

The matter was finally set at rest when the French Academy sent two expeditions, widely spaced as to latitude, to measure meridian arcs by triangulation. One was to Lapland in latitude 66° N. and the other to Peru in latitude 1½° S. The results proved conclusively that the earth was flattened at the poles—a tribute to Newton's marvelous insight into the laws governing the mechanics of the universe. No closer approximation to the true figure has ever been needed for practical geodetic work. But the amount of the flattening or ellipticity still remained to be determined accurately.[7]

### 211. Spheroids of Reference

Geodesists were very active during the 19th century in making geodetic measurements to determine the lengths of the axes of the generating ellipse, corresponding to the polar axis and the equatorial diameter of the earth. With each new accession of data and development of scientific thought, new values were derived. Between 1799 and 1951, there were 26 determinations of the dimensions of the earth, the values of the flattening ranging from 1/288.5 to 1/334.29.[8]

From the standpoint of the Coast Survey, the two most important determinations of the elements of the spheroid, insofar as the Bureau's work (geodetic and cartographic) is concerned, are those made by Bessel in 1841 and by Clarke in 1866. In both cases, the calculations were based upon the measurement of meridian arcs in various parts of the world outside the continent of North America. Clarke's investigation is generally regarded as the more precise and later observations have shown that for this part of the globe it represents the true figure somewhat better than the spheroid of Bessel. The comparative values are as follows:

| | Semimajor Axis (*Meters*) | Semiminor Axis (*Meters*) |
|---|---|---|
| Bessel (1841) | 6,377,397.2 | 6,356,079.0 |
| Clarke (1866) | 6,378,206.4 | 6,356,583.8 |

These represent flattenings or ellipticities of 1/299.15 and 1/294.98, respectively.

7. If $a$ is the semimajor axis of the earth and $b$ the semiminor axis, then the flattening $f$ is defined as $\frac{a-b}{a}$.

8. *Elements of Various Earth's Ellipsoids,* 6 Journal, Coast and Geodetic Survey 31 (1955). In these determinations, the meridian-arc method was principally used. In this method, in its simplest form, the linear distances between three points on a meridian are measured by triangulation and the angular distances between them determined from the observed differences in their astronomic latitudes. For other determinations, including those from satellite data, *see* Thomas, *Use of Near-Earth Satellite Orbits for Geodetic Information,* Technical Bulletin No. 11 (Table 3), U.S. Coast and Geodetic Survey (1960). (*See also* note 13 *infra.*)

The Bessel spheroid of 1841 was used in the Bureau's work between 1844 and February 1880,[9] when the Clarke spheroid of 1866 was adopted.[10] This is the spheroid that is in use today and on which all the formulas, tables, and computations are based. In referring to reference spheroids it is customary to append to the word "spheroid" the name of the investigator and the date of making the determination, thus: "Bessel spheroid of 1841," "Clarke spheroid of 1866," etc. The date of adoption for a particular triangulation has only a local value.

Prior to the adoption of the Bessel 1841 spheroid, the work of the Bureau must have been computed on some other spheroid, but no specific reference could be found in the official documents. It is noted, however, that in the computations of the 1834–1839 triangulation of Long Island, reference is made to a flattening of 1/302. The nearest approach to this value is the Walbeck spheroid of 1819, which has a flattening of 1/302.78.[11]

A noteworthy contribution to the science of geodesy was made in 1909 when Hayford, a geodesist in the Coast Survey, investigated the figure of the earth using the large triangulation net then existing in the United States, and taking into account the unequal density of the earth's crust. The practical result of this investigation was a new figure of the earth somewhat larger than Clarke's with a flattening of 1/296.96. This was adopted with some slight modification by the International Geodetic and Geophysical Union in 1924 (now the International Union of Geodesy and Geophysics) as the best available figure for the earth as a whole and designated it the International Ellipsoid of Reference.[12] While this spheroid probably best approximates the geoidal surface, the Bureau has never changed over to it, expediency dictating against undertaking a task of such magnitude (recomputing all the existing triangulation) without any practical advantage accruing to its geodetic or cartographic work.[13]

9. Annual Report, U.S. Coast and Geodetic Survey 53 (1880). The dimensions of this spheroid were first published in Dec. 1841 in No. 438 of "Schumacher's Astronomische Nachrichten," being a correction to an earlier determination by Bessel in 1837, the latter calculation having been based on an error in the computation of one of the French meridian arcs which Bessel used in his investigation. This resulted in a semimajor axis 240.30 meters less and a semiminor axis 129.47 meters less than the 1841 values, giving a flattening of 1/300.7. There is no indication that the 1837 spheroid was ever used in Coast Survey work.

10. Annual Report, U.S. Coast and Geodetic Survey 136 (1884).

11. *Elements of Various Earth's Ellipsoids, supra* note 8.

12. The internal inconsistency in Hayford's value for the semiminor axis and his determined flattening was removed and a flattening of 1/297.0 exactly, substituted. The derived values are: semimajor axis = 6,378,388 meters, semiminor axis = 6,356,912 meters. For a summary of Hayford's investigation and the basis for his determination, *see* Shalowitz, *The Geographic Datums of the U.S. Coast and Geodetic Survey,* 12 FIELD ENGINEERS BULLETIN 10, 27, U.S. COAST AND GEODETIC SURVEY (1938). It is now known that Hayford's semimajor axis is probably some 200 meters too large (*see* note 13 *infra*).

13. In 1956, a new determination was made of the figure of the earth by the Army Map Service based on four arcs: a meridional arc extending from South Africa to Scandinavia, a meridional arc from Chile to Canada, a parallel traversing the United States, and a parallel extending from western Europe to

It is appropriate to note here that while no closer approximation to the true figure of the earth has been found necessary for practical geodetic work than is given by the spheroid, with its northern and southern hemispheres symmetrical and equal, it has been postulated for many years that based upon certain considerations of an astronomic and physical geography nature, the earth has the shape of an ovaloid, with the southern hemisphere somewhat larger than the northern.[14]

## 22. GEOGRAPHIC DATUMS IN CONTERMINOUS UNITED STATES

With the adoption of a spheroid of reference for the country, the Bureau was faced with the important scientific and practical problem whether to adopt a single geographic datum for the country as a whole or whether to use several such datums. The early leaders wisely decided in favor of a single datum. They predicated that decision on the consideration of astronomic and geodetic determinations of points on the surface of the earth.

(*a*) *Astronomic Determinations*.—The position of a point on the surface of the earth, with reference to the equator and to a principal meridian, may be determined by observations on the stars. These consist in measuring the angular distance that the particular heavenly body is above the observer's horizon, as indicated by the spirit level on his instrument. Since gravity acts at right angles to this level surface, the astronomic observations are referred to the direction the plumb line assumes at the point of observation. This direction is normal to the geoidal surface, since the latter is by definition a surface that is everywhere normal to the force of gravity. Thus, it is not necessarily normal to the spheroidal surface. In general, the geoidal surface is higher than the spheroidal surface under the land and lower at sea. The two intersect each other at some distance seaward of the shoreline. (*See* fig. 30.)

(*b*) *Geodetic Determinations*.—By geodetic determinations are meant those latitudes and longitudes that are computed through the network of triangles from the measured angles and distances by starting from some pre-

Siberia. The first two arcs are the longest of their kind ever available—about 100°. An assumed flattening of $1/(297 \pm 1)$ yielded a value of $6{,}378{,}260 \pm 100$ meters for the semimajor axis. Chovitz and Fischer, *A New Determination of the Figure of the Earth from Arcs*, 37 TRANSACTIONS, AMERICAN GEOPHYSICAL UNION 534 (1956). The Army Map Service determination would come down to something like 6,378,150 meters, if the accepted satellite flattening of 1/298.3 were used. The National Aeronautics and Space Administration has indicated that their observations show a value of 6,378,163 meters for the semimajor axis with a flattening of 1/298.24.

14. MERRIMAN, ELEMENTS OF PRECISE SURVEYING AND GEODESY 239–241 (1899). Studies of variations in satellite orbits also suggest the earth's shape as resembling a pear with the stem end up. *Earth's Shape*, 40 TRANSACTIONS, AMERICAN GEOPHYSICAL UNION 172 (June 1959).

determined position of one of the triangulation stations. Geodetic coordinates are determined with respect to the normal to the spheroid at the point of observation and not with respect to the plumb-line direction at the point (*see* fig. 30). Where the geoid and the reference spheroid coincide or are parallel the normal will have the same direction as the plumb line and the astronomic and geodetic values at that point will be in agreement. At all other points, differences will be found to exist, their magnitude depending upon how closely the adopted spheroid fits the geoid at those particular points.[15] For the Clarke spheroid of 1866, differences varying up to a minute of latitude have been found to exist. These differences between observed and computed positions corresponding to the astronomic and geodetic values of the point are variously referred to as *plumb-line deflection, deflection of the vertical,* or *station error.*[16]

Accurate surveys of large areas cannot therefore depend only upon astronomic determinations. The survey of a local area can be oriented by determining astronomically the latitude and longitude of one point and the azimuth of one line, and from these values computing the remaining points of the survey by the ordinary trigonometric methods. This will usually suffice if the survey is a detached one such as of an offlying island or some outlying section. But if such survey is joined to or overlapped by other surveys similarly oriented, discrepancies will arise. Each survey will be consistent within itself on the adopted spheroid, but common points will be found to have different geographic values.

In any engineering or scientific undertaking, involving a large area, it is important that full coordination and correlation be obtained between the surveys, maps, and charts of the country. A hydrographic or topographic feature can have but one latitude and longitude, and it must be the same on every map or chart on which it appears. Because of the deflection of the vertical this can be accomplished only through the use of a single geographic datum for the entire country; that is, by referring all the triangulation to the latitude and longitude of a single point whose position on the spheroid is determined from a consideration of the astronomic and geodetic values of common points in the system. This is the true geodetic process.

15. If the reference spheroid and the geoid coincided throughout, positions on the earth could be satisfactorily determined from astronomic observations alone, limited to the precision of the observations.

16. One of the classic examples of a decided deflection of the vertical is the island of Puerto Rico where the distance between the astronomic latitude stations at Ponce on the south coast and San Juan on the north coast was found to be about 1 mile longer than the distance as computed through the triangulation. This was due to the irregular distribution of masses at the surface, since the island consists of a high mountain range running east and west, with the deep water of the Atlantic to the north and the Caribbean to the south.

### 221. Independent Datums

In beginning the mapping of any large area such as the United States, it is inevitable that, for a time, many detached systems of triangulation will exist, each based on one or more astronomic determinations of latitude, longitude, and azimuth; that is, on its own independent datum.[17] This was the condition of the primary triangulation in the United States during the first fifty years or so of the Bureau's active operation. Some of the detached portions were the early triangulation in New England and along the Atlantic coast; the transcontinental triangulation along the 39th parallel centered on St. Louis, and another portion of the same triangulation in the Rocky Mountain region; and three separate portions of triangulation in California in the latitude of San Francisco, in the vicinity of the Santa Barbara Channel, and in the vicinity of San Diego. With the lapse of time, these separate systems expanded until they touched or overlapped, causing gaps, overlaps, or offsets at the junctions.[18]

This condition prevailed until 1899 when the transcontinental arc of triangulation was completed, thereby connecting the various detached systems into one continuous triangulation. The work was then ripe for establishing a single geographic datum for the whole country.

### 222. Selecting a Standard Datum

The selection of a single geographic datum for the United States was governed by both theoretical and practical considerations. Of the former may be mentioned the requirement that the adopted datum must not differ widely from the ideal which would place the triangulation system in such position that no serious error would occur in any part of the system. Of the latter may be mentioned, first, the desirability that the adopted datum should produce minimum changes in the various Bureau publications, including its charts; and, second, the desirability, other things being equal, of adopting that datum which allowed the maximum number of geographic positions already in the office files to remain unchanged, thereby requiring a minimum amount of new computation.

17. An independent datum is established primarily for horizontal control over a limited area with reference to an assumed starting point, whose position on the spheroid of reference by latitude and longitude and whose azimuth to an adjacent station have been determined astronomically, but which has not been connected to the standard datum of the continental area (*see* 223).

18. Church, Triangulation in Rhode Island 9, Special Publication No. 62, U.S. Coast and Geodetic Survey (1920).

## 223. United States Standard Datum

In determining the best geographic position of the station that was to define the adopted datum, the plumb-line deflections were studied at a large number of triangulation stations throughout the country, where both astronomic and geodetic determinations were available, with an assumed value for one of the stations. From these data, the latitude, longitude, and azimuth for station *Meades Ranch* in central Kansas was computed which made the sum of the squares of the differences between the astronomic and geodetic values of the latitudes, longitudes, and azimuths a minimum. This best theoretical value on the adopted spheroid of reference was found to be so close to the value based on the datum in use in New England that the latter was adopted in order to save the labor of recomputing all the triangulation in the northeastern part of the country.[19] The adoption of this datum, therefore, did not change the geographic positions of the then completed triangulation in New England and along the Atlantic coast to North Carolina, nor in the states of New York, Pennsylvania, New Jersey, and Delaware.

On March 13, 1901, the adopted datum was officially given the name "United States Standard Datum." It is defined by station *Meades Ranch,* whose position on the Clarke spheroid of 1866 is as follows:

$$\text{Latitude} = 39^\circ 13' 26''.686$$
$$\text{Longitude} = 98^\circ 32' 30''.506$$
$$\text{Azimuth to station } \textit{Waldo} = 75^\circ 28' 14''.52.$$[20]

## 224. North American Datum

Early in 1913, the United States Standard Datum was adopted by both the Dominion of Canada and the Republic of Mexico for their triangulation. This was an important development in international scientific cooperation because it placed nearly the whole of North America on a single datum and made it possible to coordinate the surveys of practically an entire continent. Such an ideal arrangement had never been accomplished in any other part of the world. To reflect the continental character the datum had now assumed, the name was changed to "North American Datum." But it is important to remember that

19. Station *Meades Ranch,* which had been established in 1891, was selected as the basis for the geographic datum because it was near the center of area of the United States, and because it was common to two great arcs of triangulation extending across the country—one along the 39th parallel and the other along the 98th meridian.

20. Although the azimuth to station *Waldo* was included in the fundamental data for *Meades Ranch,* this azimuth is now of secondary importance since in the latest adjustment the azimuths throughout the net are controlled by many Laplace azimuths (true geodetic) scattered through it (*see* note 21 *infra*).

while the two designations are different they refer to the same datum. They may be used interchangeably unless the date of adoption is material.

## 225. North American 1927 Datum

At the time of the adoption of the United States Standard Datum and the North American Datum, the primary triangulation system consisted of a meager skeleton joining the arc near the Atlantic coast with the arc near the Pacific coast. This system was gradually expanded into a large number of interconnected loops.

As the various arcs in the loops were observed they were adjusted by the Method of Least Squares to the arcs already completed in order that the results would be consistent when made available for engineering purposes. When any loop was completed, the total discrepancy in closure was adjusted into the last arc that closed the loop. This method had the disadvantage that it forced distortions into the new arcs which should have been distributed through loops including both the new and the old arcs. It was, however, the only feasible method to use until the main framework of the national net had been completed, since it would have been quite impracticable to readjust the entire net, or even a large portion of it, each time a new arc was added.

(*a*) *Western Adjustment.*—With the completion in 1926 of the triangulation framework in the western half of the control net, extending from the meridian of 98° to the Pacific coast, the logical necessity arose for undertaking a unified adjustment of the whole region, one that would give a control framework of such high accuracy as to permit new arcs to be added without undue distortion.[21] This was no small undertaking, and special methods had to be devised so that the cost would not become prohibitive. The method adopted

21. *Laplace Azimuths.*—An important development in the science of geodesy also contributed to the desirability of an overall adjustment of the network. When the earlier datums were adopted, it had not yet been fully established that an arc of triangulation tended to swerve from its true orientation as the distance from the starting point increased. Hence, in the earlier adjustments all azimuths carried through the triangulation were made to depend upon the single standard azimuth adopted for the line *Meades Ranch* to *Waldo*. When the final adjustment was made, information had accumulated which showed that geodetic and astronomic longitudes anywhere in the United States were subject to probable errors of less than 0″.5, and that about the same degree of accuracy could be expected for astronomic azimuths. The geodetic azimuths, however, were found to be subject to probable errors as great as 5″. Therefore, by introducing a number of observed astronomic azimuths into the triangulation the probable azimuth errors were reduced and the orientation of the network in the new adjustment greatly strengthened. But since astronomic observations are referred to the direction of the plumb line and not to the normal to the spheroid, they had to be corrected for the deflection of the vertical (*see* 22(*b*)). This was done by first determining the astronomic longitude at a station and comparing it with the geodetic longitude (the longitude carried through the triangulation). This gave the deflection of the vertical in an east-west direction within a small fraction of a second. This value was then used to correct the astronomic azimuth and thus obtain a true azimuth to be held fixed in the adjustment of the triangulation. This corrected azimuth is known as a *Laplace azimuth*, and the station as a *Laplace station*.

was somewhat similar to that used in the adjustment of a first-order level net. By the use of junction figures, the adjustment was divided into a number of different parts which could be carried on simultaneously, thus making it possible to complete the work within a reasonable time. (*See* fig. 12.)[22]

In this adjustment, the latitude and longitude of station *Meades Ranch* on the reference spheroid were held fixed because the figure of the earth investigation in 1909 had shown that its position on which the United States Standard Datum (and North American Datum) depended, approached closely the ideal for the country.[23]

While the position of station *Meades Ranch* remained the same, all other stations in the net were changed in position. The changes were small in the vicinity of *Meades Ranch* but at greater distances they were fairly large. In the State of Washington, for example, the change in position was slightly over 1″ in latitude (31 meters) and nearly 1″.4 in longitude (29 meters).[24]

In strictness, it was not a new datum since no changes were made in the dimensions of the spheroid nor in the position of the initial station, but it was nevertheless designated "North American 1927 Datum" in order to guard against the readjusted data becoming confused with the old data. The new name for the datum therefore indicates new positions for the stations of the net rather than changes in the fundamental properties of the datum, except for the value of the azimuth to station *Waldo* which was reduced by 4″.88, making the present value 75°28′09″.64 (*see* 223).[25]

Points are said to be on the North American 1927 Datum when they are connected by a continuous triangulation through which the latitudes, longitudes, and azimuths have been computed on the Clarke spheroid of 1866, starting from the adopted position of station *Meades Ranch,* and rigidly adjusted to the scheme of the readjusted triangulation.

(*b*) *Eastern Adjustment.*—A short time after the western half of the national net had been readjusted, the eastern half was recomputed in the same way. The two adjustments resulted in a very accurate net for the whole country. Since their completion, new arcs have been fitted into the net without undue distor-

22. ADAMS, THE BOWIE METHOD OF TRIANGULATION ADJUSTMENT, SPECIAL PUBLICATION NO. 159, U.S. COAST AND GEODETIC SURVEY (1930).

23. In this investigation, 765 astronomic stations were used. CHURCH (1920), *op. cit. supra* note 18, at 11.

24. HORIZONTAL CONTROL DATA 15, SPECIAL PUBLICATION NO. 227, U.S. COAST AND GEODETIC SURVEY (1957).

25. The new value for the azimuth from *Meades Ranch* to *Waldo* on the North American 1927 Datum may be found in SUTHERLAND, FIRST-ORDER TRIANGULATION IN KANSAS 13, SPECIAL PUBLICATION NO. 179, U.S. COAST AND GEODETIC SURVEY (1934).

tion and only rarely has it been necessary to upset the adjustment of small sections of the net to force some arc of the main net to take its share of loop-closure discrepancies. (*See* fig. 12.) [26]

## 23. GEOGRAPHIC DATUMS IN ALASKA

In Alaska, as in conterminous United States (*see* Part 3, 35), commercial considerations governed largely the distribution of surveys. Development of the fishing industry in Southeast Alaska, opening of the gold fields in the Klondike region and around Nome, beginning of the Alaska railroad in Resurrection Bay, all emphasized the need for early publication of charts. This meant the execution of triangulation in various detached areas, each of which was based on independent astronomic data. These detached portions were extended from time to time until many of them overlapped. With this overlapping came the difficulty of making the charts fit. Each chart was correct in itself, but when joined together the shoreline would not fit. To correct this, it was necessary to adopt a geographic datum for each area where overlapping triangulation existed.

Over the years, four principal datums were established in Alaska—Southeast Alaska, Yukon, Valdez, and Unalaska. Only the first two will be described—the first, because the bulk of the topographic and hydrographic surveys of Southeast Alaska are plotted on this datum, having been made prior to the connection with the North American 1927 Datum; the second, because it is the official datum for the Alaska-Canadian boundary.[27]

### 231. Southeast Alaska Datum

Field work for the triangulation of Southeast Alaska dates back to 1882. Toward the end of 1901, nine different groups of triangulation had been joined together to form one continuous scheme on one datum, known as the "Southeast Alaska Datum." Eight astronomic longitude stations, all chronometric, and 32 astronomic latitudes were used in this adjustment. Various astronomic azimuths were also held fixed because the triangulation was considered too weak to carry the azimuth.

26. Horizontal Control Data, *op. cit. supra* note 24, at 14.

27. For information regarding the other two datums, together with the various independent astronomic datums that were used in Alaska, *see* Shalowitz, *supra* note 12, at 27.

The Southeast Alaska Datum applies to all triangulation in Alaska between Dixon Entrance and Mount St. Elias. With the extension of triangulation through British Columbia by the Canadian Government, a connection was effected between the work in Southeast Alaska and the work in conterminous United States. This permitted the recomputation of the work on the North American 1927 Datum. This has been completed as far as the triangulation is concerned, but many of the hydrographic and topographic surveys are still on the old datum. These are being corrected as occasion demands.

### 232. Yukon Datum

This datum was used for the triangulation along the 141st meridian, the boundary between Canada and Alaska, and covers the area from Mount St. Elias to the Arctic Ocean. The Yukon Datum is based on one astronomic station near the crossing of the 141st meridian and the Yukon River. The datum is defined in terms of the coordinates of station *Boundary* at the Yukon River, astronomically determined as follows:

$$\text{Latitude} = 64°40'51''.42 \pm 0''.164$$
$$\text{Longitude} = 141°00'00''.00$$
$$\text{Azimuth to station } \textit{Bald} = 27°00'00''.00.$$[28]

While the connection with the North American 1927 Datum changed the geographic positions of the boundary monuments and the triangulation stations used in their determination, the monuments will, however, be considered for treaty purposes as defining the 141st meridian. Hence, the Yukon Datum will remain the official datum for the 141st meridian work.

### 233. Consolidation of Datums

As of 1963, the whole of Alaska—from Dixon Entrance to the Arctic Ocean and to Bering Strait—including the Aleutian Islands and the Alaska Peninsula, has been consolidated by one continuous triangulation and placed on the North American 1927 Datum.

A noteworthy event occurred in 1951, when the distant, offshore islands in the Bering Sea were connected to the triangulation network on the mainland of Alaska, thereby placing the Bering Sea area on the North American 1927

28. Joint Report Upon the Survey and Demarcation of the International Boundary Between the United States and Canada Along the 141st Meridian from the Arctic Ocean to Mount St. Elias 132, U.S. Department of State (1918).

Datum. The true geographic positions of the islands were thus determined for the first time (*see* fig. 31).[29]

## 24. OTHER DATUMS

Besides the datums developed for conterminous United States and for Alaska, the Coast Survey has necessarily had to adopt other standard datums for use in outlying areas too distant from continental United States to permit tie-ins—for example, in the Philippine and Hawaiian Islands—or where for other reasons tie-ins could not be effected—for example, in Puerto Rico and the Canal Zone.[30]

### 241. Philippine Islands

In the Philippine Islands, the triangulation developed along the same lines as the triangulation in the United States. Military and commercial considerations necessitated the beginning of work at different points throughout the islands, each control scheme being on its own geographic datum as determined by astronomic observations connected with that particular scheme. Later, as the work was extended to the south and embraced additional astronomic stations, a standard datum for the islands was established in 1911 in order that no serious error would occur in any part of the system. This is known as the "Luzon Datum" because it is derived wholly from observations on Luzon Island, although supplemented by theoretical inference and approximate results from other regions. It was not termed a Philippine datum because the incompleteness of available data made it unwise to adopt the latter name.

### 242. Hawaiian Islands

The work in the main Hawaiian group between Hawaii and Kaula is based on the "Old Hawaiian Datum," a name derived from the fact that it is the same geographic datum that was in use for triangulation of the islands Oahu and Hawaii before the office adjustment was begun. To the westward

29. Pierce, *Datum Connection to the Bering Sea Islands*, 5 Journal, Coast and Geodetic Survey 3 (1953). The trilateration method was used (a measurement of the sides of a triangle, as distinguished from triangulation, in which the angles are measured), the distances being measured by electronic methods. The longest distance measured was 501 statute miles. *Ibid.* For a discussion of the accuracies attained on this project, *see* Meade, *Preliminary Adjustment of Shoran and EPI Observations in the Bering Sea*, 5 Journal, Coast and Geodetic Survey 10 (1953).

30. These datums are more fully described in Shalowitz, *supra* note 12, at 18–23. For a discussion of the use of satellites as a means of connecting islands to continental geographic datums, *see* Thomas, *supra* note 8, at 4.

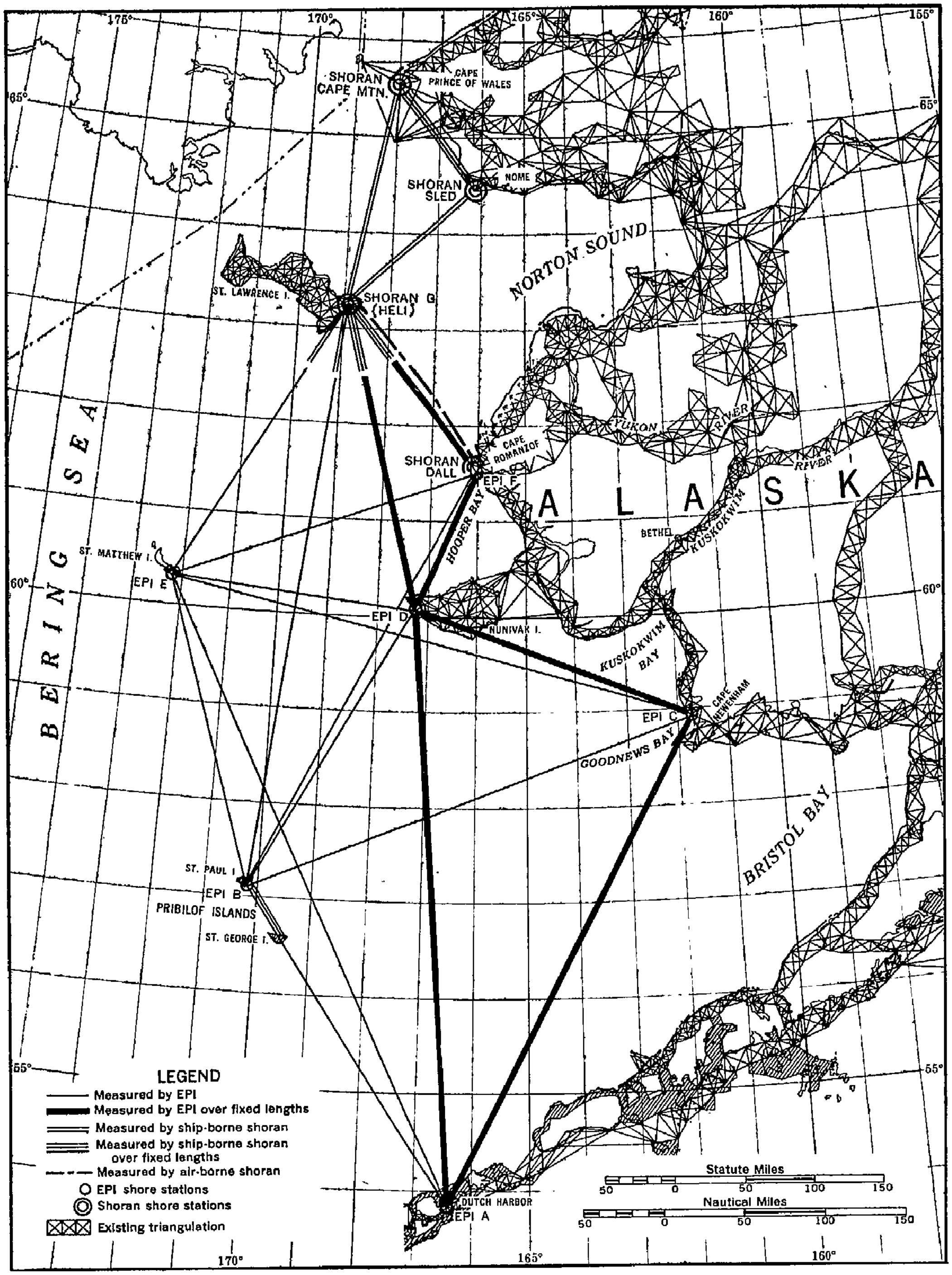


FIGURE 31.—Extending the North American 1927 Datum to the distant, offshore islands in the Bering Sea by E.P.I. and Shoran trilateration.

of Kaula, there is no connected triangulation and the surveys of the various shoals and islands are in the nature of detached surveys controlled by their own independent astronomic observations.[31]

### 243. Puerto Rico and Vicinity

Prior to 1901, the triangulation on Puerto Rico was based on the "San Juan Astronomic Datum" and the other islands had their own independent datums. With the completion of the interisland connection and a study of a number of astronomic observations on the island of Puerto Rico and adjacent islands, the "Puerto Rico Datum" was established as the best geographic datum for Puerto Rico, Mona Island, Vieques, Culebra, and the Virgin Islands.

This work is now tied to the North American 1927 Datum through Hiran surveys along the Atlantic Missile Range.

### 244. The Canal Zone

Although the Canal Zone is under the jurisdiction of the Canal Zone Government, both the Atlantic and Pacific approaches to the Canal have been surveyed by the Coast and Geodetic Survey (*see* 5641). The main scheme of triangulation across the Canal Zone was done by the Isthmian Canal Commission but the adjustment was made by the Coast Survey. Prior to 1911, two datums were in use (both astronomic), one at each end of the Canal. When a triangulation connection was made between the two areas and the work adjusted, discrepancies were found to exist between the two datums. A single standard datum, the "Panama-Colon Datum," was then adopted for the entire Canal Zone. This was accomplished by selecting a station central to the whole area and computing its latitude and longitude through the triangulation from both ends of the scheme. The values were then averaged after correction for the computed effects of topography and compensation.

This work is now tied to the North American 1927 Datum by work of the Inter-American Geodetic Survey of the Corps of Engineers.

31. The incongruity that might result in the charts from the lack of a single geographic datum for this portion of the Hawaiian Islands is offset by the absence of important geographic features in the area and by the smallness of chart scale that would be required to include all or a part of these islands on one chart. Hiran distance and line crossing azimuth surveys are now practically completed to place the islands from Hawaii to Kure on a single datum.

## 25. SPHEROIDS AND DATUMS

From what has been said about spheroids and datums, it is clear that no relationship exists between a geographic datum as such and a spheroid of reference. It is a misnomer, for example, to refer to the Clarke spheroid of 1866 as a datum, as is sometimes done. Points may be inconsistently located on the same spheroid, as where the triangulation of a country consists of a network of independent triangulation systems, each based on its own astronomic position but computed on the same spheroid of reference. Unless the various systems are connected and adjusted they would not be on the same datum. It follows then that points to be on the same geographic datum must necessarily be referred to the same spheroid, but points referred to the same spheroid need not be on the same geographic datum. In all the survey work of the Bureau, only one spheroid of reference has been used since 1880—the Clarke spheroid of 1866—but as has been seen a number of geographic datums were used.

## CHAPTER 3

# Multiple Projection Lines on Early Surveys

Before a topographic sheet (*see* 124) or a hydrographic sheet (*see* 125) was taken into the field to begin the survey of an area, a projection was first laid down on the sheet, that is, lines representing the parallels of latitude and meridians of longitude, and from these lines the triangulation control points plotted. On many of the early surveys of the Bureau two or more systems of latitude and longitude lines appear. These are traceable to various causes (*see* 35) some of which have been discussed in Chapter 2. In the engineering use of such surveys, it is important to keep this fact in mind. Two surveys cannot be properly evaluated, whether for studies of shoreline changes or for other purposes, unless comparable projection lines appear on the survey sheets. Before discussing the reasons for the existence of multiple projection lines on the early surveys, something of the nature of projections will be described, particularly as they relate to the type of projection ultimately adopted for the topographic and hydrographic surveys of the Bureau.

### 31. THE PROBLEM OF MAP MAKING

We have seen in Chapter 2 that for practical geodetic work, the earth may be taken to have the shape of a spheroid—a sphere flattened slightly at the poles.[1] It is axiomatic that the ideal method of studying the earth and its component relationships is by means of a globe. Being an accurate model of the earth the scale is constant, and areas, shapes, distances, and directions are preserved as on the earth. Because of this, a true idea of the fundamental principles of geography can be obtained—the general distribution of land and

1. The polar diameter of the earth is about 26 miles shorter than the equatorial diameter. For discussing projections the earth may be considered as a sphere, since the irregularities are very small when compared with the great size of the earth. If the earth were represented by a spheroid with an equatorial diameter of 50 feet, the polar diameter would be 49 feet 10 inches.

water areas, the relative sizes and shapes of continents and countries, and the correct direction and distance geographic features are from each other. But globes, in order to show any degree of detail, would have to be so large as to preclude their practical usefulness. For example, a globe on a scale of 1:80,000, the scale of the 1200 series Coast Survey charts along the Atlantic and Gulf coasts, would have a diameter of 523 feet. For detailed geographical information we are, therefore, dependent upon flat-surface maps.[2]

If it were possible to flatten a globe into a plane surface, without tearing or stretching, then the art of map projection would never have arisen. But we know this to be impossible from the simple attempt to flatten a hollow rubber ball. The problem of the map maker has therefore been to devise some means by which a portion or all of the curved surface of the earth can be represented on a plane with the least amount of distortion. The process by which this is accomplished is termed "map projection."

## 32. DEFINITION OF MAP PROJECTION

To Hipparchus—astronomer and mathematician, who lived in the 2d century B.C. and who is credited with having invented the trigonometry—we are indebted for the present-day method of dividing the earth by a system of parallels of latitude and meridians of longitude.[3] With this system, points on the earth's surface are located by their latitudes and longitudes, that is, their distance north or south of the equator and east or west of the meridian of Greenwich. Such points are said to be described by their geographic or geodetic coordinates. This is a universal system and is used exclusively in all the geodetic work of the Coast Survey and in all its cartographic work.[4] The problem of map projection has been to find some method of transferring the imaginary meridians and parallels on the earth to a flat map. They can be drawn in an arbitrary manner, but to avoid confusion and to be of scientific value they must follow an orderly correspondence. A map projection may

2. Most surveys, whatever their nature, have for their ultimate aim the making of a map. By its means can be visualized what has been surveyed. Until that is done there can be little or no conception of the nature or relation of the features located. In the simple survey of a city lot or farm, it is necessary to plot the courses and distances measured in order to determine the shape of the parcel of land. Even in a triangulation survey for the establishment of control points, some form of sketch must be prepared if the relationships of the points located are to be comprehended.

3. 11 ENCYCLOPEDIA BRITANNICA 582 (1960). The meridians are formed by imaginary planes passing through the poles, and the parallels by planes passing through the earth parallel to the equator.

4. The Bureau has also computed the plane coordinates on the State Coordinate Systems (*see* Part 1, 2113 B) of all triangulation points adjusted on the North American 1927 Datum (*see* 225).

therefore be defined as a systematic drawing of lines representing meridians and parallels on a plane surface, either for the whole earth or for some portion of it.[5] The number of ways in which this orderly arrangement can be determined is almost without limit, depending upon the conditions imposed.

## 33. TYPES OF PROJECTIONS

In strictness, the term "projection" is geometrical in concept and ought to be confined to representations obtained directly according to the laws of perspective, but geographers have borrowed it from geometers and have applied it to any method of representation of the surface of the earth upon a plane, whether it be by geometric construction, as in perspective projections, or by development.[6] For the field surveys and the nautical chart work of the Coast Survey, the latter type of projection is used exclusively. Of these, there is a large variety, each projection fulfilling a condition that exists on the sphere which it is desirable to preserve in the map, whether it be equivalence of area, right shape, true distances, or correct bearings. For example, in the "conformal" class of map projections the property of correct shape is preserved for geographic features, rather than correct size. In contrast, there is the "equal-area" type of map projection in which correct size is preserved, rather than correct shape. For mapping extensive portions of the world, it is mathematically impossible to preserve both properties in the same projection. Therefore, any projection is at best a compromise and the choice of projection usually depends upon the purpose which the map or chart is to serve.

It has already been noted that a sphere or spheroid is a nondevelopable surface and cannot be spread out in a plane without distortion. For that reason an ideal map is impossible of attainment.[7] However, there are some curved surfaces—the cone and the cylinder—that are developable and use is made of them as intermediate aids to projection. If the cone is cut from apex to base or the cylinder from base to base these surfaces can be spread out in a plane

5. Deetz and Adams, Elements of Map Projection 22, Special Publication No. 68, U.S. Coast and Geodetic Survey (1944).

6. One objection to the perspective projections is that in their use one is limited to the properties which they already possess; they cannot be made to satisfy any special conditions which may be of importance in the particular mapping under consideration, or they may possess features which are not desirable on the map or chart. Perspective projections find application in astronomy and in the flat-surface representation of an extensive area, such as a hemisphere.

7. Small areas can of course be represented with a high degree of fidelity because the earth is so large that for practical purposes any small portion can be considered a plane and no difficulty is encountered in reproducing one plane on another.

without stretching or tearing.[8] Projections that use the cone as the developable surface for determining their elements are called conical projections, while those that use the cylinder are called cylindrical projections.[9] In this chapter only the conical type will be considered, this being the type used for the field surveys of the Bureau.[10]

## 34. CONICAL PROJECTIONS

Conical projections employ a cone tangent generally at the middle parallel of the map to be constructed, but variations may be produced by altering the position of the place of tangency or by substituting for the tangent cone an intersecting cone which cuts the spheroid at two parallels. In the first, the scale is held true along one parallel, while in the second the scale is maintained true along two parallels. There is thus a wide variety of the conical type of projections. In this discussion, only those projections will be considered that lead up to the development of the polyconic projection, the projection that is used for all the topographic and hydrographic surveys of the Coast Survey.

### 341. Simple Conic Projection

In the simple conic projection,[11] a right cone tangent to the sphere at the middle latitude (the standard parallel) of the area to be mapped is used. The apex of the cone will then be in the prolongation of the axis of the sphere. The slant height of the cone is the radius of the middle parallel and becomes the central meridian of the map. Distances corresponding to the latitude values on the surface of the earth are laid off on the central meridian and through these points circles concentric with the middle parallel are drawn using the apex of the cone as center. The meridians are determined by laying off on the middle parallel distances equal to the true longitude values and drawing straight lines from these subdivisions to the apex. The scale of the projection is therefore

8. Actually, the projection is not constructed upon the cone or cylinder, but the principles are derived from a consideration of these surfaces, and then the projection is drawn upon the plane just as it would be after development. Deetz and Adams (1944), *op. cit. supra* note 5, at 27.

9. Both of these forms are generally included in the one class of conical projections, for the cylinder is really a special case of the cone with the apex at infinity.

10. A conical projection was also used for a time as the base for the nautical charts of the Bureau (*see* 6411).

11. This projection is credited to Ptolemy, the Greco-Egyptian astronomer, geographer, and geometer who lived in the 2d century.

true along the standard parallel and along all meridians, but above and below the standard parallel the scale along the parallels will not be true because these parallels when projected on to the tangent cone are greater than on the sphere. This makes the projection unsuitable for mapping areas with a considerable north-south extent. In this projection, parallels and meridians intersect at right angles as on the sphere.

This projection is, then, characterized by straight meridians and concentric arcs of circles for parallels, the two intersecting at right angles.

### 342. Bonne Projection

An important modification of the simple conic projection was made by the French engineer Rigobert Bonne (1727–1795) in a projection which bears his name.[12] As in the simple conic a cone tangent to a selected standard parallel is used. The central meridian is subdivided true to scale and concentric circles drawn to represent the parallels of latitude. But instead of subdividing only the standard parallel true to scale, as in the simple conic, Bonne subdivided all the parallels according to their values on the earth. Through the corresponding points on each parallel he drew smooth curves for the meridians. Thus, the scale along all the parallels is correct by construction, and the shortcoming of the simple conic projection in this respect is remedied, making the Bonne projection more suitable for maps having considerable north-south extent. But with the exception of the central meridian no other meridian intersects the parallels at right angles, the departure from perpendicularity increasing with the distance from the central meridian and the approach to the polar regions where they intersect quite obliquely. The scale along the meridians is therefore too great for all except the central one, and this defect makes it unsuitable for projecting extensive east-west areas.

The characteristics of this projection are, then, curved meridians except the central one, concentric arcs of circles for all the parallels, and nonorthogonality of intersections.[13]

12. The Bonne projection was adopted in France about 1803. Annual Report, U.S. Coast and Geodetic Survey 292 (1880).

13. There is some evidence that the Bonne projection was used for some of the nautical charts of the Bureau. In the 1880 annual report, it is stated with reference to the 1844–1845 charts of Delaware Bay and River (scale 1: 80,000) that they have conic projections and that the "parallels of latitude are sensibly curved, but owing to their small latitudinal extent the meridians appear necessarily as straight lines and consequently the character of the particular conic projection is not revealed. There is, however, reason to suppose that it was Bonne's." *Id.* at 293.

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### 343. Polyconic Projection

The advent of the Bonne projection was a distinct improvement over the simple conic, but its limitations indicated the propriety of still another modification, namely, developing each parallel of latitude as the circumference of the base of a right cone tangent to the sphere along that parallel. The result was termed a "polyconic projection." Ferdinand Hassler, the first Superintendent of the Coast Survey, appears to have been the one to originate, at least in concept, this type of projection. This may be inferred from Hassler's statement that "This distribution of the projection, in an assemblage of sections of surfaces of successive cones, tangents to or cutting a regular succession of parallels, and upon regularly changing central meridians, appeared to me the only one applicable to the coast of the United States. Its direction, nearly diagonal through meridian and parallel, would not admit any other mode founded upon a single meridian and parallel, without great deviations from the actual magnitudes and shape, which would have considerable disadvantage in use." [14]

In the polyconic projection, the central meridian appears as a straight line while all other meridians appear concave toward it. The parallels appear as arcs of nonconcentric circles of different radii, the centers of which lie on the central meridian (produced), the equator alone being represented by a straight line, and all parallels have their convexity turned toward it. Near the middle portion of a map, or for limited charts of large scale, the intersections of meridians and parallels do not differ much from a right angle but the departure from orthogonality increases markedly as extensive east-west areas are mapped. Developed arcs of the parallels appear in their true length according to the scale of the map, as also do the differences of latitude on the central meridian; hence, for equal differences of longitude the corresponding parts on any parallel are equal, whereas the meridional differences widen out as we recede from the central meridian. These characteristics of the polyconic projection are readily observable in a development of the sphere (*see* fig. 32).

The polyconic projection belongs neither to the conformal nor the equal-area class of projection (*see* 33), but may be considered as in a measure *only compromising* various conditions impossible to be represented on any one map or chart.[15] Its great popularity rests on its mechanical ease of construction

14. Transactions of The American Philosophical Society (New Series) 407–408 (1825). In a dissertation on the relative value of the polyconic projection with other projections, Charles Schott—a former chief of the Computing Division of the Survey—credits E. B. Hunt—an Assistant in the Survey—with having named this projection the "polyconic projection." Annual Report (1880), *supra* note 12, at 292.

15. Deetz and Adams (1944), *op. cit. supra* note 5, at 62. It has been stated that the polyconic projection is a link between those projections which have some definite scientific value and those generally called conventional, but possessing properties of convenience and use. Hinks, Map Projections 52 (1921).

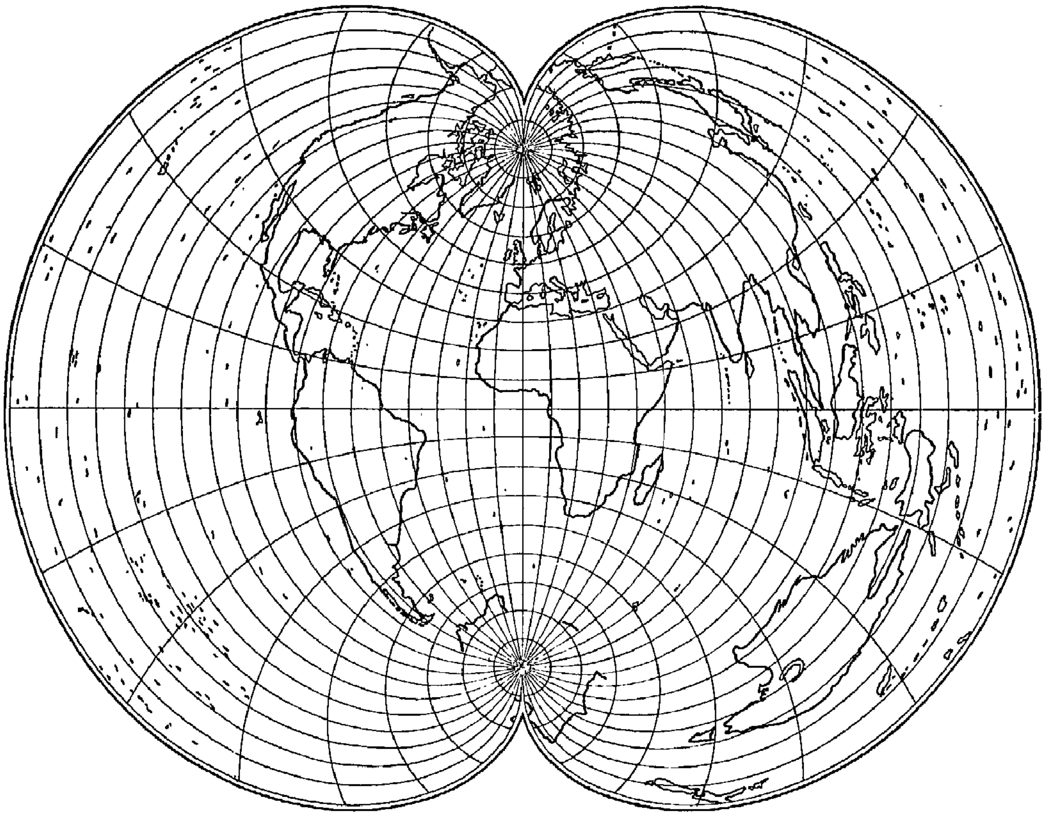

FIGURE 32.—Development of the world on the ordinary polyconic projection.

and on the fact that a general table can be computed for use in any part of the world.[16] In most other projections there are certain elements that have to be determined for the region to be mapped, and therefore a separate table must be

16. Projection tables for the construction of a polyconic projection appeared in the Annual Reports of the Coast Survey for 1853, 1856, 1859, and 1865, and were based on the Bessel spheroid of 1841 (*see* 211). The 1856 tables specially provided for projecting maps of large extent. These received some further extension in 1859. The 1865 tables provided for a special case. The first polyconic tables based on the Clarke spheroid of 1866 (*see* 211) were published as Appendix 6 to the Annual Report for 1884, and as a special publication (No. 5) in 1900. The latter has gone through several editions, the latest being the sixth (1946 reprint) and is titled TABLES FOR A POLYCONIC PROJECTION OF MAPS AND LENGTHS OF TERRESTRIAL ARCS OF MERIDIAN AND PARALLELS, SPECIAL PUBLICATION NO. 5, U.S. COAST AND GEODETIC SURVEY (1946). This title for the publication first appeared in 1930. Prior thereto it was called simply "Tables for a Polyconic Projection of Maps." The reason for the change was that only the last two columns of each right-hand page are strictly applicable to the polyconic projection. These give the *X* and *Y* coordinates for plotting the intersection of parallels and meridians. The remaining columns of the tables are true lengths in meters of meridional arcs and arcs of the parallels as they appear on the spheroid, and are used in the construction of other projections. The tables are based on the legal value of the meter in the United States which is 39.3700 inches and corresponds to 1 meter=3.2808333 feet and 1 foot=0.3048006 meter. *Id.* at 3.

computed for each region under consideration; the universal table for the polyconic projection is, therefore, a great point in its favor.[17]

The projection described above is the one generally referred to in this country as the polyconic projection, but actually it is an exceedingly broad class and contains examples of many kinds of projections.[18] It has also been referred to as "ordinary," "simple," "Coast Survey," and "American" polyconic, the last designation having been given it by European writers. It is the projection that is used on all the present field surveys of the Bureau.[19]

This form of the polyconic projection is, then, characterized by curved meridians except the central one, nonconcentric arcs of circles for the parallels, and nonorthogonality of intersections.

## 344. Rectangular Polyconic Projection

As a matter of historical interest, mention should be made of the *rectangular* polyconic projection (*see* fig. 33), which is a modification of the ordinary polyconic (*see* text following note 18 *supra*). In this projection, the parallels are constructed as in the ordinary polyconic but they are not all divided truly. Only a selected parallel is truly divided and through the points of division the meridian lines are drawn so as to cut all the parallels at right angles—hence, the name rectangular polyconic.

The first reference to the use of this projection in Coast Survey work is found in the Annual Report of 1853, where a detailed description is given of two forms of the polyconic projection—the rectangular polyconic, and the equidistant polyconic (*see* 345). It is there stated: "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." It is then stated that beyond the limit of the equidistant polyconic (a square degree on a scale of 1:10,000) "the *rectangular-polyconic* method should be employed, at least in all Coast Survey projections." Finally, the report states: "The polyconic method of projection has been developed in the Coast Survey office, and the

17. This advantage is shared by the Mercator projection (*see* 613 note 11) for which a general table has also been computed and can be at once applied to the construction of a sailing chart for any part of the world.

18. Adams, General Theory of Polyconic Projection 13, Special Publication No. 57, U.S. Coast and Geodetic Survey (1934).

19. Detailed instructions for the construction of small-scale and large-scale polyconic projections are given in Deetz and Adams (1944), *op. cit. supra* note 5, at 63–65, and in Tables for a Polyconic Projection of Maps (1946), *op. cit. supra* note 16, at 8–9.

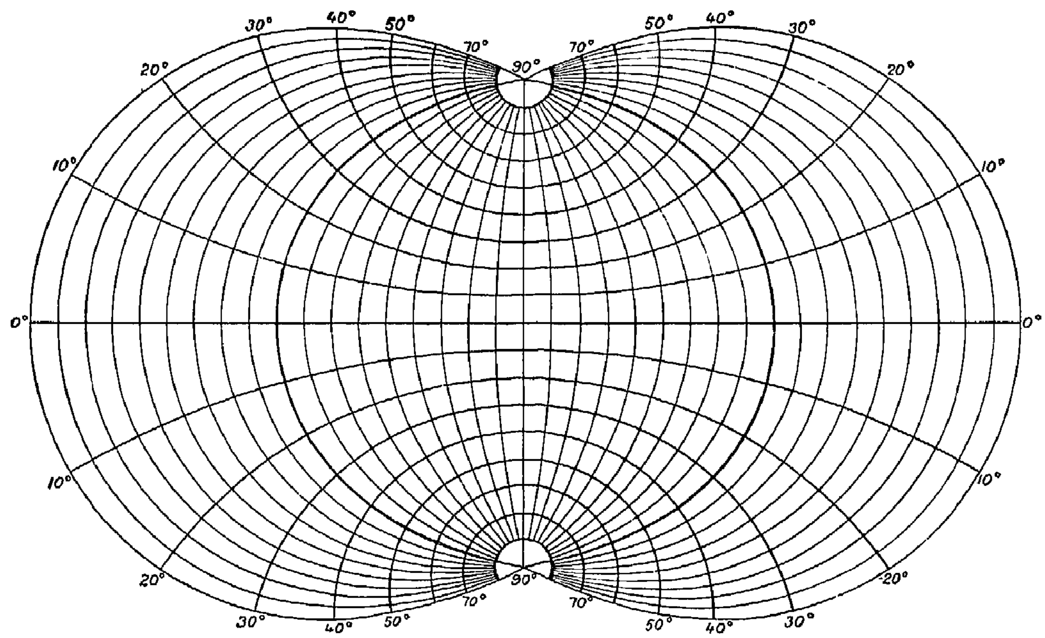


FIGURE 33.—Development of the sphere on the rectangular polyconic projection.

subjoined tables, prepared for facilitating its use, were there computed, and are now first published." [20]

From these extracts, there can be no doubt that at this period in the history of the Survey the rectangular polyconic projection was being used, and very likely for all work other than for small areas such as those covered by planetable and hydrographic sheets (*see* 345).[21]

## 345. EQUIDISTANT POLYCONIC PROJECTION

The equidistant polyconic projection—so-called in the annual report of the Survey for 1853—appears to have been used for the field sheets of the Coast

20. Annual Report, U.S. Coast Survey (Appendix 39) 99, 100 (1853). The tables included in the report gave values for the construction of the projection by means of rectangular coordinates and were based on the constants of the Bessel spheroid of 1841 (*see* 211). For a mathematical development of this projection, *see* ADAMS (1934), *op. cit. supra* note 18, at 13–23. This projection has been used by the British War Office for the construction of maps. *Id.* at 18.

21. For the area covered by the chart and map work of the Survey there is little difference between the ordinary polyconic and the rectangular polyconic. Thus, for a chart representing the whole of North America, the unaided eye can barely perceive any departure from orthogonality in the intersections of meridians and parallels, which is the chief distinction between the two projections. It is only in the development of the whole sphere or of a hemisphere that departures from right angles become apparent.

Survey and perhaps some charts during the early years,[22] and possibly as late as 1882.[23]

In this projection, a central meridian and a central parallel are constructed as in the ordinary and the rectangular polyconic. Additional parallels are then constructed (for the average sheet, the top and bottom parallels) from the tabular values, and the points of intersection of the different meridians with these parallels are then found and the meridians drawn. On the meridians thus determined, distances are laid off from the central parallel equal to the distances between corresponding parallels on the central meridian, and the other parallels are drawn (the tabular auxiliary parallels except the central one are then removed from the sheet). From this process of construction, a projection results in which equal meridian distances are intercepted everywhere between the same parallels—hence, the name equidistant. This should be regarded as a convenient graphic approximation, admissible within certain limits, rather than as a distinct projection, although it is capable of being extended to the largest areas with results quite peculiar to itself. If extended to include the entire earth, with the equator as the central parallel, all the parallels would become concave toward this line, for the distance between parallels measured along the curved meridians being constructed equal to that along the central straight meridian, it necessarily follows that the parallels must converge in receding from the central meridian. This is exactly the reverse situation that exists in the ordinary and the rectangular polyconic projections (*see* figs. 32 and 33).[24]

### 346. Identification of Projections on Early Surveys

Because of the limited area covered by the field surveys of the Bureau, the type of projection used is not readily identifiable. Thus, on the average topographic and hydrographic surveys, at scales 1:10,000 or 1:20,000, the curvature of the meridians never becomes sensible and the parallels only rarely so.

22. This is evident from the statement in the 1853 report that "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.*" Annual Report (1853), *supra* note 20, at 100. *See also* text at note 20 *supra.*

23. Craig, A Treatise on Projections 208, Treasury Document No. 61, U.S. Coast and Geodetic Survey (1882).

24. Annual Report (1853), *supra* note 20, at 100. To have called this a *polyconic* projection was particularly faulty, since it does not possess the basic requirements of such a projection, namely, parallels of latitude formed by a system of nonconcentric arcs of circles whose centers lie on the central meridian (*see* 343). The only similarity to a polyconic projection is the fact that the auxiliary parallels used to develop the meridians are conic developments. The later works on projections do not include the equidistant polyconic in the classification of projections nor in the polyconic category. *See* Adams (1934), *op. cit. supra* note 18, and Deetz and Adams (1944), *op. cit. supra* note 5.

And even where a difference between two types of projections is perceptible, the difference may be obscured by unequal distortion of the paper, and identification by measurements becomes impossible.

While there may be some doubt as to the identity of the projection used prior to 1853, when the first polyconic tables were published (*see* note 16 *supra*), as a practical matter there is no difference whether the survey was projected on one of the forms of the polyconic, heretofore discussed, or on the Bonne projection (*see* 342). The important thing to remember is that because of the limited extent of these surveys, whatever the projection used, the shapes, areas, distances, and azimuths are preserved as they are on the surface of the earth. The plotting of control points, the determination of geographic positions of plotted points, or corrections to the projection lines may be accomplished by the use of the meridional distances and arcs of the parallel given in Special Publication No. 5 (*see* note 16 *supra*), the scale being applicable throughout the projection.

It is also important to bear in mind, when comparing surveys, maps, or charts on different projections, that while the type of projection used determines the geometrical characteristics of the map or chart, the geographic positions of points (their latitudes and longitudes) are unaffected, if the maps or charts are on the same datum (*see* 22). In other words, while the scale on one map may vary because of the projection used, features may be compared with other maps on a different projection provided comparisons are made by latitudes and longitudes and provided that the datums are the same, because a point on the surface of the earth can have one and only one latitude and longitude.

## 35. REASONS FOR MULTIPLE PROJECTION LINES

The reasons for multiple projection lines on the early surveys can usually be traced to one or more of the following:

1. A change in the spheroid of reference for the computations.
2. A change in longitude values.
3. A change in the horizontal datum for the triangulation.

These changes resulted in a change in the geographic values of control points. To take them into account, the survey could of course be replotted on a new projection using the new values of the control points. Expediency, however, has dictated against so time-consuming a procedure. Instead, the practice was adopted of applying a differential displacement to the projection lines to take into account the new geographic values of the control points. This gives acceptable accuracies (*see* 38).

While all of these changes may have contributed toward changing the geographic values of control points in an area, the projection lines on a survey sheet were not always corrected immediately upon a change. Corrections were generally applied when it became necessary to use the survey for charting or for other purposes, so that one actual change might be the result of more than one cause. For example, one correction might reflect a change in the spheroid and a change in the horizontal datum.[25] This frequently makes it difficult to segregate and allocate the various corrections applied.[26]

### 351. A Change in the Spheroid of Reference

The use of a new spheroid meant new factors for the computations, which in turn meant new values for the geographic positions of the control points. Therefore, on the early surveys, where the original triangulation positions were based either on the spheroid prior to the Bessel or on the Bessel spheroid of 1841 (*see* 211), it was necessary to apply a correction to the projection lines to bring the work to the new spheroid.

When the triangulation consisted of small detached portions in various parts of the country (*see* 221), it made relatively little difference what spheroid was used (provided of course it was not extremely erroneous) and the change from one spheroid to another produced little effect on the geographic values of the triangulation points. As the work expanded and greater distances became involved, the corrections became more significant. These corrections are not constant, except for small local areas, but are dependent upon the distance of the points from the origin of the triangulation.[27]

#### 3511. *Magnitude of Corrections*

Some idea of the magnitude of the corrections necessary for a change from the Clarke spheroid of 1866 to the Bessel spheroid of 1841 for an area comparable

25. This might also apply to the computations. The recomputation of points in an arc of triangulation may not have been made immediately upon the introduction of telegraphic longitude, but may have been made after the triangulation was adjusted or after a new spheroid was adopted, in which case one correction would include changes due to both causes.

26. The independent datum used for the early triangulation in the New England area later became the basis for the United States Standard Datum (*see* 223). The change to the new datum in this area was therefore merely a change from the Bessel to the Clarke spheroid and the corrections to the triangulation would indicate the magnitude of the change due to this cause (*see* 3511).

27. This problem has been studied in the Coast Survey and the results are given in Lambert, Effect of Variations of Assumed Figure of the Earth on the Mapping of a Large Area 4–15, Special Publication No. 100, U.S. Coast and Geodetic Survey (1924).

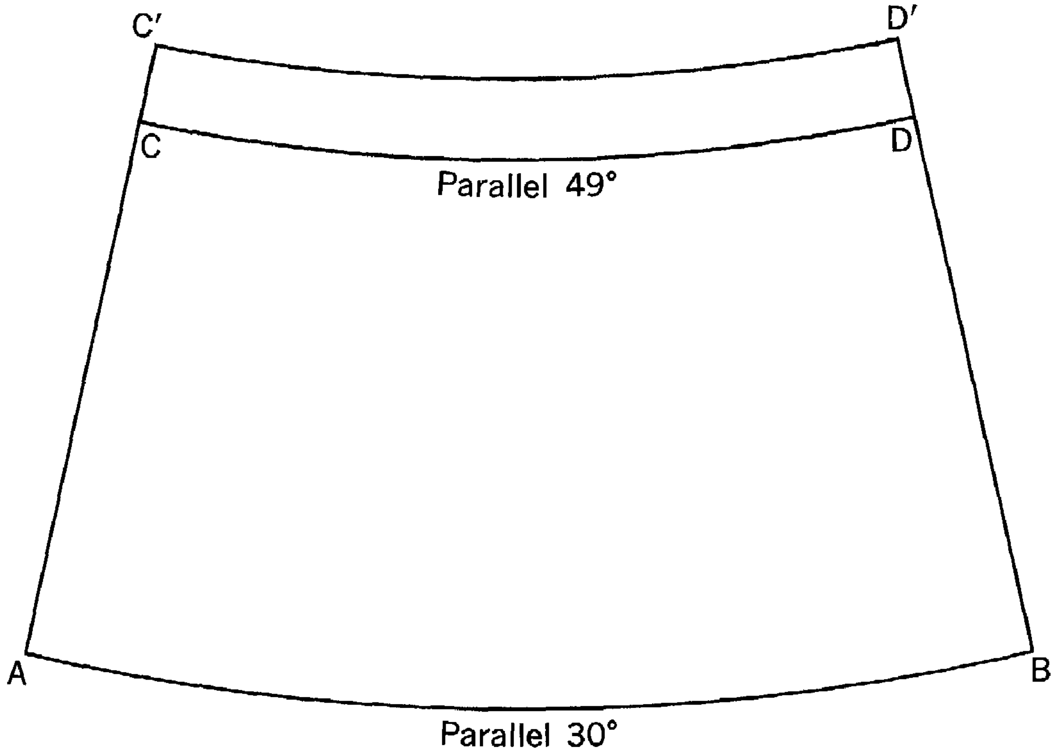


FIGURE 34.—Effect of change of spheroid on the triangulation of a country.

to the United States can be had from the following example, which is paraphrased from LAMBERT (1924), *op. cit. supra* note 27, at 10–11:

Assume two points, $A$ and $B$ (*see* fig. 34), in latitude 30°, and 40° apart in longitude. For the Clarke spheroid, the distance $AB$ measured along the 30th parallel is 3,859,529 meters, and the distance $CD$ along the 49th parallel is 2,926,965 meters. The length of the arc of the meridian $AC$ or $BD$ between the parallels of 30° and 49° is 2,109,475 meters.

If we inquire merely what the distances are between the same meridians and parallels on the Bessel spheroid, which has a semiminor axis 505 meters less and a semimajor axis 809 meters less than the Clarke spheroid (*see* 211), we obtain the following: The arc of the meridian between 30° and 49° is 2,109,286 meters, or 189 meters less than on the Clarke spheroid. The arc of 40° on the 30th parallel is 3,858,994 meters, or 535 meters shorter than on the Clarke spheroid, and the arc of 40° on the 49th parallel is 2,926,515 meters, or 450 meters shorter than the corresponding arc on the Clarke spheroid.

A length of 31 meters along the meridian represents 1″ of latitude while 27 meters and 20 meters represent 1″ of longitude on the 30th and 49th parallels, respectively. Therefore the differences in distances found correspond to 6″.1 in latitude and 20″ and 22″ in longitude.

If now we suppose the distance $AB$=3,859,529 meters to have been obtained from the Clarke spheroid and then laid off on the 30th parallel of the Bessel spheroid, it would correspond on the latter to a difference of longitude of not exactly 40° but of 40°00′20″.0.

Similarly, the meridian distances $AC=BD=2{,}109{,}475$ meters, when laid off from latitude 30° northward, puts the end points $C'$ and $D'$ not in latitude 49° even, but in latitude 49°00′06″.1. (The distances $CC'$ and $DD'$ are greatly exaggerated in the figure.) Along this parallel, the distance $C'D'$ is 2,926,822 meters, or 143 meters less than the distance between corresponding points on the Clarke spheroid.[28]

## 352. A Change in Longitude Values

One of the primary causes of corrections to the projection lines on early surveys was a change in the longitude values of the triangulation stations.

The determination of longitude (the difference between the local time at a given place and the corresponding Greenwich time) was one of the important problems that the Coast Survey had to deal with in the early years of its history. The problem engaged the attention of the most able and distinguished astronomers, mathematicians, and other scientists of the time, some of whom were associated with the Survey.[29]

### 3521. *Methods of Longitude Determination*

Various methods of longitude determination have been used by the Coast Survey at different periods in its history. Prior to the advent of the radio method, the principal methods employed were the lunar, the chronometric, and the telegraphic.[30] Both the lunar and the chronometric methods were subject to considerable error as evidenced by later telegraphic determinations.

28. For additional interpretations of the problem posed, *see id.* at 11–13.

29. In different periods of history, various meridians have been used as the initial or zero of longitudes from which other longitudes were reckoned. Hipparchus, the earliest astronomer to determine longitude by astronomical observations, used the meridian of Rhodes. Eventually, each country came to have its own initial meridian, usually the meridian of its capital. In the United States, the center of the dome of the old Naval Observatory at Washington, D.C., was the initial meridian—sometimes called the American meridian. Many of the early state surveys are referred to this meridian. Congress, by the Act of Sept. 28, 1850 (9 Stat. 515), ordered "that hereafter the meridian of the observatory at Washington shall be adopted and used as the American meridian for all astronomical purposes, and that the meridian of Greenwich shall be adopted for all nautical purposes." This act was repealed Aug. 22, 1912 (37 Stat. 342). In 1884, a conference of nations, called at the instance of the President of the United States, recommended the adoption of the meridian of the Royal Observatory, Greenwich, England, as the common initial or zero of longitude for all nations. Beall, Astronomic Determinations by U.S. Coast and Geodetic Survey and Other Organizations 3, Special Publication No. 110, U.S. Coast and Geodetic Survey (1925). In the Coast Survey, longitudes were always reckoned from Greenwich, although on some of the early charts of New York Harbor (1845) longitudes based on the City Hall of New York were also shown, and on the early Boston Harbor chart (1856) the charted longitudes are reckoned from the Boston State House, while the positions of lighthouses and light vessels are based on Greenwich.

30. Solar eclipses seem also to have been used in the early days. In one of Hassler's early reports, the following statement appears: "A special station was made in 1838 upon Weazel mountain near Paterson, N.J., for latitudes and azimuths; and a solar eclipse occurring just at that time, gave occasion for an observation of longitude at the same place. Every solar eclipse that has occurred during the time the work has as yet lasted, has been observed at some one of the survey stations." Annual Report, U.S. Coast Survey 5 (1841) (H. Doc. 28, 27th Cong., 2d sess.).

### A. LUNAR METHOD

One of the first methods used by the Coast Survey for the determination of longitude was the lunar method. The observer at a station of which the longitude was required observed the position of the moon and noted the *local* time of observation. From the Ephemeris, he could find at what instant of Greenwich time the moon was actually in the position in which he observed it. The difference between this time and the local time of observation was his longitude reckoned from Greenwich. The moon's position could be fixed by measuring the angular distance between the moon and the sun or one of the four larger planets, or between the moon and one of the brighter stars, or by occultation of a star, or a group of stars such as the Pleiades, or by moon culminations. In each case, the Greenwich time at which the moon occupied the position in which it was observed was obtained either from the Ephemeris, from observations at Greenwich at about the time in question, or from similar observations at some station of known longitude.[31]

The lunar method required extreme accuracy of observation because the longitude error was many times the observational error. Also, due to the nearness of the moon to the earth, long, complex, and difficult computations were required for reducing the observations to the center of the earth.

### B. CHRONOMETRIC METHOD

Another method used in the early work was by transporting chronometers between stations whose difference in longitude was to be ascertained. This was known as the chronometric method. The difference in time was obtained by comparing the local chronometer times at the two stations by means of other chronometers transported between the stations, the rates of all chronometers having previously been determined. Since it was necessary to travel back and forth between the stations, the cost of such a longitude determination increased with increased cost of travel and its accuracy decreased as the time required to make a round trip increased. This caused the chronometric method to give way to lunar methods in certain situations.[32] The method was also used in later years at many stations not reached by the telegraph.

31. BOWIE, DETERMINATION OF TIME, LONGITUDE, LATITUDE, AND AZIMUTH 78, SPECIAL PUBLICATION No. 14, U.S. COAST AND GEODETIC SURVEY (1917), and BEALL (1925), *op. cit. supra* note 29, at 5.

32. The points at which the boundary between the United States and Canada along the 141st meridian crosses the Yukon and Porcupine Rivers were originally determined by lunar methods. (The final demarcation of the boundary was determined telegraphically.) BOWIE (1917), *op. cit. supra* note 31, at 79.

The chronometric method required precision in the chronometer and the accurate determination of its rate. An error of 1 second in the chronometer time meant an error of 15″ in longitude, which for the average latitude of the United States (40°) was equivalent to an error of 356 meters.

### C. TELEGRAPHIC METHOD

When, in May 1844, Morse flashed his first telegraphic messages over the wires between Washington and Baltimore, with a transmission time of his signals so short as to be barely perceptible, a new era in longitude determination was foreshadowed.[33] Two years after this epoch-making event, on October 10, 1846, the telegraphic method was put into successful operation by the Coast Survey and time signals were exchanged between the United States Naval Observatory (old site) at Washington, D.C., and the Central High School at Philadelphia, Pa.

In the telegraphic method, the error of the local chronometer was determined at each of the two stations by the ordinary time observations, and the two chronometer times were then compared by telegraphic signals sent between the two stations.

During the long interval since its introduction and until the adoption of the radio method in 1922, the telegraphic method was gradually brought to a high state of perfection and represented the most accurate known method of determining differences of longitude.[34]

## 3522. *Magnitude of Corrections*

When the methods prior to the telegraphic were used for longitude determinations, there was considerable variation in the results obtained. For example, with the same method, the longitude determinations at the principal observatories, such as Cambridge, Mass., where many chronometers were used and numerous observations extended over a long period, were of a much higher order of accuracy than the determinations at some of the triangulation stations where conditions did not permit the same degree of precision. Also, the

33. Annual Report, U.S. Coast and Geodetic Survey 202 (1897).

34. In the Annual Report for 1897, it is stated: "It will be seen from these results that we are justified in assigning to any of our American longitude results a probable error of about . . . ±0″.78, which, in latitude 39°, represents a linear extension of but 18.8 metres, or 61.7 feet nearly." Annual Report, U.S. Coast and Geodetic Survey 256 (1897).

instruments used in the early work had not reached the stage of refinement they later did, and this introduced an additional error in the early determinations.

Some idea of the magnitude of the corrections due to changes in longitude values can be had from an examination of one of the early topographic surveys covering the western portion of Long Island Sound, N.Y. (Register No. T-14 (1837)). The survey was based on the Hassler triangulation of 1834. The original projection on this survey shows the longitude of station *Rikers Island* to be 1,273 meters westward of meridian 73°55′.[35] The first correction to the longitude value was that derived from the connection by telegraph of this area with Harvard College Observatory at Cambridge, Mass. This amounted to over 3′ of arc and brought the longitude of station *Rikers Island* to 1,224 meters west of meridian 73°52′.[36]

Until the year 1866, the longitude of Cambridge Observatory from Greenwich, England, depended upon moon culminations, eclipses, transits, occultations, and chronometer transportation. The adopted value was 71°07′22″.50, and this served as the standard for all the work connected with that observatory. With the completion of the electric cable across the Atlantic in 1866, the longi-

35. According to an unpublished 1912 report by the Geodesy Division of the Bureau on "Old longitudes in the vicinity of New York City," these early longitude values (the Hassler values) were computed from independent astronomic data. The report centers around the various longitude values of the New York City Hall, beginning with the value of 74°03′05″.2 in the Hassler computations. The earliest published position is given as 74°00′56″.7 (from a circular to the Collector of Customs, dated May 27, 1843, a copy of which is filed in Vol. 1 of "Miscellaneous Scientific and Business Papers" (Acc. No. 5), at page 63), or a difference of 2′08″.5 from the Hassler value. The report states that on the 1844 and 1845 charts of New York and vicinity (the first charts published of the area), the scaled position of the City Hall is 74°00′41″, or a difference of approximately 2′24″ from the Hassler value, the difference being "due to the fact that the Hassler positions are based on independent astronomic data, the best that could be obtained in 1837." The report states further that the first positions published in the Bessel registers (*see* note 39 *infra*) gave the longitude of the City Hall as 74°00′44″.587, or a change of approximately 3″.6 in longitude from the position on the first published charts, and a difference of approximately 2′21″ from the Hassler value. The second positions appearing in the Bessel register give the longitude of the City Hall as 74°00′03″.09, a change of approximately 41″.5 from the first Bessel longitude, and a difference of 3′02″ from the Hassler value. The positions in red in the Bessel register made in 1869 show a change of +20″.6 in longitude from the second Bessel value, due to the telegraphic determination of longitude (*see* text at note 37 *infra*). The longitude of the City Hall is given as 74°00′23″.71, which differs from the Hassler value by 2′41″. The positions based on the telegraphic determination of longitude were first published in the Annual Report of the Survey for 1851. The final positions on the United States Standard Datum give the longitude of the City Hall as 74°00′23″.017, a difference of approximately 2′42″ from the Hassler value. The report concludes with the statement that after a consideration of all the facts gathered "we are led to believe that the longitudes of the Hassler computations were based on independent astronomic data . . . and that they were never intended to be used in making the final published charts. They were simply used for making the field sheets of a particular detached locality, and that they were correct as far as relative positions were concerned . . . . The various changes in longitude that were made between 1845 and the time of the U.S. Standard Datum were due to various causes such as moon culminations, parallax, chronometers, etc., and to the telegraphic determination of longitude."

36. A small part of this correction may have been due to the adoption around this time of the Bessel spheroid of 1841 for the computations, but the major correction was due to the introduction of telegraphic longitudes. Annual Report, U.S. Coast Survey 163, 164, 278 (1851).

tude of Cambridge Observatory was found to be 71°07′42″.75. In consequence, in April 1869, the longitudes of the surveys on the Atlantic coast were increased by 20″.25 of arc, which in the latitude of station *Rikers Island* amounted to 475 meters.[37]

A similar increase in longitudes, or pushing westward of the coastline, was found necessary on the Pacific coast, only the amount of change was even greater. In the spring of 1869, San Francisco and Cambridge Observatory were directly connected by wire, and the longitude of station *Telegraph Hill,* which had previously been determined from 206 moon culminations observed at 7 different places and reduced to the station by means of chronometer transportations, was found to be greater by 46″.5 of arc, which in the latitude of San Francisco amounted to 1,138 meters.

### 353. A Change in the Horizontal Datum

Under this category are included only those changes that result from the adoption of a standard horizontal or geographic datum. The subject of datums in the United States and Alaska and the development of the final North American 1927 Datum have been discussed in Chapter 2. It was there pointed out that a number of independent datums existed in the United States prior to the adoption of the United States Standard Datum (*see* 22). This brought about the major changes in the latitudes and longitudes of triangulation stations, resulting in a shift in the projection lines. The change to the North American 1927 Datum was of considerably less magnitude (*see* 37).

## 36. SUMMARY OF CORRECTIONS TO PROJECTION LINES

As a result of the three items considered in 351, 352, and 353, it is possible to encounter on the early surveys corrections to the projection lines corresponding to the following situations:[38]

37. Annual Report (1897), *supra* note 33, at 201. The value of 71°07′42″.75 was later adjusted to 71°07′44″.85 from additional determinations. *Ibid.* For a historical account of the trans-Atlantic longitude program of the Coast Survey beginning with the initial project in 1843, *see* Knox, *Precise Determination of Longitude in the United States,* 47 The Geographical Review 555 (1957).

38. There is an additional projection-line correction sometimes encountered on survey sheets—the correction due to office adjustment of the triangulation. If the survey is based on field computations of the control points, their geographic positions will not correspond to the adjusted values. The correction due to this cause, however, is usually of the order of 5 to 10 feet, which would be of little significance cartographically. On many of the early surveys this correction was probably absorbed in other changes.

(*a*) *Atlantic and Gulf Coasts*

(1) Unknown spheroid and chronometric and lunar longitudes—independent datum.

(2) Bessel spheroid of 1841 with old data (chronometric and lunar longitudes from Greenwich and telegraphic longitude within network)—independent datum.

(3) Bessel spheroid of 1841 with new data (telegraphic longitude from Greenwich)—independent datum.

(4) Clarke spheroid of 1866—independent datum.

(5) United States Standard Datum (same as North American Datum).

(6) North American 1927 Datum.

(*b*) *Pacific Coast*

The work on the Pacific coast was started in 1850, several years after the Bessel spheroid of 1841 was adopted by the Bureau (*see* 211); hence, item (1), above, never entered into the work on that coast. Items (2) to (6), however, are equally applicable.

## 37. EXAMPLE OF CORRECTIONS TO A SURVEY SHEET

Figure 35 is a section of a topographic survey of the Mississippi River area made in 1867 (Register No. T–1037) and shows the number and magnitudes of the several corrections applied to the original projection. Since the survey was made after the Bessel spheroid of 1841 was adopted (*see* 211), only the last five of the corrections listed under 36(*a*) had to be applied at different times, as the survey was needed for charting or for other use.

The successive values for station *South Base* are as follows:

| | *Latitude* | *Longitude* |
|---|---|---|
| (1) | 29°09′25″.82 (794.8 m.) | 89°13′19″.81 (535.3 m.) |
| (2) | 29°09′25″.82 (794.8 m.) | 89°14′18″.12 (489.6 m.) |
| (3) | 29°09′24″.18 (744.6 m.) | 89°14′17″.10 (462.2 m.) |
| (4) | 29°09′19″.65 (605.3 m.) | 89°14′17″.29 (467.6 m.) |
| (5) | 29°09′19″.546 (601.8 m.) | 89°14′18″.121 (489.7 m.) |

The first value is based on the Bessel spheroid of 1841 with astronomic data. It corresponds to the original projection shown on the survey sheet with black solid lines.

The second value is based on the same spheroid but with the introduction of telegraphic longitude. This made no change in the latitude value, but increased the longitude by 58″.31, or 1,576.0 meters. This change includes the 20″.25 due to cable connection between Cambridge Observatory and Greenwich, England (*see* text at note 37 *supra*).

The third value is due to a change from the Bessel to the Clarke spheroid. The triangulation was still on an independent datum. This effected a reduction in latitude of 1″.64 or 50.2 meters, and a reduction in the longitude value of 1″.02 or 27.4 meters.

The fourth value resulted from the adoption of the United States Standard Datum (N.A. Datum) and reduced the latitude value by 4″.53 or 139.3 meters. The longitude value, however, was increased by 0″.19 or 5.4 meters.

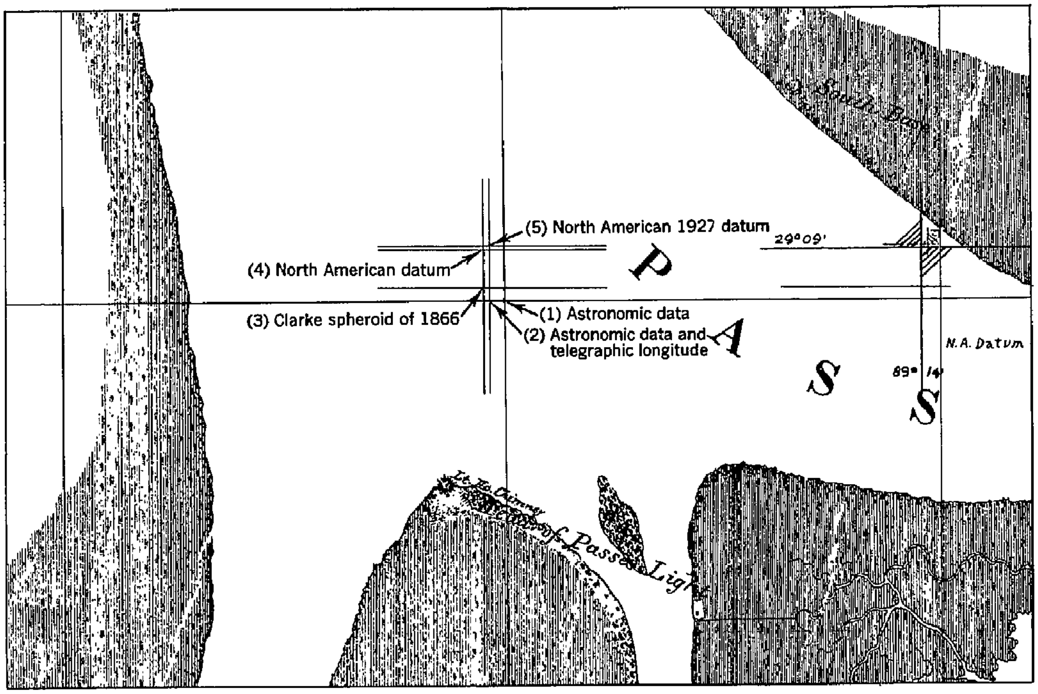


FIGURE 35.—Portion of early topographic survey (on reduced scale) showing corrections to the projection lines as a result of changes in the geodetic data.

The fifth and final value brought the work to the North American 1927 Datum. The latitude was reduced by 0".10 or 3.5 meters and the longitude was further increased by 0".83 or 22.1 meters.[39]

From the example given, it should be obvious that before features on successive surveys are studied and conclusions drawn, it is of the utmost importance to first bring the surveys to a common datum, if comparisons are to be made by superposing the projection lines. This does not necessarily mean the latest datum unless the comparison is to be made with a survey that is based on the latest datum. When requests are made for copies of early surveys, it is customary to place them all on a common datum—generally the latest—before they are sent from the Washington Office. The user should make certain this is the case before using them.

39. The early values of the triangulation stations were recorded in a series of volumes or registers and were maintained in the Chart Division of the Bureau. These registers are still referred to when it becomes necessary to identify a station on a survey sheet that has not been brought to the latest datum (*see* 382). Triangulation stations that have been reduced to the North American 1927 Datum are maintained in a card file in the Geodesy Division of the Bureau and copies may be obtained on request.

## 38. CHANGING THE DATUM OF A SURVEY SHEET

Practically all of the recent surveys of the Bureau in continental United States are based on the North American 1927 Datum, but many of the early surveys are still on the North American Datum or some independent datum (*see* 224 and 23). To change the datum of a survey sheet, the usual practice is to apply corrections to the projection lines on the sheet.

There are two methods of applying a datum correction—a numerical one and a graphic one. The method selected is usually dictated by the presence of certain conditions which will be described below.

### 381. DISTORTION FACTOR

Before datum corrections can be applied, the distortion factor of the survey sheet must be determined in a north-south and an east-west direction. This is done by comparing the scaled distances between projection lines on the sheet with the corresponding values given in Special Publication No. 5 (*see* note 16 *supra*). The distortion factor is determined from the relationship

$$\frac{\text{Tabular value} - \text{Survey value}}{\text{Tabular value}} = \pm \text{ Distortion factor.}$$

Several distances in each direction should be measured in order to obtain a mean factor and to ensure against errors in the original projection. The distortion factor should be applied to every distance that is to be plotted on the sheet.[40]

### 382. NUMERICAL METHOD

In the numerical method, three widely distributed triangulation stations on the sheet are selected whose geographic positions on the North American 1927 Datum are available. Identify these stations on the datum of the projection in the old registers (*see* note 39 *supra*), or in any of the publications of the Bureau, and check their geographic positions with the positions plotted on the sheet. The mean of the differences between the values on the two datums is the correction to be applied to the projection on the sheet. The differences for the three stations should nearly equal each other. If a wide variance is found, an investigation should be made for possible errors in the computations or for failure to identify common stations on the two datums.

40. To reduce measurements on a distorted sheet to true values the formula for "correction factor" should be used (*see* 1321).

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(*a*) *Applying the Correction.*—Great care must be taken to see that the correction is applied in the proper direction. The following rule will be found helpful in determining the direction:

> If the latitude (N.) and longitude (W.) on the old datum are greater than the corresponding values on the new datum, then the new projection will be to the north and west, respectively, of the old projection; if the old values are smaller than the new ones, it will be to the south and east.

From this, the direction of the correction for other relationships can be readily determined. To avoid errors of application in plotting, a sketch should be made showing the relationship of the two datums to one of the selected triangulation stations, with the corresponding latitudes and longitudes indicated.

The new datum is usually marked in colored ink by short intersections at two or more projection intersections. At one of the intersections the name of the datum, the latitude and longitude, the initials of the cartographers who made the correction and the verification, and the date the correction was made, are all shown in colored ink. (*See* fig. 36.)

*Example:* In figure 36, the latitudes and longitudes of triangulation station *Front* (1918) on the old and new datums are as follows:

| *North Latitude* | *West Longitude* |
|---|---|
| 47°25′ 450 meters (old datum) | 124°10′ 900 meters (old datum) |
| 47°25′ 300 meters (new datum) | 124°10′ 750 meters (new datum) |
| 150 meters difference | 150 meters difference |

Applying the rule given above, the new projection is found to be to the north and west of the old projection. Therefore, the intersection of latitude 47°25′ N. and longitude 124°10′ W. on the new datum is obtained by laying off the distance 150 meters (corrected for distortion) in a north and in a west direction from the old datum.

(*b*) *Reference Station on the Sheet.*—If the value of the latitude and longitude of one of the plotted stations is recorded on the sheet, the correction may be obtained by subtracting from it the corresponding value on the new datum.[41] Where photographic copies of old surveys are used, the single correction thus obtained is sufficiently accurate for use on the entire sheet. In the Washington Office, where the original survey sheet is available, additional stations are used and a mean correction obtained in accordance with the procedure outlined above.

The numerical value shown on the sheet should always be checked against the plotted position of the station before using it for determining a datum correction.

41. As a rule the early surveys did not include such a reference station. Since 1942, this (together with the geographic datum) has been a specific requirement. ADAMS, HYDROGRAPHIC MANUAL 691, SPECIAL PUBLICATION NO. 143, U.S. COAST AND GEODETIC SURVEY (1942).

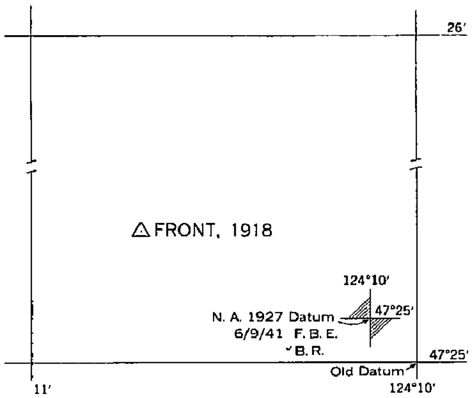


FIGURE 36.—Change of datum of survey sheet—by numerical method.

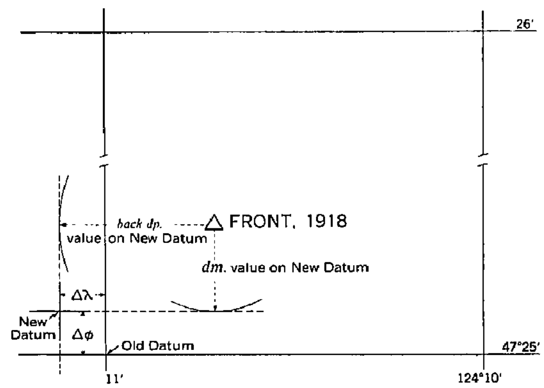


FIGURE 37.—Change of datum of survey sheet—by graphic method.

### 383. Graphic Method

This method of correcting the datum of a survey sheet is applicable under three conditions: (1) as an alternative to the numerical method, (2) where geographic positions of the stations on the datum of the sheet can be found neither in the old registers (*see* note 39 *supra*) nor in any of the publications of the Bureau, and (3) where the old registers are not available.

Under these conditions, three well-distributed stations on the sheet are selected the geographic positions of which are available on the new datum. Determine the *dm.* and *dp.*[42] of each station from the projection line nearest to it (this will mean using the back *dms.* and *dps.* in some cases), and with these values as radii, short pencil arcs are swung in the proper directions from the plotted position of the station as a center. Pencil lines are then drawn tangent to these arcs and parallel to the latitude and longitude lines on the sheet. The intersection of these lines will give the position of the new datum. The offsets ($\Delta\phi$) and ($\Delta\lambda$) are then carefully scaled from the old datum on the sheet. Figure 37 illustrates the application of this method to the example given in 382.

The same procedure is followed with the other selected stations. The offset values obtained in each case are then compared. If they do not differ by a

42. The equivalents in meters of the seconds of latitude and longitude of triangulation stations are known as the *dms.* (meridional differences) and *dps.* (parallel differences), respectively, of the stations. Thus, if the position of a station is given as latitude 54°44′34″.189 N. (1,057.2 meters), longitude 130°56′42″.362 W. (756.5 meters), its *dm.* is 1,057.2 meters north of the 44′ parallel, and its *dp.* is 756.5 meters west of the 56′ meridian. The back *dm.* is the distance in meters from the next minute of latitude (45′ in the case cited), and the black *dp.* is the distance in meters from the next minute of longitude (57′ in the case cited).

plottable amount, the intersections as determined are accepted; otherwise a mean value is used. Any appreciable differences are investigated. The method of designating the new datum on the sheet is the same as for the numerical method.

### 384. Unrecoverable Stations

Stations sometimes become unrecoverable and cannot be included in the triangulation to connect them with the new datum. Where a survey sheet contains such stations only, then the relationship between the old and new datums must be obtained from stations on adjoining sheets for which the new datum values are available. A mean of the corrections derived from the adjoining sheets should be used.

In some of the published volumes of triangulation data for the coastal states a list of "lost" (unrecoverable) stations, with their geographic positions (unadjusted) on the North American Datum, was also included.[43] While such values would not be used for extending triangulation, they are adequate for coordinating old and new surveys.

## 39. PROJECTION CONSTRUCTED AFTER SURVEY

Some of the early surveys (hydrographic and topographic) were executed prior to the determination of the geographic positions of the control points, as where the local triangulation had not been connected to the main net of triangulation or where astronomic observations had not been made. In such cases, the only elements given were the distances from the points to the two axes of a system of rectangular coordinates (which is assumed) and the distances between the points. The projection for plotting these consisted simply of axes of ordinates and abscissas so laid on the sheet as to embrace all the points that were required by the surveyor in his work. The points were plotted from these by the intersection of two arcs with the distances of the points from the axes as radii, either north or south and east or west of the axes, as the plus or minus sign may indicate. In some cases, where it became necessary to undertake the topography when neither the data for constructing a projection nor for plotting the coordinates were available, the points were plotted by distances. Where a survey sheet had no projection, it was customary to draw squares of

43. *See,* for example, Mitchell, Triangulation in Maryland 234–255, Special Publication No. 114, U.S. Coast and Geodetic Survey (1925).

1,000 meters, or some other specified number, on it. This facilitated the construction of a projection on the sheet at a later date.[44]

In constructing a projection on such a sheet, the distortion factor is one of the important elements that has to be considered. Upon the accuracy of its determination depended the accuracy of the projection. Paper does not always distort uniformly and the shrinkage or expansion should be determined in both a north-south and an east-west direction and a factor applied to all measurements to be laid down on the sheet (*see* 381). The smaller the distance to be plotted the less will be the error of distortion so that in laying down projection lines from plotted triangulation stations, corrections are avoided by selecting stations close to the lines to be constructed.

There are two methods of reconstructing a projection on a survey sheet—a rigid one applicable to small-scale surveys, and a graphic one applicable to large-scale surveys. In both methods the essential problem is the determination of the cardinal lines of the projection, namely, the central meridian and the central construction line.

### 391. On Small-Scale Surveys

For surveys on scales smaller than 1:10,000, the rigid method is used and comprises the following steps:

(1) Three triangulation stations, *A, B,* and *C,* are selected (*see* fig. 38), so situated with respect to the central meridian that the distance *de* will cover more than half the latitude extent of the survey sheet. Two of the stations should be selected, if possible, in about the same latitude (*see* (6) below). From the scaled lengths of *BA* and *CA* and the corresponding computed lengths (make inverse computations for these if they are not in the triangulation data), determine the distortion factor along each line (*see* 381).

(2) Select the central meridian (as near to the middle of the sheet as possible) and compute the distances *Bd* and *Ce* and the latitudes of the points *d* and *e*.[45]

44. Wainwright, Plane Table Manual 28, Special Publication No. 85, U.S. Coast and Geodetic Survey (1922). Sometimes it was necessary to make a topographic survey in advance of the triangulation work. In such case, a base line was measured and laid down on the sheet. The ends of the base were occupied with the planetable and additional points located by intersection and directions taken to all visible points. The survey then proceeded as usual (*see* 4111). Lengths of 1,000 meters were usually laid down on the sheet in several places for the purpose of determining the true scale at any time in the future (*see* 131). *Id.* at 64.

45. This is accomplished on Form 27, Position Computation, Third-Order Triangulation. Since both the distance and latitude are involved in the position computation formulas, a trial-and-error method is used. A value is assumed for the required latitude ($\phi'$) and from the known longitudes ($\lambda$) and ($\lambda'$) of station *C* and the central meridian, respectively, and the known azimuth ($\alpha$) of the line *Ce* (obtained either directly from the triangulation data or from the inverse computation), the distance ($s$) is computed from the longitude formula. This distance is then used in the latitude formula and the latitude increment or decrement ($\Delta\phi$) is obtained. This computed $\Delta\phi$ may not agree with that derived from the assumed latitude ($\phi'$), but by repeated assumptions a value for $\Delta\phi$ will be obtained that is in absolute agreement with the assumed latitude. (To obtain a close first approximation, a sketch should be drawn at about one-fifth the scale of the sheet, using a rectangular grid and using as units of measurement the values of a minute of latitude and longitude at the center of the sheet. From this sketch the latitude where a given line crosses the central meridian can be scaled and this value used as the first assumed value in the computation.)

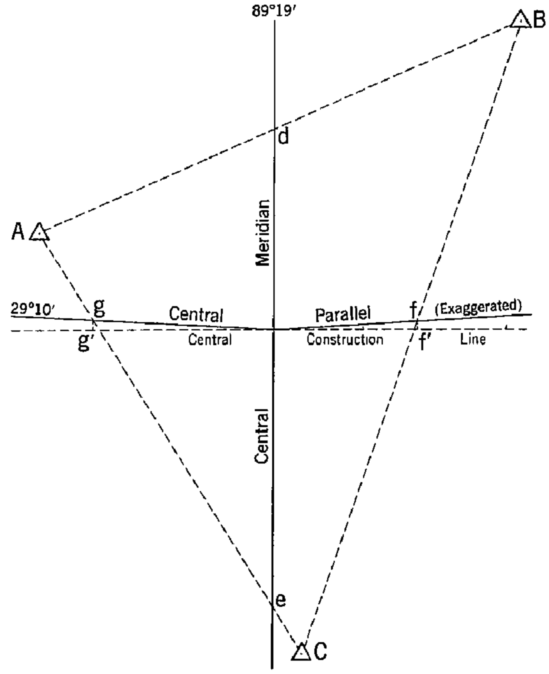


FIGURE 38.—Construction of a polyconic projection on a completed survey sheet—for small-scale surveys.

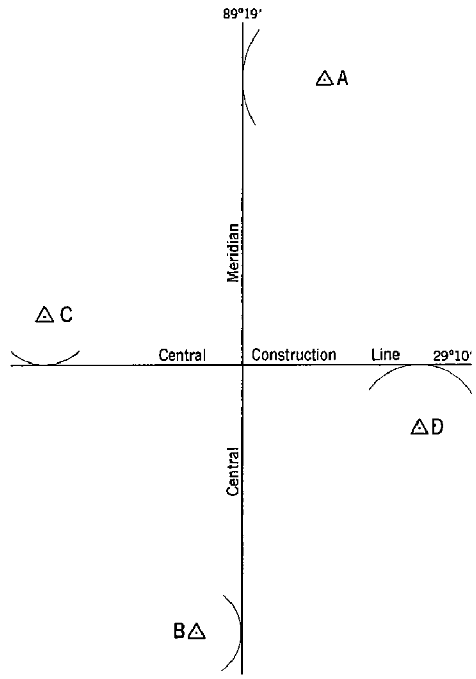


FIGURE 39.—Construction of a polyconic projection on a completed survey sheet—for large-scale surveys.

(3) Plot points *d* and *e* along lines *BA* and *CA* correcting each computed distance for the distortion determined along the respective lines. Through *d* and *e* draw a straight line for the full length of the sheet. This is the *central meridian* of the projection.

(4) Scale the distance *de* on the sheet and from the computed latitudes obtain from Special Publication No. 5 (*see* note 16 *supra*) the true distance on the earth. From these two values the distortion in a north-south direction is determined (*see* 381).

(5) On the central meridian lay off the true distance from point *d* or *e* to the central parallel and at this point construct a perpendicular to the central meridian for the full east-west length of the sheet. This is the *central construction line.*

(6) From here the problem is the ordinary one of constructing a polyconic projection (*see* note 19 *supra*). The distortion factor to be applied to east-west measurements may sometimes be obtained from the disposition of the selected triangulation stations (*see* (1) above), otherwise follow instruction below.

(7) The projection should be checked against every triangulation station on the sheet. Small differences in latitude or longitude may be due to unequal distortion of the sheet. In such case the projection should be made consistent with the triangulation even though this results in a slightly skewed projection.

*Determining East-West Distortion.*—If the east-west distortion of the sheet is not available from the disposition of the triangulation stations, it can be determined in the following manner:

(1) Compute the longitude crossings of the lines *CB* and *CA* (*see* fig. 38) on the central parallel or any other parallel that will give a distance long enough to determine a good distortion factor.[46]

(2) Plot the computed distances *Cf* and *Cg* (corrected for distortion) along lines *CB* and *CA*, and at points *f* and *g* draw short lines parallel to the central meridian. Lay off to the south (in north latitude) on these lines the *Y*-coordinates from Special Publication No. 5 (*see* note 16 *supra*) for the appropriate longitude distance and obtain points *f'* and *g'*. The scaled distance between these points compared with the tabular distance as determined from their *X*-coordinates will give the distortion factor in an east-west direction (*see* 381).

(3) Wherever possible, advantage should be taken of the location of some of the triangulation stations to reduce the amount of computation for determining this distortion. For example, in figure 38, the parallel through station *A* can be used instead of the parallel through *g*, thereby making it unnecessary to compute the longitude of *A*.

## 392. On Large-Scale Surveys

For small areas such as those covered by the large-scale topographic and hydrographic surveys of the Bureau, the polyconic projection is practically identical with the rectangular projection or a modification thereof (projection with converging meridians); therefore, in reconstructing a projection on surveys of scale 1:10,000 or larger, the following graphic method can be substituted for the more rigid method described above:

(1) After the distortion of the sheet has been determined from comparisons between scaled and computed distances, two triangulation stations *A* and *B* are selected near the north and south extremities of the sheet and as close to the center of the sheet as possible (*see* fig. 39). From the "Arcs of the parallel" in Special Publication No. 5 (*see* note 16 *supra*), the distances from each station to the central meridian are obtained and with these distances (corrected for distortion) as radii and the stations as centers, arcs are swung toward the center of the sheet. A line is then drawn tangent to these arcs for the entire length of the sheet. This line is the *central meridian* of the projection.

(2) Two other triangulation stations *C* and *D* are selected near the east and west extremities of the sheet and as close to the central parallel as possible. From the "Meridional arcs" in Special Publication No. 5 (*see* note 16 *supra*), the distance in meters is obtained from each station to the central parallel. To these distances are added or subtracted the *Y*-coordinates from the tables in Special Publication No. 5 corresponding to the difference in longitude between the central meridian and each station. (For north latitude, *add* if the station is above the central parallel and *subtract* if below. For south latitude the reverse is true.)

46. This is accomplished on Form 27 in a manner similar to that described in (2) above for determining the latitude intersection. With the azimuth of the line *CB* as previously determined and the known latitude increment or decrement ($\Delta\phi$), a value for $s$ is found by trial and error that will make the sum of the latitude terms in the computation formula equal to $\Delta\phi$. From this value of $s$ the required longitude ($\lambda'$) is computed. A close first approximation for the distance ($s$) can be obtained by making $\Delta\phi$ equal to the 1st term in the latitude formula (neglecting the 2d term) and with the $s$ value thus found, the 2d term is computed. A new value for the 1st term is then found that will make the sum of the two terms equal to $\Delta\phi$. The resulting value of $s$ is then used in the longitude formula to obtain $\lambda'$. Because of the distances usually involved, it will seldom be necessary to carry the computation beyond the 2d term in the latitude formula.

(3) With the distances thus obtained (corrected for distortion) as radii, arcs are swung from stations *C* and *D* in a direction toward the central parallel. A line is then drawn tangent to these arcs for the entire width of the sheet. This line will be perpendicular to the central meridian and will be the *central construction line* of the projection.

(4) The remainder of the projection is constructed according to the method given in Special Publications Nos. 5 and 68 for large-scale projections (*see* note 19 *supra*).

### 393. Modified Methods

It is sometimes necessary to modify the above methods because of special conditions encountered. The rigid method may not always be applicable in its entirety, as where all the triangulation stations are on one side of the central meridian. In such cases, a combination of the two methods is used.[47] Even in a small-scale survey, if the longitude extent is small enough, the curvature of the parallels may be neglected and the graphic method used.

There are also cases where the survey is a planetable traverse or a running ship survey in which the azimuths and distances at one end are comparatively accurate but which decrease progressively in accuracy toward the other end. Where such a survey is plotted without a projection and an attempt is later made to add a projection adjusted to selected stations subsequently located by triangulation, it will be found that a single harmonious projection cannot be constructed. If the work is not to be replotted, then the only way to bring the entire survey into harmony geographically is to place a discontinuous projection on it, each portion being based on the triangulation in its vicinity.

In adapting any of the methods to a particular situation, the two considerations to be kept in mind are the theory of the polyconic projection and the means available for determining the distortion of the sheet.

47. The central meridian is determined graphically and the intersection of the central parallel with a line between two of the triangulation stations is computed. The Y-coordinate of the intersection is plotted and a perpendicular erected to the central meridian, the intersection of the two being the center of the projection.

CHAPTER 4

# Analysis and Interpretation of Topographic Surveys

The early topographic surveys of the Bureau have been the subject of inquiry from the legal profession perhaps more than any other of the Bureau products. These inquiries usually relate to the method of survey, the instructions under which the early field parties operated, the relative accuracy of the surveyed features, and the interpretation of certain conventional symbols used in the representation of the features. This chapter reflects many of these inquiries, and the analysis and interpretation are based on the author's field experience in the making of such surveys, on his office experience in the review of many hundreds of such surveys, and in the preparation of replies to inquiries which necessitated reference to original source material.

## 41. THE PLANETABLE

From the beginning of the Coast Survey, the principal instrument used for making topographic surveys was the planetable. Other methods have been employed occasionally to meet some special purpose or as an adjunct to the planetable, but the great bulk of the surveys along our coasts, prior to the advent of aerial photogrammetry, was executed with the planetable. While the instrument has undergone a number of refinements since its first use by the Bureau, the principle underlying its operation is the same.

The first published description of the planetable, insofar as it relates to Coast Survey work, is found in a paper by Hassler in the 1825 Transactions of the American Philosophical Society.[1] The discussion is limited, however, to the mechanical construction of the instrument and no instructions are given for its use in the field. Hassler emphasizes its usefulness and efficiency as a mapping

1. Hassler, *The Survey of the Coast of the United States*, II TRANSACTIONS, AMERICAN PHILOSOPHICAL SOCIETY (New Series) 348 (1825).

instrument in the following statement which is important to keep in mind in evaluating and interpreting the early surveys:

> The best method of surveying the minute details which are to fill up a triangulation, is undoubtedly by the plane table and its alhidade, with a telescope revolving in the vertical. This method will give to the detail surveyor the full result of the triangulation with respect to the relative position and distances of the points to be determined, in a mechanical form, appropriated to the nature of his work; and which will not only be a guide and reference, but also a means of enabling him to determine his distances, and to verify his work constantly as he proceeds, and by reviewing the fundamental points, to discover an error immediately, before it may mislead him. The detail surveyor can therefore proceed with confidence and celerity, and his work will be greatly diminished by this method, as well as by saving all the work commonly called plotting (necessary in all other methods), which besides introduces new errors, while those made in the field remain concealed until it is too late to correct them properly.

Here we have the key to all planetable surveying. No field notes are necessary for later office plotting. The planetable topographer maps as he surveys. Delineating the shoreline, sketching the contours, mapping the roads and other topographic features are accomplished in the field while the terrain is in full view of the topographer. All angles are measured graphically and all distances are determined optically, and both are immediately plotted on the survey sheet by the topographer and no record of the measurements is retained. This is an important fact. Information is repeatedly requested relative to the "field notes" of a particular planetable survey and it is often difficult to impress the inquirer with the fact that no such notes exist.[2] A brief description of the instrument and its use will be given in order to clarify this point.

### 411. Description of Instrument and Method of Use

As used in the Coast Survey, the planetable consisted of a drawing board, about 30 by 24 inches in size, mounted on a tripod in such manner that the board could be leveled and revolved about a central axis without disturbing the tripod. Clamped to the board was the field survey sheet containing a projection and the available triangulation stations in the area.

A part of the instrumental equipment of the planetable was the "alidade." This consisted of a ruler upon which a telescope was mounted, the telescope having motion in a vertical plane only, so that its line of collimation was always parallel to the edges of the ruler.

2. A description of the planetable is contained in an 1875 manuscript article by A. M. Harrison entitled, "A Historical Account of the Plane Table," and is on file in the Coast Survey library (Accession No. 2592).

### 4111. *How the Planetable Was Oriented*

Before any surveying was done with the planetable, it was first correctly oriented; that is, it was so placed in position that every line drawn on the survey sheet from the point which represented the position of the table on the ground to any other point on the sheet was parallel to the corresponding line in nature.

The simplest method of orienting the planetable was to occupy one of the triangulation stations shown on the survey sheet. The table was then placed over the station mark so that the plotted point was approximately over the point on the ground. The alidade was placed on the sheet so that its fiducial edge passed through the triangulation point occupied and through some other distant triangulation point shown on the sheet. The table was rotated until the distant signal was bisected by the vertical cross hair in the telescope. It was then properly oriented. If the telescope was then directed to any undetermined point and at the same time the edge of the alidade was kept on the point occupied, a line drawn along the edge of the ruler and through the occupied point gave a direction to the undetermined point. Similar directions from two other occupied stations fixed the position of the unknown point. A failure of the three lines to intersect in a common point indicated an error and the work had to be done over.[3]

Since the points located in this manner were graphic locations, no notes were available from which they could be later replotted. On the more modern topographic surveys, many such stations were permanently marked on the ground and descriptions to aid in their recovery were retained in the office files.

### 4112. *Introduction of the Telemeter Rod*

An important part of the instrumental equipment of a planetable party was the telemeter or stadia rod (*see* fig. 40). With its aid the topographer was able to locate topographic features without the necessity of direct measurement over the ground, such as by chaining. The telemeter was so graduated that the number of divisions on it that were intercepted between two horizontal wires in the eyepiece of the alidade was equal to the number of units in the distance

3. It was not always necessary to occupy a predetermined station in order to fix the position of the planetable or to determine the position of an unknown point. The instrument could be set up at any convenient point where three stations shown on the survey sheet were visible, and which conformed to certain geometric conditions, and the table oriented by a graphic solution of the *three-point problem.* This method is described in Swainson, Topographic Manual 57–61, Special Publication No. 144, U.S. Coast and Geodetic Survey (1928).

between the observer and the rod. (The units were usually in meters.) The distances thus determined were immediately plotted on the survey sheet and no other record was kept.

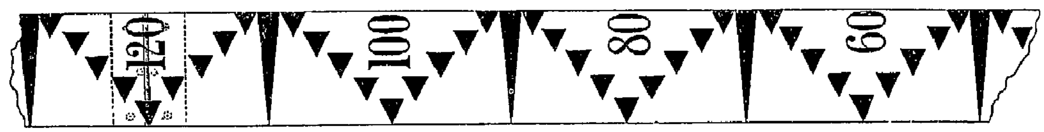

FIGURE 40.—Form of graduations on a telemeter rod used in 1865.

The telemeter rod was not always a standard part of the planetable equipment in Coast Survey work. In the earliest instructions for topographic work, it is noted that "The survey must always be conducted with the chain" (*see* 42, par. 35). The first published reference to the use of a telemeter for measuring distances is found in Appendix 22 of the Annual Report of 1865, where it is stated: "However frequent may be the number of bases furnished by the secondary triangulation, and however serviceable as a substitute in the measurement of distances the telemeter may have proved itself, we cannot entirely dispense with the chain." [4]

While the disadvantages resulting from the use of the chain were clearly recognized, especially on account of the necessity of dependence upon the chainmen for correct distances, the use of the telemeter was at first not generally regarded as valuable for most purposes as was the method of chaining. Even after its use by officers of the Survey had demonstrated the rapidity with which the details of a survey could be determined and the facility with which it could be used in places where the use of the chain was impracticable, together with the important fact that whatever errors occurred rested entirely with the observer, it was still considered merely as an "important acquisition" to the planetable equipment. However, in the Plane Table Manual published in Appendix 13 of the Annual Report of 1880, the chain is no longer mentioned as part of the planetable equipment.[5]

4. Annual Report, U.S. Coast Survey 226 (1865). For a description of the chain used during this period and the method of using it, *see id.* at 226, 227.

5. It is important to note that while the use of the chain in planetable work necessitated the keeping of a record by the chainman in which all crossings of high and low water, intersections of brooks, fences, roads, etc., were noted, such record, as far as it has been possible to ascertain, was never retained as a permanent part of the survey. The information was transferred to the planetable sheet before the topographer left the station so that any errors resulting from the chaining could be detected immediately. *Id.* at 227.

FIGURE 41.—Mapping an Alaska shoreline with the planetable. The planetabler constructs his map as he surveys. The rodman on the point of rocks is holding a telemeter rod and the observer is measuring its distance and direction from the planetable.

## 4113. *Mapping the Shoreline*

In mapping the shoreline, the topographer set up his instrument at some commanding point where he could see the beach for 400 or 500 yards. The rodman walked along the beach setting up his rod at short intervals and particularly wherever there was a change in direction. The topographer determined the direction and distance of the rod from his instrument, plotted the point on the sheet, and drew the shoreline through the series of points located, sketching in the shoreline between the rodded points. (*See* fig. 41.)

There is no way of ascertaining on early surveys which points along the shore were actually determined by a measured distance unless the prick points made by the dividers in plotting the distances, or some other identifying marks (*see* Register No. T–263 (1849)), can be recovered.[6]

6. On planetable surveys (aluminum mounted) used in conjunction with air photo compilations for delineating the shoreline (where indefinitely shown on the photographs), such shoreline was identified by a dot and dashed line, the dots indicating the precise locations of the rodded points, as distinguished from sketching. *Field Memorandum No. 1 (1935)*, 9 FIELD ENGINEERS BULLETIN 103, U.S. COAST AND GEODETIC SURVEY (1935). The latest practice, where the shoreline is not visible on the photographs, is to locate the shoreline on the photographs at intervals by measurements from the nearest identifiable points of detail (short dashes in red ink are used to delineate the shoreline at the measured points, the latter being close enough to ensure that the shoreline is correct within 0.5 mm.), or by planetable traverse or sextant fixes plotted in the water area on the photographs. SWANSON, TOPOGRAPHIC MANUAL (Part II) 339, SPECIAL PUBLICATION NO. 249, U.S. COAST AND GEODETIC SURVEY (1949).

## 412. The First Planetable Manual

The first comprehensive treatise on the planetable and its use in topographic surveying was published as Appendix 22 of the Annual Report of 1865. This apparently was the first of its kind in the English language (*see* introductory note to Appendix 22). While this treatise was intended to set the practice for the future, it can be assumed that it represented to a large extent the existing practices of that period. It was prepared by A. M. Harrison and contains a description of the two-point and three-point problems.

### 4121. *Other Published Manuals*

Other topographic manuals were issued from time to time, each new manual comprising some significant change from the previous one.

(*a*) "A Treatise on the Plane-Table and Its Use in Topographical Surveying," by E. Hergesheimer, appeared in the Annual Report of 1880 (Appendix 13). In this treatise, the treatment of the three-point problem is considerably enlarged; references to the chain as a means of measuring distances in planetable work were removed and the telemeter method substituted (*see* 4112). The use of the word "stadia" was introduced and its theory discussed at length.

(*b*) "A Plane Table Manual," by D. B. Wainwright, was published in the Annual Report of 1898 (Appendix 8), and was reprinted as a separate in 1899. This was based on the material in the 1880 manual but with new arrangements, rewrites, and additions. The use of the word "stadia" was adopted in place of "telemeter" to accord with its common use by engineers and surveyors.

(*c*) "A Plane Table Manual," by D. B. Wainwright, was published in the Annual Report of 1905 (Appendix 7), and issued as a separate the same year. Although essentially a reprint of the previous manual, a new arrangement of the three-point problem was introduced with the idea of simplifying the description of the conditions found in practice and the several steps required for its graphic solution. A description of the hypsograph for computing elevations in planetable surveys was introduced for the first time in a planetable manual, having been designed in the Coast Survey in 1902. This manual was reprinted in 1915 (with corrections) and in 1916 as separates. The "corrections" in the reprint refer to the substitution of the symbols adopted by the U.S. Geographic Board in 1911 for the symbols included in the 1905 reprint (*see* note 72 *infra*). The Geographic Board symbols were also included in the 1916 reprint.

(*d*) A "Plane Table Manual," by D. B. Wainwright, was published in 1922 as Special Publication No. 85. The only significant changes from the previous manual are the addition of a historical note on the planetable, including some illustrations of early instruments and topographic maps, and a reduction in the page size to make it pocket size.

(*e*) The last planetable manual to be issued by the Bureau (as of March 1964) was the "Topographic Manual," by O. W. Swainson, published in 1928 as Special Publication No. 144. It is virtually a completely new treatment of the procedures for planetable surveying, in which all discussions of the theory of methods have been omitted. It is divided into four parts and covers the following topics in the order listed: General Requirements for Topographic Work, Instruments and Equipment, Field Work, and Office Work.

## 42. EARLIEST INSTRUCTIONS FOR TOPOGRAPHIC WORK

Prior to the publication of the 1865 manual, topographers were guided in their work by special instructions issued by the administrative officers of the Bureau.[7] The earliest instructions for topographic work now extant were issued about 1840 by Ferdinand Hassler, the first Superintendent of the Survey.[8] Because of their importance in indicating the practice intended to be followed by planetable parties at that time, and because of their value in interpreting early surveys, they are included here in their entirety.

### INSTRUCTIONS FOR CHIEFS OF PLANE TABLE PARTIES

Sir:

In the execution of your Topl. duties you will be governed by the following instructions, to wit:

*On Property*

1. Make requisition upon the assistant having charge of the topography for all articles necessary to carry on your operations.

2. On taking the field transmit to said assistant an inventory of all property in your possession and another when your field work is ended, stating in this last what articles have been worn out, lost or destroyed and what is fit or unfit for further use, and where stowed.

3. You will give said assistant a receipt for all property committed to your charge, and be held responsible for said property until relieved from accountability by the Department in charge of the work.

*On the Projections*

4. You will make a projection upon paper according to the scale adopted for the section of your work, subdividing such projection to such distances of 1′, 2′, 5′ as best adapted to the scale of the intended map and the facility of introducing the points to be placed on it.

5. In the projections the points determined by the main and secondary triangulation are to be inserted by their situation in latitude and longitude with the help of the tables calculated for that purpose.

6. Every one of these individual projections must be made to start from about the centre of the sheet to be used in the field, and the elements for them to be taken in the tables must be those corresponding to the latitude of the middle of the sheet.

7. The introduction of the triangle points upon these projections is made by means of the shortest ordinates taken from the tables, for the quadrilateral which includes them,

7. This is evident from the following statement by Hassler in his report on "The Survey of the Coast of the United States," which was published prior to the execution of the first topographic survey: "The organisation of the detail surveys always depends upon the administrative views according to which the work is to be executed. Its details must therefore be omitted in the present papers. Regular and full instructions must be given to the detail surveyors in writing, both on the principles which they shall make use of in their works, and on the objects to be attended to." Hassler, *supra* note 1, at 404.

8. These instructions are handwritten and appear in the volume (17) of correspondence marked "Coast Survey, Scientific, 1844–1846." Although neither dated nor signed, other instructions for topographic work and for the general work of the Coast Survey (dated 1840 and 1841 and signed by Hassler) appear in the same volume and contain many paragraphs from the unsigned instructions. The assumption that the latter instructions were issued by Hassler around 1840 is therefore a reasonable one.

and from the nearest side of the square the points are marked by small dividers, the distances intersecting one another perpendicularly—by these means the distances to be taken will never exceed the half length of the divisions of the projection.

8. The points of the main triangulation are surrounded by a small triangle—those of the secondary by a small circle to distinguish the two kinds of points.

9. The sides of the triangles must be drawn upon the projections in Indian ink; and the numbers indicating their length must be written near them.

10. When a side of a triangle is only partially included in a projection its direction is to be had by calculating the latitude and longitude of a point taken on that side at such a distance from the point already fixed as will fall in the projection.

11. The meridians and parallels, as well as the names of the triangle points are to be all clearly written in ink.

*On Surveying*

12. You will first carefully reconnoitre the ground you are to survey in order to be able to form a regular plan of operation for the intended work.

13. In placing the plane table in its proper direction at the beginning of a station, upon which the future position of the work depends, only the actually determined lines of the triangles that have been marked, as stated above, must be used as *directrices*, but never a line between two points not so directly connected together, and not forming a side of the same triangle.

14. The magnetic needle is to be used for no important determination—the only use that is allowed of it will be to survey bye-roads, the extremities of which have been well determined, running through woods—also the outlines of woods and marshes that cannot be surveyed by any other means or that are of no great importance.

15. The names of the villages, rivers, brooks, hills, denomination given to a district or locality, and sometimes single houses, etc., are always to be written, and care is to be taken to get the exact orthography. The direction of the course of the rivers and creeks must be indicated by a small dart, the point of it down stream.

16. All mills, waterworks and factories on a large scale must be marked by peculiar and appropriate signs, together with their particular names if any they have.

17. On the sea shore and the rivers subject to the tides, the high and low water lines are to be surveyed accurately; and the kind of ground contained between them, whether sand, rock, shingle or mud marked accordingly. The low water line is taken by offsets whilst running the high water, and when not too far apart from each other, but when their distance is great they must be surveyed separately: a couple of hours before the end of the ebb, and the same time during the commencement of the flood tides will be the proper time for taking the low water line, and your operations must be so timed, as to be on the shore on those periods.[9]

18. You will establish points along the shores, and mark them securely by means of stakes, at suitable distances, for the use of the hydrographical parties in taking their soundings—and also furnish them with the high and low water lines, from your map, they may require.

19. The size of the scale upon which the survey is made will determine the degree of minuteness in the noticing and measuring of the details. The scale of 1/10,000, and still more that of 1/5,000, admit any details whatsoever.

9. In the supplemental instructions for planetable surveys issued by Hassler Sept. 7, 1840, the following is stated with respect to this item: "6. On the sea shore and the rivers subject to the tide, both lines of the high and the low water must be marked as near as possible, because this is not always possible to be done by the sounding parties; therefore in this part of the work, it is proper for the two parties to work together conjointly, and according to distinct agreement, or everyone to work according to his best knowledge, and compare afterwards."

20. The distinction and limitation between woods and cultivated lands are sufficiently permanent in that part of the country which falls within the Coast Survey at present to require the determination of the limits of the woods by more or less actual measurement: this must therefore be done.

21. You will distinctly mark and distinguish on your map the different kinds of culture of the open land: namely, the upland or grain land—the meadows, whether fresh or salt and the marshes of whatever kind.

22. The woods and bushy land can be well distinguished from one another; and the kind of wood or timber must be written on the spot that it may be attended to in the finished drawing of the maps.

23. The distinction between the culture of grain land and meadows, and the orchards, gardens, homesteads, etc. are to be indicated—the fruit trees and forest trees being marked by their different distinct forms.

24. The houses, gardens and outhouses, and all similar domestic establishments, are to be marked in their proper form by introducing into the drawing a sketch made at the place itself: the ability of estimating small distances, and of drawing by the eye will assist greatly in introducing them without much measurement whilst upon the spot. The dwelling houses are to be represented fully black, and the barns, outhouses and the like, thus ☒, for distinction sake.

25. All the details of known marks of pilot directions, principal churches and buildings are to be noticed with more or less accuracy or measurement according to their importance.

26. All improvements of dams, draining by ditches and similar works, the bye-roads through the woods, etc. are to be determined and followed up in their course with more or less accuracy according to their importance—the latter may lead to farms and other improvements of interest often of more extent than supposed.

27. The width of all roads must be measured and laid down—and where a road widens or contracts must always be shown.

28. Whenever regular maps of cities, towns or villages have been published they are to be procured, if possible, and inserted in the map under execution by means of such points as are determined by the secondary triangulation or plane table operations; should these points, which are usually churches or principal buildings, not be on the published map, they must be introduced on it with all possible accuracy by visiting their location and taking or procuring all necessary measurements. Whenever there is no such map, a survey of the main streets is necessary and the houses etc. will then be easily introduced in the same manner as given for farming establishments etc.

29. The delineations of the mountains, hills, declivities, rocks and all similar, so called, *accidents* of the ground, are to be introduced at the place itself by the eye whilst they are in presence of the surveyor, according to the regular principles adopted for the hachures.

30. The horizontal curves of equal elevation must always be described as near as possible by the eye, from the aspect of the hills; and the equidistant adopted, according to the scale, must be the same throughout the whole of the map: the tracing of the curves should always be done when the surveyor is on the ground.

31. In the representation of all topographical details you will follow strictly the conventional signs furnished you; and in writing the names of the different objects on your map you will conform as near as possible to the character and size of the letters given in the table accompanying the signs.

32. All these details when well executed will give to the resulting map that character of care and attention which it is absolutely necessary our works should have.

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33. In order to secure all these topographical details, it is requisite that the pencil lines be drawn in Indian ink always near the spot—that is before any one encampment is left for the next one, in order that in any case of doubt it may be easy to verify the doubtful parts, and in general adapt the drawing closer to the reality by the objects being fresh in memory and still, either under the eye or easily accessible.

34. The days on which no field work can be done will be devoted to the drawing in ink, but if none should occur for some time it will be better to cease outdoor operations for a few days in order to secure in ink what is already done and avoid too great an accumulation of work in pencil and the effacing of the pencil lines.

35. The survey must always be conducted with the chain, and the "Method of intersections," and sketching by the eye the contours of shore lines, marshes, etc. must never be resorted to except where it is not possible to get along with the chain, or where a large extent of straight sandy or marshy sea coast exists, and then the points fixed by intersections should not exceed 400 metres when the scale of the survey is 1/10,000, and the like ratio inversely for all other scales.

36. When the parties break up at the end of the season, all the instruments, chains, etc. in whatever state they may be, belonging to the Coast Survey collection are to be brought or sent safely (always accompanied by some one of the party) to the office of the Coast Survey, as well as for accidental repairs and revision as for safe keeping, and these delivered to the assistant in charge of the topography.

37. The camp equipments, utensils and other implements will be lodged in the neighborhood of the station or camp last occupied under safe shelter and with responsible people.

38. At the end of each month you will communicate to the assistant having charge of the topography the place of your encampment and nearest post office.

39. You will make requisition upon the disbursing officer for whatever funds may be necessary to enable you to execute your operations, and send him, at the end of each month, an abstract of your disbursements accompanied by the vouchers. Economy is recommended in all your operations.

40. You will keep a diary, in which you will enter your daily occupation, the state of the weather and all occurrences that may happen of interest to the work.

### 421. Rules for Representing Topographic Features

Mention should also be made of a published pamphlet entitled "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey," which appeared in 1860.[10] While intended primarily to set the practice for the finished charts, the pamphlet contains discussions of certain features shown on topographic surveys and may be considered as representative of the practice of that period (*see* 4461). A large part of the pamphlet was reproduced as Appendix 20 to the Annual Report for 1860. Pages 216 to 222 of the report contain the pertinent data.

10. Reference to the correspondence of 1859 and 1860 shows that the material was prepared largely by Henry L. Whiting, an expert topographer.

## 43. THE FIRST TOPOGRAPHIC SURVEY

Although the organic act authorizing a survey of the coast was approved in 1807, actual work for triangulation was not begun until 1816. Congressional action caused a break until 1832 when work was again resumed.

The first topographic survey was made in 1834 (Register No. T–1) and covered the north shore of Great South Bay, Long Island, from Patchogue to Babylon. This is fairly typical of the topographic surveys of this period, although some departures in the treatment of certain features might be noticed on surveys made by different topographers. The details represented included the shoreline, roads, the limits of marshy and woodland areas, and individual buildings. The symbols representing the wooded areas were tinted green and the marsh areas blue.[11]

In considering these first surveys, it is important to keep in mind that this was the formative period of the Survey's existence, and standards of accuracy and definitive procedures had not yet been established. The amount of detail included by one topographer may have differed from what another topographer included. The importance which a surveyor attached to a given area was also a contributing factor to the amount of detail he included in his survey and was generally reflected in the extent to which minor convolutions in the shoreline were delineated. Of interest, in this connection, is the following commentary on Mr. Renard's topographic survey of 1837 (Register No. T–13):

> To be sure, the topography of those days differed very materially from that of later years. There was no contouring, the hills being indicated only by hachures and comparatively little close detail being given. As optical methods for distance measuring had not then been introduced and it was necessary to depend upon chaining when direct measurements were wanted, particular objects needed for the control of detail were usually fixed by intersections from two or more stations and there was far greater freedom in sketching details than is now usual. And Mr. Renard had the reputation, among some of his contemporaries, of stretching that freedom of delineation to an extent even then unusual.[12]

The above was true even in later years and ofttimes adjoining topographic surveys by different topographers exhibit differences in representation in the common area, particularly along a marshy shore. An example of this is found at the junction of Register No. T–1471*b* (1879) and Register No. T–1482*b* (1878).

11. In the same year, a survey was also made of Fire Island Beach on the south shore of Great South Bay (Register No. T–479).

12. HASSLER'S ADMINISTRATION (Part I) 86. This material is in typescript form and is unauthored and undated. It is filed in the Survey library and is identified as USCGS/.091/1921–2.

But apart from the personal interpretation of the individual topographer, many of the early surveys exhibit a generalization that is not evident on the later surveys. This may be attributed to the fact that during the first 10 years of the topographic work of the Bureau, several of the best features of the planetable were ignored in practice. Only the most salient points of the shoreline were delineated and located with any degree of accuracy, the bights and coves being sketched with the greatest freedom.[13]

Two factors contributed to this failure to take full advantage of the planetable as a mapping instrument. One was the use of the chain for measuring distances, which under the best of conditions was a slow process; the other was the fact that the graphic solution of the three-point problem for the determination of planetable stations had not yet become standard topographic practice.

### 431. Accuracy and Detail

It was stated in an earlier chapter that in the early days of the Coast Survey, when so much surveying was to be done and there was pressure to get out charts of the country's uncharted shores, it was only natural that some of the relatively unimportant areas would be surveyed with what today would be considered no more than reconnaissance accuracy (*see* 11). But excluding these, and surveys made during the very earliest period of the Bureau's work prior to the standardization of procedures, there were always certain prescribed standards of accuracy to which the work had to conform. If the work was done at all, it was done with that accuracy. But accuracy is not to be confused with detail. One topographic survey may show all the waterways tributary to the main waterway, whereas an earlier survey may have omitted them, thus lacking the detail of the later survey. But insofar as the main waterway was concerned both surveys could be of comparable accuracy. The difference between the two terms can better be illustrated by a hydrographic survey. A sparseness of soundings in an area of no navigational importance would simply mean that the survey in that area lacked detail, but the soundings that do appear in that area were obtained with the same degree of accuracy as they were in the fully sounded main channel.

13. Wainwright, Plane Table Manual 13, Special Publication No. 85, U.S. Coast and Geodetic Survey (1922).

## 44. FEATURES LOCATED ON TOPOGRAPHIC SURVEYS

### 441. The High-Water Line

The most important feature on a topographic survey is the high-water line. It is the line that is used on the nautical charts of the Coast Survey as the dividing line between land and water; the line that indicates whether the coast is building out or receding; and in most states it defines the seaward limit of riparian ownership.

Nautical charts are intended primarily for use in navigation. The limit of land and water is the most striking outline that exists in nature, and is shown as the strongest and most conspicuous line of boundary on the chart. From its delineation, the navigator is frequently able to identify his position along the coast. This line is therefore surveyed accurately, that is, as accurately as is consistent with economy and the purpose for which the survey is intended (*see* 4422).

#### 4411. *Basis for Using the High-Water Line*

There are many reasons why the high-water line is preferred to any other tidal boundary for the dividing line between land and water on nautical charts, and hence on the topographic surveys of the Bureau. Among these are the following:

(*a*) The nautical chart depicts the land area and the water area. The most logical division is the high-water line because this includes all land not covered by the mean tidal range. It represents the line of permanent emersion of the land area. Seaward of this line is an area of alternate emersion and immersion. Seaward of the low-water line is the area of permanent immersion. Any line in between high water and low water could not be considered the dividing line between land and water since at some time during the tidal cycle the area inshore of that line would be covered by water.

(*b*) To the mariner, the high-water line gives the truest conception of the appearance of the shore, inasmuch as it generally represents the limits of vegetation.

(*c*) In taking bearings to distant points of land, the mariner can better identify the approximate high-water line than he can any other line between high and low water. Also, on a bold coast, the elevations of objects, such as lighthouses, if referred to a high-water datum, is a safety factor for the mariner when locating his distance from shore by angles of elevation to such objects. (The same measured angle would give a distance nearer to shore than if the elevation were reckoned from sea level.)

(*d*) From the standpoint of the surveyor, the high-water line is the only line of contact between land and water that is identifiable on the ground at all times and does not require the topographer being there at a specified time during the tidal cycle, or the running of levels. The high-water line can generally be closely approximated by noting the vegetation, driftwood, discoloration of rocks, or other visible signs of high tides (*see* 4421).

(*e*) The treatment of isolated rocks along a coast is an important consideration on a nautical chart. If a tidal plane other than high water were used, for example mean sea level, some rocks would be shown as bare rocks which during half the tidal cycle would be covered with water. This would not only be a misrepresentation of their character under normal conditions, but would be a danger to navigation because misleading to the navigator. For example, a rock that projects 8 feet above low water in an area where the range of tide is 10 feet, would be shown as a rock baring 3 feet if the plane used were mean sea level—in other words, as visible at all times. Yet a mariner who was in the vicinity of the rock when the tide was 8 feet or more above low water would see no rock at all. For the same condition but using a high-water datum, a rock awash symbol would be shown and the navigator would not expect to see the rock at some stages of the tide.[14]

(*f*) The same reasoning that dictates the use of a low-water datum for soundings (*see* Part 1, 2321 B(*b*)) is applicable to rocks and a high-water datum but in reverse form; that is, the chart should never show a rock as always projecting above water that the mariner would find covered at some stage of the tide.

(*g*) Any other datum below high water would also contravene the generally accepted definition of an island as "A body of land extending above and completely surrounded by water at mean high water."[15] If mean sea level were used as the datum, there would be cases, as with rocks, where an island would be charted, although covered with 1 or 2 feet of water at mean high tide. It would be a contradiction to call such a piece of land an island.

(*h*) The above technical reasons for the use of the high-water line on charts also fit in with the legal concept of the boundary between public and private lands as developed through the common law of England and which has become a part of American jurisprudence. At common law, the line of ordinary high water was the limit of the rights of the Crown to the shore. The principle back of this was that it was land not capable of ordinary cultivation or occupation. Conversely, land inshore of that line was capable of cultivation and therefore was considered to be the subject of private ownership. It was also stated that the basis for rejecting the line of the high spring tides as the dividing line between Crown lands and private lands was "that such lands [lands covered by the high spring tides] are for the most part dry and maniorable."[16]

## 442. The Line of Mean High Water

Thus far, the term high-water line has been used in a very general sense, without regard to variations in this line due to the types of tide that prevail along

14. At the Seventh International Hydrographic Conference, held at Monaco in May 1957, it was proposed that a datum lower than mean high water be used on nautical charts as the dividing line between land and sea. The proposal failed of adoption. The United States delegation, representing the Coast and Geodetic Survey and the Hydrographic Office of the Navy Department, opposed the change. *Report of Proceedings* 64, 147, *Seventh International Hydrographic Conference (1957)*.

15. Mitchell, Definitions of Terms Used in Geodetic and Other Surveys 41, Special Publication No. 242, U.S. Coast and Geodetic Survey (1948).

16. *Attorney General* v. *Chambers*, 4 De G. M. & G. 206, 218 (1854). The common-law rule is applied in most of the states. In a few, it has been modified by statute to extend private ownership to the low-water line.

our coasts (*see* Part 1, 232). It is therefore important to define with greater exactness the nature of the line actually surveyed.

The topographic instructions for planetable work under which the Bureau now operates call for "The careful location of the mean high water line (not considering storm-high water)."[17] And generally, this has been the practice from a very early period. In the first planetable manual, it is stated: "It is always best to determine the high and low water lines, both at spring and neap tides."[18] This is interpreted to mean that from these determinations an approximate mean high-water line could be delineated.

The first specific instruction regarding the nature of the line to be surveyed is contained in the "Plane Table Manual," published as Appendix 8 to the Annual Report of 1898. It is there stated, at page 455, that "In tracing the shoreline on an exposed sandy coast care should be taken to discriminate between the average high-water line and the storm-water line." A similar instruction has been included in every subsequent edition of the planetable manual.

In the treatise on the planetable included as Appendix 13 to the Annual Report of 1880, no mention is made of the line to be considered the shoreline, but in discussing the plane to be used for elevations the following statement appears at page 189: "Probably the best reference for heights of points on the earth's surface is to the mean level of the sea, since the mean of any rise and fall of the tides is approximately this level. In practice, however, mean high water is usually taken, as this includes all land not covered by the tide range, and is the line dividing land from water."

It is therefore reasonable to assume that on all of our topographic surveys the intention was to delineate, as near as it was possible to determine without recourse to leveling, the line of mean high water. It remains, then, to inquire how the topographer identified such line on the ground.

### 4421. *The Surveyed Line*

As was explained in Volume One, Part 2, 1613, different types of tide prevail along the coasts of the United States. It was shown that along the Atlantic coast two high waters occur each day but with very little variation in the two heights, while along the Pacific coast there is a marked difference between successive high-water heights. Along either coast, the plane of mean high water at

17. Swainson (1928), *op. cit. supra* note 3, at 5.
18. Annual Report, U.S. Coast Survey 219 (1865).

any place has been defined technically as "the average height of all the high waters at that place over a considerable period of time." [19]

High water is the maximum height reached by a rising tide. The height may be due solely to periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions. The rise and fall of the tide varies from day to day. For the most part, this variation is of a periodic nature related to the positions of the sun and moon relative to the earth. The variation in rise and fall results in varying heights for high water and low water. The term "high water" should not be confused with the term "mean high water" (*see* note 19 *supra*).

The mean high-water line along a coast is the intersection of the plane of mean high water with the shore. This line, particularly along gently sloping beaches, can only be determined with precision by running spirit levels along the coast. Obviously, for charting purposes, such precise methods would not be justified, hence, the line is determined more from the physical appearance of the beach. What the topographer actually delineates are the markings left on the beach by the last preceding high water, barring the drift cast up by storm tides. On the Atlantic coast, only one line of drift would be in evidence. On the Pacific coast, however, with two high waters of unequal height, each leaving its own line of drift, the tendency of the topographer would be to delineate a line somewhere in between the two lines of drift. If only one line of drift exists, as when a higher tide follows a lower one, the markings left by the lower tide would be obliterated by the higher tide and the tendency would be to delineate the line left by the latter, or possibly a line slightly seaward of such drift line.

In addition to the above, the topographer, who is an expert in his field, familiarizes himself with the tide in the area, and notes the characteristics of the beach as to the relative compactness of the sand (the sand back of the high-water line is usually less compact and coarser), the difference in character and

19. MARMER, TIDAL DATUM PLANES 76, SPECIAL PUBLICATION NO. 135, U.S. COAST AND GEODETIC SURVEY (1927). This edition was cited by the Supreme Court in *Borax Consolidated, Ltd.* v. *Los Angeles,* 296 U.S. 10, 26 (1935), in defining ordinary or mean high-water mark along the California coast. In the 1951 edition of Tidal Datum Planes, at page 86, the definition of mean high water has been changed slightly so as to make it of more general application. The definition now reads: "Mean high water at any place may be defined simply as the average height of the high waters at that place over a period of 19 years." For a discussion of the *Borax* case in relation to the term "ordinary high-water mark," *see* Volume One, Part 1, 6413.

color of the sun cracks on mud flats, the discoloration of the grass on marshy areas, and the tufts of grass or other vegetation likely along the high-water line.

### 4422. *Accuracy of Determination*

The accuracy of the surveyed line here considered is that resulting from the methods used in locating the line at the time of survey. It is difficult to make any absolute estimate as to the accuracy of the early topographic surveys of the Bureau. In general, the officers who executed these surveys used extreme care in their work. The accuracy was of course limited by the amount of control that was available in the area.[20]

With the methods used, and assuming the normal control, it was possible to measure distances with an accuracy of 1 meter,[21] while the position of the planetable could be determined within 2 or 3 meters of its true position. To this must be added the error due to the identification of the actual mean high-water line on the ground (*see* 4421), which may approximate 3 to 4 meters. It may therefore be assumed that the accuracy of location of the high-water line on the early surveys is within a maximum error of 10 meters and may possibly be much more accurate than this. This is the accuracy of the actual rodded points along the shore and does not include errors resulting from sketching between points. The latter may, in some cases, amount to as much as 10 meters, particularly where small indentations are not visible to the topographer at the planetable.

The accuracy of the high-water line on early topographic surveys of the Bureau was thus dependent upon a combination of factors, in addition to the personal equation of the individual topographer. But no large errors were allowed to accumulate. By means of the triangulation control, a constant check was kept on the overall accuracy of the work.

20. In the 1865 Annual Report of the Survey, at page 229, the following statement is made with regard to the accuracy that was attained in military reconnaissance work during the Civil War: "At Chattanooga, from two different bases of about half a mile each, plotted on separate sheets, and measured once carefully with the common 20-metres chain, the same chain being used for both measurements, after considerable intermediate plane-table triangulation carried on by two officers, two objects were determined two and a half miles apart, common to both sheets, which were on a scale of 1–10,000, and the discrepancy was but about 15 metres. Many other points of junction indicated this to be the maximum error. In this case the leaves were mostly off the trees, and the hills afforded good points. The sheets covered about 20 square miles each. At Nashville there was a discrepancy of about 10 metres in two miles. This would not do, of course, in finished work, but it is very close under the circumstances."

21. Annual Report, U.S. Coast and Geodetic Survey 192 (1880).

### 443. High-Water Line in Tidal Marshes

#### 4431. *Formation of Marsh*

In areas of tidal marshes, a different procedure was followed. Marsh is a product of the shallow water of lagoons and other sheltered localities. It usually results from the deposit of sediment on the bottom, which is thus built up to a point where certain kinds of vegetation can take root. The presence of this vegetation accelerates the upward building by its own decay and deposit upon the bottom and by intercepting fine sediment in the waters causing its deposit. During the early stages of the marsh, grass may even grow so rankly that it will rise above the water surface when the ground in which it grows is still below the plane of low water. When marsh building has progressed to a stage where the level is somewhere between high and low water, waves and currents attack its seaward edge, forming a small vertical cliff here. This is a characteristic feature of marsh in this stage of development. The marsh continues building, somewhat more slowly, until ultimately it is dry all the time or substantially all the time. It is then known as meadow. Unless there is some evidence on the survey, it must be assumed in the case of marsh that the high-water line has not been determined.[22]

#### 4432. *The Surveyed Line—Outer Edge of Marsh*

Obviously, it would be an extremely difficult task to identify the actual high-water line in marsh areas. The marsh may be in various stages of growth, from its early beginnings, when it is mostly in a submerged stage, to its latest development, when it is close to or slightly above the plane of high water. Between these two extreme conditions, marsh areas may be entirely submerged at low water, may be exposed at low water and submerged at high water, or may be partially exposed at high water. From the standpoint of the Bureau's topographic surveys, this means that where there are marsh areas, the actual high-water line might start at the water's edge in one portion of the marsh and meander through the area in irregular fashion, terminating at another portion at the water's edge or at the edge of firm ground in the interior.

22. This statement on marsh formation is paraphrased from testimony given by R. S. Patton, while Chief of the Chart Division (later Director) of the Bureau, in the case of *Best Renting Co.* v. *City of New York*, 162 N.E. 497 (1928). Involved was the question whether under a deed from the Crown conveying land, including all marshes and creeks, the land of the plaintiff was included in a grant as meadows or marshes. Material on tidal marshes can be found in Annual Report of the U.S. Coast Survey 82–86 (1869); in Nesbit, Tide Marshes of the United States, Misc. Special Report No. 7, U.S. Department of Agriculture (1885); and in Johnson, The New England-Acadian Shoreline 517–561 (1925).

In surveying such areas, the Bureau has not deemed it necessary to determine the actual high-water line but rather the outer or seaward edge of the marsh, which to the navigator would be the dividing line between land and water.[23] Therefore, from the topographic survey alone, and in the absence of any corroborating collateral information, no conclusion could be drawn as to the exact location of the high-water line, nor as to the condition of the marsh area with reference to the tidal plane of high water; that is, whether the ground itself was above water, or whether only the marsh grass was above water, and the ground below water at the time of high tide.

Where the topographic or hydrographic survey shows a low-water line outside the marsh line it would be a safe indication that the marsh at its outer edge was above low water, but it would still be no indication as to the condition of the marsh with respect to high water unless determined by other evidence (*see* 4433).[24]

(*a*) *Modern Practice.*—On modern planimetric, shoreline, and topographic manuscripts, where the actual shoreline is obscured by marsh grass, mangrove, cypress, or other similar marine vegetation, the outer edge of the vegetation is mapped as an *apparent shoreline* and is shown by a thin, solid line, the change from the line marking the actual shoreline being abrupt and not gradual.[25]

### 4433. *Condition of Marsh—Evidence From Collateral Sources*

An important source of information that sometimes throws light on the condition of the marsh area, with respect to the tide, is the contemporary hydrographic survey. This is illustrated in figures 42 and 43. Figure 42 is a section of Register No. T–1482*b* (1878), a topographic survey of Jamaica Bay, Long Island. It will be observed that in the vicinity of "Craft's Dock," both to the north and to the southeast, the outer edge of the marsh is indicated by the usual solid line, with the conventional marsh symbol inshore. Standing alone, no definite conclusion is possible regarding the stage of development of

23. On most of the early surveys, no distinction was made between this line and the line of high water on fast ground. Beginning with 1938, the shoreline marking the outer edge of marsh, mangrove, or cypress swamps was shown by a fine solid black line to distinguish it from the high-water line on fast land which is shown by the standard weight solid black line, the change from one to the other being made abruptly. *Field Memorandum No. 1 (1938)*, 12 FIELD ENGINEERS BULLETIN 241, U.S. COAST AND GEODETIC SURVEY (1938).

24. Register No. T–1392 (1875) (Newport Bay, Calif.) is a good example of such condition. Where the topographer has delineated a low-water line in some areas but showed a merger with the edge of the marsh in other areas, the presumption would strongly favor the existence of a vertical cliff (*see* 4431). This is exemplified by Register No. T–892 (1859) (San Gabriel River, Calif.) (*see* fig. 44).

25. SWANSON, TOPOGRAPHIC MANUAL (Part II) 338–341, SPECIAL PUBLICATION No. 249, U.S. COAST AND GEODETIC SURVEY (1949).

the marsh, whether late or early. All that can be said is that the high tide covered the area of the marsh to a line somewhere between the outer and inner limits. An examination, however, of Register No. H–1392 (1878), the contemporary hydrographic survey of the area (*see* fig. 43), discloses two lines of soundings crossing the area indicated as marsh on the topographic survey. The soundings, reduced to the plane of mean low water, range from zero to minus ½ foot, which means that the bottom of the marsh varied in elevation from zero to ½ foot above the plane of mean low water. With an average range of tide of about 5 feet, the relation of the marsh to the plane of high water becomes readily apparent.[26]

On the more recent surveys, clarifying information may frequently be obtained from the "Descriptive Reports" that accompany the surveys (*see* 1242). This is illustrated by an examination of Register No. T–4456 (1929), a topographic survey of the south shore of Chesapeake Bay. Along the north shore of one of the waterways on the survey, a marsh area is indicated which is bounded on its outer edge by a solid black line, the symbol for the high-water line, and at its inner edge by a growth of grass, brush, and trees. Here again it would be impossible to determine the character of the marsh, in relation to the stage of the tide, from a mere physical examination of the survey sheet. But in the accompanying Descriptive Report, this pertinent information is found: "The northerly shore line of Long Arm from the highway bridge to the log bridge is a continuous grassy marsh of varying width as shown and *covered at high tide by water from one-quarter to one foot in depth*." (Emphasis added.) This is further clarified by the following general note in the report which is applicable to all references to marsh areas on the survey: "Note 1: In the preceding discussions of details the statement that a marsh is submerged or covered by a certain depth of water at high tide, is intended to convey the idea that the ground and not the grass is covered. In no place where grassy marsh is shown is the grass or seed growth covered by water."

In one of the great marsh expanses along the Massachusetts coast, much light was thrown on the interpretation of the outer marsh line by the statement that "while the outer edge of the marsh as shown on this sheet is a definite line at about half tide the line of demarcation between marsh and water at high tide is in most cases considerably further inshore and not well defined."

26. An excellent illustration of the value of the contemporary hydrographic survey in determining the elevation of marsh areas is Register No. T–967 (1860). An examination of Register No. H–790 (1861) shows the corresponding areas with minus soundings ranging in elevation from 0 to 5 feet (with a 6-foot range of tide) indicating the marsh area to be above low water but below high water (*see* 5621).

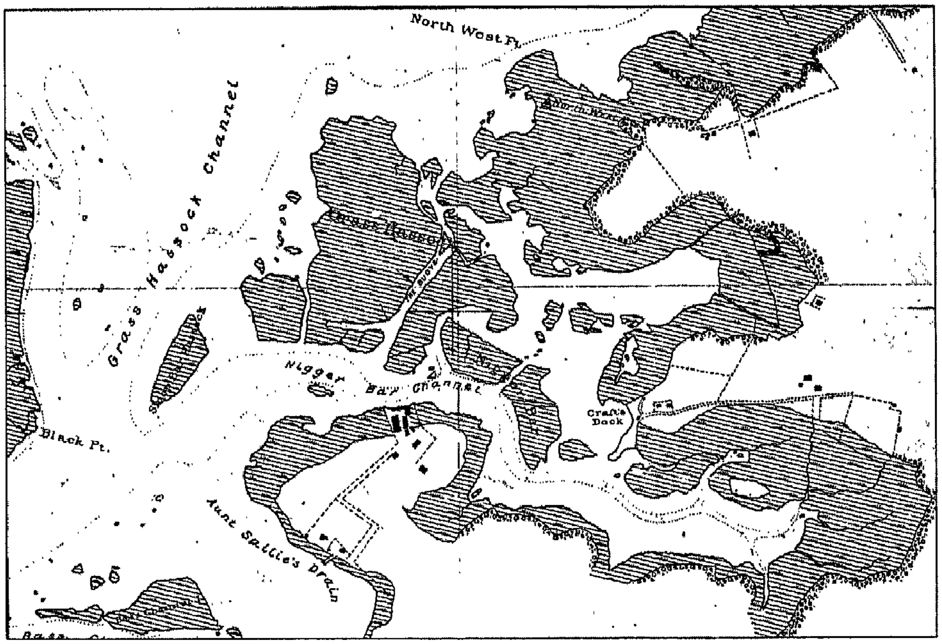


FIGURE 42.—Portion of topographic survey of 1878.

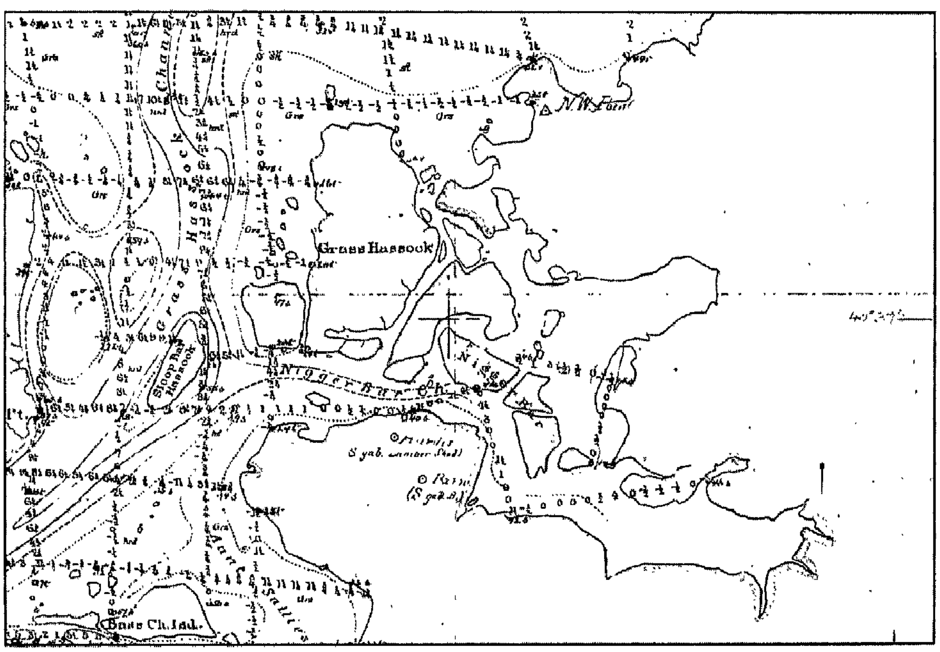


FIGURE 43.—Contemporary hydrographic survey of area shown in figure 42.

While in the cases cited, the collateral information tended to prove that the outer edge of the marsh line was below high water, the same sources may often disclose evidence which shows that the marsh was in a later or meadow stage of development. If the records for the contemporary hydrographic survey showed that the sounding lines were run at high water or nearly high water and the lines stopped short of the outer edge of the marsh, it would be strong indication that the survey boat could not penetrate beyond the outer edge because there was not enough water to float it. It is not uncommon to find such notes in the sounding records as "boat aground" or "end of line on beach" which would throw additional light on the status of the marsh area.

Other collateral sources may be the descriptions of the old triangulation stations in the area,[27] if such exists, which sometimes were quite elaborate as to description and sketch, or the annual reports of the Bureau, which in the early days included considerable information regarding certain individual surveys.[28]

While not necessarily related to the condition of marsh growth with respect to the plane of reference, aerial photographs, particularly infrared and color photographs, if available, should always be examined for possible clarifying information as to some detail on the planetable survey (*see* Part 1, 2232). Aerial photographs furnish a fruitful source of information for ground details because the camera with its view from above registers a complete picture of the terrain below, whereas the planetable topographer is limited in any instance to what he can see from the point where he stands. Differences in detail between a planetable survey and a later photogrammetric survey from aerial photographs must be carefully evaluated to determine whether such differences are the result of changes or are due to omissions.

27. On the early surveys, the symbol for a main triangulation station was a triangle, but for a secondary station it was a small circle (*see* 42, par. 8).

28. The survey itself may contain information from which a deduction can be made as to the character of the marsh at a given date. In a case involving an area in Jamaica Bay, the following testimony was adduced from an official of the Coast Survey (*see* note 22 *supra*) in answer to the question: "Now, drawing your attention to this ink line on Plaintiff's Exhibit 4, and particularly with reference to the word 'Marsh,' would you say that as far as that map shows that piece of land marked 'Marsh', might be below low water?" A. "There is one indication there which leads me to believe that that particular marsh was in the meadow stage, bare at—certainly—there is no question of it being bare at low water, but very probably bare at high water. That indication is this, on the righthand side of that area, you find a straight line which indicates the limit of the artificial dredging. That is not a natural shore line. That would be my inference, that it is the result of dredging. The fact that the area designated as 'Marsh' extends to that line and is not separated by a boundary similar to this, leads me to infer, and it is only an inference, that it has not been necessary to fill in the section just to the left of that line in order to have a boundary or a formation which would retain the waters in the channel at all stages of the tide and prevent it spreading over here. In other words, if it had been necessary to deposit material here in order to limit the channel, there would probably have been an indication similar to this (indicating)." From Transcript of Record on Appeal, *Best Renting Co.* v. *City of New York*, *supra* note 22, at 266.

### 444. Inner Edge of Marsh

On many of the early topographic surveys, the inner or landward limits of the marsh (the line separating the marsh from the fast land) are shown variously by "a continuous line, a dotted line, or by a continuous line with short hachures at right angles to it, by lone hachures or ends of the parallel lines significant of marsh areas." [29] The Bureau has always interpreted such line as indicating merely the dividing line between the marsh land and the fast or upland, and not as representing any particular tidal elevation other than that inshore of this line the land is bare at all stages of the tide. Generally, it may be considered as the limit of penetration of the highest tides, but, as has been noted previously, in certain stages of marsh development it may coincide with the high-water line (*see* 4432).

The detail with which the line was surveyed depended largely upon its accessibility. Not being a feature readily seen by the mariner the tendency was towards generalization.[30] Where the dividing line between the two characters of land was inaccessible, as where the upland was heavily wooded or overgrown, or where marsh faded imperceptibly into meadow, the dividing line was altogether omitted and the transition shown by the appropriate conventional symbol.

Notwithstanding its use on some of the early surveys, the representation of the inner edge of the marsh by a definite line was never a requirement until the publication of the Topographic Manual of 1928 when it was made permissive by the instruction that "The inner edge of the marsh (the limit of submergence at high water) when clearly defined may be drawn by a line distinctly lighter than the high-water line." [31] The parenthetical phrase used here should be considered as a very general definition of the "inner edge of the marsh" and not as referring to an exact tidal plane (*see* 4432).

29. From letter of F. C. Donn, a field and office man, to the chairman of the topographical conference convened in 1892 by the Superintendent of the Coast Survey (*see* 465). Annual Report, U.S. Coast and Geodetic Survey (Part II) 610 (1891).

30. In all references to the inner edge of marsh or fast land in the early manuals, the discussion deals with the inking of the topographic sheet (by appropriate conventional symbols) and not with the surveying aspect. But it may be concluded that there was no intention that the dividing line be located with great accuracy and detail the value of which would be vitiated by a generalization in the final inking. Annual Report, U.S. Coast Survey 218 (1860), and Wainwright (1922), *op. cit. supra* note 13, at 66. Occasionally, however, as a result of the judgment of the individual topographer, the inner edge of the marsh was very carefully delineated. For example, on Register No. T–1369 (1874), the dividing line between the inner edge of the salt marsh and the outer edge of the fresh marsh is shown by a continuous fine black line. A note in the early correspondence (Jan. 2, 1875) states that "Care was taken to delineate exactly the division line between salt and fresh water marsh, a point that may be of future value in land dispute."

31. Swainson (1928), *op. cit. supra* note 3, at 9. But at page 93 it is stated that "Neither the inner border of a marsh nor a shoal covered at high tide has a distinct continuous line to mark its limits, each being represented in its proper form and within its area by its conventional symbol only."

This practice of using a definite line for the inner edge of the marsh was reversed in 1938 by *Field Memorandum No. 1, supra* note 23, at 242, which provides in part that "The edge of high ground at the back of the marsh, mangrove and cypress areas shall be indicated by symbols only . . . and *not* by a fine line."

The practice in 1949 was to show the inshore limits of marsh by a broken blue line on planimetric and topographic manuscripts, but by conventional symbols on shoreline manuscripts.[32]

### 445. Marsh Areas Mostly Flooded at High Water

A feature frequently encountered on topographic surveys is a marsh representation (with solid or broken horizontal rulings), without a solid bounding line. This is interpreted to indicate that there existed no well-defined edge at high water which the topographer could consider the dividing line between land and water. What he saw was a marshy area mostly flooded at high water. Such formations are characteristic of marsh in the early stages of development and may be found contiguous to a well-defined marsh or outside the high-water line. The elevation of the ground in such cases is below high water and usually below low water, although scattered tufts of grass may in places protrude above high water.

The earliest reference to such formations was contained in the treatise on the planetable published in the Annual Report of 1865. They were referred to as "grassy shoals" and "grass upon flats, or shoals covered at high tide," and were described as "always found in water scarcely agitated by waves or currents." They were to be shown on the finished topographic sheet without a "distinct continuous line to mark their limits, each being represented in its proper form and within its area by its conventional sign only, but the shape should be well and correctly defined." [33] This practice is still continued on planetable surveys [34] and on photogrammetric surveys.[35]

The same collateral sources mentioned in 4433 should be examined for additional information regarding the condition of such marsh areas with respect to the tidal plane.[36]

32. Swanson (1949), *op. cit. supra* note 25, at 340, 343.

33. Annual Report, U.S. Coast Survey 220, 230 (1865). Appended to this report, as Sketch No. 32, is a composite drawing of the eastern end of Deer Island and shows the method of representing such marsh areas. (*See* fig. 49.)

34. *Field Memorandum No. 1 (1938), supra* note 23, at 241.

35. Swanson (1949), *op. cit. supra* note 25, at 343.

36. *See,* for example, Descriptive Report for Register No. T–5976 (1949). There have been instances where such marsh formations have been enclosed by a dotted or pecked line (*see* Register No. T–1115 (1869)). This is interpreted to be a cartographic expedient rather than a distinction from those areas shown without such enclosing line (*see* contemporary hydrographic survey Register No. H–1064 (1869), and representation on recent topographic survey of same area, Register No. T–5976 (1949)).

From a study of successive topographic and hydrographic surveys, the progressive development of a marsh area with relation to the tide can be traced. This is important in determining ownerships of a past date, especially where the land has become bare at high water either through natural processes or through artificial development.

## 446. The Low-Water Line

A feature on topographic surveys which frequently assumes significance for purposes other than charting is the low-water line. One reason for this is that in some of the states the tidelands (lands between high and low tide) are subject to alienation by the state.[37] Many of the grants to such lands were made years ago prior to waterfront improvements, and it frequently becomes important to know where the low-water line was located at the time of the grant or as close thereto as possible. The hydrographic and topographic surveys of the Bureau often provide the only authentic evidence available.[38] In using these surveys, it is essential that a proper understanding be had of the method of surveying such line, the accuracy with which it is determined, and any other information that would tend to throw light on its delineation on the survey sheet.

### 4461. *How Determined*

Both to the hydrographer and the topographer, the low-water line is one of the most uncertain and difficult features to delineate. Unlike the high-water line, it is actually visible but momentarily to the topographer. If located by the hydrographer it must generally be accomplished when the height of the tide is well above low water, making it difficult to develop readily its many irregularities. It was, therefore, recognized at a very early period in the work of the Coast Survey that the determination of the low-water line must be left for its final delineation to both parties, "everyone to work according to his best knowledge, and compare afterwards."[39] This provision was, of course, never interpreted to mean that the low-water line on both surveys must be made to agree (an examination of a number of the early surveys supports this conclusion), but

37. In *Oakland* v. *Buteau*, 29 P. 2d 177 (1934), the Supreme Court of California defined the "line of ship channel" as the line of "ordinary low tide."

38. Although riparian ownership in this country extends generally to high-water mark, in a few states it extends to low-water mark. In Massachusetts, for example, by virtue of a 1641–1647 ordinance, the title of the owner of land bounded by tidewater extends to low-water mark where the sea does not ebb beyond 100 rods (1,650 feet). *Commonwealth* v. *Alger*, 61 Mass. 53, 67–81 (1853).

39. "Addition to the Instructions lately given for the planetable surveys of the Coast Survey," dated Sept. 7, 1840, and filed in volume (17) of correspondence marked "Coast Survey, Scientific, 1844–1846."

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rather that the chart compiler, cognizant of the limitations of both methods of surveying, should use his best judgment in selecting the portion to be taken from each survey for the delineation and location of the low-water line on his chart.

In the pamphlet on "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey," published in 1860 (*see* 421),[40] the following pertinent observations are made on the difficulties surrounding the determination of the low-water line in the field:

> There are circumstances and cases where the topographical survey could not embrace all features of low water unless at great disadvantage and expense, and even then imperfectly and inconsistently with hydrographic results. On the other hand, the hydrography could not develop all the irregularities of low water by the ordinary process of field-work. In bays, coves, rivers, etc., where the character of the shore is irregular, the condition of the shore at low water generally corresponds to that of high water, and the points, islands, banks, etc., of such shores, afford facilities for the topography to determine the low-water line with rapidity and accuracy, with all minor details commanded and determined. The same degree of detail, however, could not be obtained by the usual hydrographic process of work.
>
> Shoals off-shore, in the middle of large sounds and bays and extensive flats, either connected or unconnected with the main shore, can be determined more favorably and economically by the hydrography. They come within the full scope of that work, and can generally be commanded by sounding lines and angles in a satisfactory manner. The position being remote from shore, often of soft and undefined substance, impracticable for occupied stations, makes the determination by the topographical parties difficult and objectionable.[41]

This idea has been reflected in every planetable manual, since the earliest in 1865, except the one included in the Annual Report for 1880.[42] In the Topographic Manual of 1928, provision for surveying the low-water line is included in the instruction that "The mean low water line should be delineated, but when it is beyond the reach of the plane table and presents no marked points for determination, or is of a character that will not permit the use of the instrument (as along the swampy shores in the South, where the muddy shoals are of great extent, and among the shifting quicksands of our great estuaries and bays), it may be left to be traced by the work of the hydrographic parties."[43] In addition, there is an instruction for "the careful location of . . . the low water line so far as the latter can be determined or estimated without waiting for low tide."[44]

40. There is only one complete copy of this pamphlet in the Bureau (*see* 462).

41. Annual Report, U.S. Coast Survey 220 (1860).

42. The reason for this omission, as well as for an absence of reference to other features of the survey, is that the 1880 manual was essentially a treatise on the planetable and its use, rather than a manual of topographic surveying.

43. Swainson (1928), *op. cit. supra* note 3, at 70.

44. *Id.* at 5.

It may therefore be inferred that whether expressed in the instructions or not, the intention was for the topographer to locate the low-water line as far as it was feasible for him to do so.[45] This conclusion is important in a consideration of the plane of reference used for the low-water line on the Pacific coast (*see* 4462).

### 4462. *Planes of Reference*

Along the Atlantic and Gulf coasts, where the diurnal inequality in the low waters is small and the plane of reference for soundings is mean low water, it must be assumed that the low-water line delineated on the topographic survey approximates mean low water. But on the Pacific coast, where the diurnal inequality in the low waters is quite pronounced, questions have arisen regarding the plane of reference for the low-water line on topographic surveys, that is, whether it approximates mean low water or mean lower low water.

Based on a detailed study of many topographic surveys, together with the contemporary hydrographic surveys, along the coasts of California, Oregon, Washington, and Alaska, and covering the period from 1850 to 1920, the conclusion was reached that the low-water line delineated on topographic surveys represents the topographer's estimate of the mean lower-low-water line rather than the mean low-water line. This necessarily results from the fact that in the determination of the low-water line on the nautical chart the compiler selected portions of the low-water line from both the hydrographic and topographic surveys whenever necessary (*see* 4461).[46] It would have been a contradiction for the topographer to delineate the *mean low-water line* when it was to be used on a chart where the plane of reference was *mean lower low water*. A comparison of topographic surveys with hydrographic surveys in lower San Francisco Bay bears this out.[47] The low-water line on the hydrographic surveys is well controlled by sounding lines that terminate at the shore so that minus soundings are available from which a mean low-water line can be plotted.[48] While the topographic low-water line is sometimes inshore and sometimes off-

45. An examination of many of the early topographic surveys shows a failure to locate the low-water line on many portions of the survey. The 1949 instructions for photogrammetric surveys state that "Features seaward from the high-water line, including the low-water line . . . are the mutual responsibility of both the photogrammetric survey and the hydrographic survey." SWANSON (1949), *op. cit. supra* note 25, at 507, 524.

46. On some hydrographic surveys, such as Register No. H–564 (1856) in San Diego Bay, where portions of the low-water line were not well controlled by soundings, the line was transferred from the topographic survey. This is also true of Register No. H–1256 (1875) in Newport Bay.

47. *See* Register No. T–664 (1857), Register No. H–628 (1857–58), Register No. H–629 (1857–58).

48. The hydrographic surveys show only zero soundings above the plane of reference, but by replotting some of the lines from the original records, soundings ranging from zero to minus 5 feet were available from which the mean low-water line could be ascertained.

shore of the hydrographic line, it does not approximate the mean low-water line and shows conclusively that the topographer was attempting to delineate a mean lower-low-water line. This is also borne out by surveys in Puget Sound. A comparison of the topographic survey with the contemporary hydrographic survey shows the topographic low-water line to correspond generally to the mean lower-low-water line on the hydrographic survey. It definitely does not correspond to the mean low-water line.[49] And on the 1913 topographic survey of Olympia Harbor (Register No. T–3379), there is a note "L.L.W. (Sketched)" which negatives any inference of a mean low-water line.

Further evidence that the topographer attempted to delineate a line based on the plane of reference for the soundings is had from a study of some "awash rocks" in Alaska. On one survey in Frederick Sound, where the plane of reference is mean lower low water, a rock was located by the topographer and marked as baring 8 feet at mean lower low water. This indicates that he was conscious of the plane of reference for the soundings. Had he been thinking of mean low water, his description of the rock would have also referred to this plane.[50] On a 1910 survey in Wrangell Narrows (Register No. T–3111), where the plane of reference at that time was 3 feet below mean lower low water (*see* 5644), "Spike Rock" is indicated as uncovering 1 foot at lowest low water (the approximate plane of reference). It was so interpreted in subsequent *Coast Pilots* which refer to the rock as "awash at extreme low water."[51] Had the topographer meant lower low water, then the rock would have uncovered 4 feet at the plane of reference and would have been in substantial variance with other sources of information for this feature.

Requirements for present-day photogrammetric surveys leave no doubt as to the low-water plane intended to be delineated. In the topographic manual it is stated: "The low-water line (designated as mean low-water line on the East Coast and as mean lower low water on the West Coast) shall be determined by office interpretation only when the aerial photographs have been taken at or near the time of low water."[52]

49. *See* Register No. T–1682 (1885) and Register No. H–1728 (1886). The plane of reference for the hydrographic survey was based on the mean of the lower low waters of a few days. This was later found to correspond to a plane 2 feet below mean lower low water. Allowance for this was made in the comparison.

50. *See* Register No. T–3687 (1917). This is also borne out by a comparison with the low-water line on the hydrographic survey of 1887 (Register No. H–1806).

51. This is also corroborated by a note on the hydrographic survey of 1881 (Register No. H–1525*b*) which reads "Rock with 1 ft. Uncovers at extreme low tides," and a minus 1 foot sounding on the hydrographic survey of 1884 (Register No. H–1616), although there is some uncertainty as to the exact plane of reference on these surveys.

52. SWANSON (1949), *op. cit. supra* note 25, at 341.

Where the mean lower-low-water line is delineated on the hydrographic survey by actual soundings, it would generally be expected to find the topographic delineation inshore of this line rather than offshore, unless it was an estimated location and not the line of contact between land and water that was visible to the topographer. This would follow from the fact that the times when the water level would fall below the plane of reference would be inconsequential when compared with the times when the water level was above the reference plane. However, in comparing surveys, the existence of a minus tide at the time the topographer surveyed the low-water line should not be ruled out.

### 4463. *Accuracy of Determination*

The low-water line on topographic surveys must necessarily be an approximation for the most part, coinciding but rarely with the actual low-water line. This is evident from the nature of the circumstances. Along most of our coastline there are two low waters in every tidal day, so that a low water occurs but once every 12½ hours. During a large percentage of the tidal cycle, the actual low-water line is not visible, the interval of visibility depending upon the slope of the shore and the range of the tide. The topographer is therefore unable to locate a continuous low-water line by measurement. To do so accurately would require projecting the low-water line along the beach by means of levels from known elevations. This method was never followed in the Bureau, unless for some special-purpose survey. The topographer usually informed himself of the time of low water and whenever possible worked along the beach at such times as to enable him to rod in both the high- and low-water lines. In exceptional cases, as where low water revealed an extensive spit penetrating the fairway, or where the low-water line made out a considerable distance from shore and the shallowness of the water or the small range of tide would have made it difficult for the hydrographic party to locate, the topographer sometimes returned to the area for the express purpose of locating the line. But generally no attempt was made to survey the line completely. The topographic survey was primarily for the purpose of delineating the high-water line and for locating signals for control of the hydrographic survey. If the topographer delineated the low-water line at all it was more or less incidental to his survey and was quite often sketched, such an estimated low-water line being merely a guide for the hydrographer who followed. No distinction was made between a sketched low-water line and a rodded one. But even where the line was actually surveyed, it was only a contact line between the water and the land, rather than the intersection of the adopted tidal plane with the shore, because the topographer might rod such line at stages of the tide from the lowest of the day to well above low water.

The provision in the earliest instructions for topographic work that "the low water line is taken by offsets whilst running the high water, and when not too far apart from each other, but when their distance is great they must be surveyed separately: a couple of hours before the end of the ebb, and the same time during the commencement of the flood tides will be the proper time for taking the low water line" (*see* 42, par. 17), bears out the approximate nature of the line as surveyed by the topographer. Two hours of the tidal cycle might shift the contact line a considerable distance horizontally on a gently sloping beach.[53]

### 447. Rocks—Bare, Awash, and Sunken

All rocks—bare, awash, or sunken—are located by the topographer wherever possible. The topographic survey being essentially a survey of the land area, is authority, both as to location and elevation, for all features in the water area that are above the plane of mean high water. In the case of a bare rock some distance from shore which was located by the topographer by "cuts" without actually visiting the rock, the determination of the elevation above high water by the hydrographic party might be given preference. The elevations of rocks awash (*see* 565) above the sounding datum would generally be taken from the hydrographic survey because the estimated height would be tied in with an exact tide stage, but the topographic location of such feature would be acceptable. Sunken rocks (*see* 565) when located by the topographer would usually show as a breaker, and the hydrographic survey would be the better authority for such features both as to location and depth below the sounding datum.

## 45. SYMBOLIZATION ON TOPOGRAPHIC SURVEYS

In the early, formative period of the Bureau (*see* 43), complete consistency in the use of conventional symbols on topographic surveys was never attained. This was due to the lack of standard symbols, the personal views of the different topographers, and the lack of complete central control. The various symbols

53. The quoted provision regarding the separate surveying of the low-water line when its distance from the high-water line was great may have been applicable during a very brief period only, because in the supplemental instructions dated Sept. 7, 1840, it is clearly stated that in the delineation of the low-water line the topographic and hydrographic parties are "to work together conjointly, and according to distinct agreement" (*see* notes 9 and 39 *supra*). No subsequent planetable manual has ever required otherwise.

used at different periods will be covered in a later section (*see* 46). In the present section will be included a discussion of a topographic survey made in mid-19th century covering a variety of features about which requests for interpretation have been received (*see* 451), and a recent example of specialized symbolization (*see* 452).

### 451. Interpretation of Symbolization on an Early Survey

Figure 44 is a photographic copy on a reduced scale of a section of Register No. T–892 (1859), a topographic survey along the southern California coast. The features that have been identified by letters of the alphabet are those about which interpretive guides were requested. The following enumeration reflects the answers furnished:

(*a*) The solid line at points such as (*A*), where not adjoining salt marsh, delineates the mean high-water line as near as it could be interpreted by the surveyor in the field from the appearance of the beach, or by reference to predicted tides, but without recourse to leveling (*see* 4421).[54]

(*b*) The solid line at points such as (*B*) delineates the edge of vegetation and may or may not be the mean high-water line. This line may be defined as the line which to the navigator would appear to be the dividing line between land and sea.[55]

(*c*) The dotted line at points (*C*) is the low-water line as estimated by the surveyor and not determined by levels (*see* 4461).[56] It is probable that the junction of the dotted line and the solid line at points such as (*C′*) means that the bank is so steep that the low-water line and the edge of vegetation practically coincide. Points (*C″*) represent the limits of the low-water line insofar as delineated by the topographer.

(*d*) The solid line at points (*D*) represents the dividing line between marsh and the somewhat higher land covered by grass. At points such as (*D′*) the solid line represents the junction between the marsh and an alkali flat (*see* (*i*), below). The solid line at (*D″*) is the dividing line between salt marsh on the north and the higher sand area on the south.

(*e*) At points (*E*) it is probable that the solid line was omitted because the dividing line between the marsh and the sand or alkali flat was not as definite as at other points.

(*f*) The area marked (*F*) is ground above high tide covered with grass.

(*g*) Areas marked (*G*) are sand areas. The areas marked (*G′*) are shown on the original survey by small irregular circles drawn in red. No definite reason is known for the use of this symbol by the topographer, but it is believed to have been intended to represent small sand dunes probably covered with brush or scrub growth.

(*h*) The series of close parallel lines in the area marked (*H*), as well as in other similar areas, represent salt marsh. Although the symbol is incomplete (it should include tufts of

54. Predicted tides in their present form were not published in 1859, but could have been computed from data contained in the annual reports of the Survey (*see* Part 1, 2322 note 56).

55. Actually the land at point (*B*) may have been covered by a few inches of water at mean high tide and the high-water line would be somewhere in the interior marsh area (*see* 4432).

56. Within the estuary, the dotted lines probably represent low-water channels through the mud flats at some stage of low tide but not necessarily at mean lower low water. The defining limits of low-water channels may therefore have been higher than the low-water line shown on the outer coast.

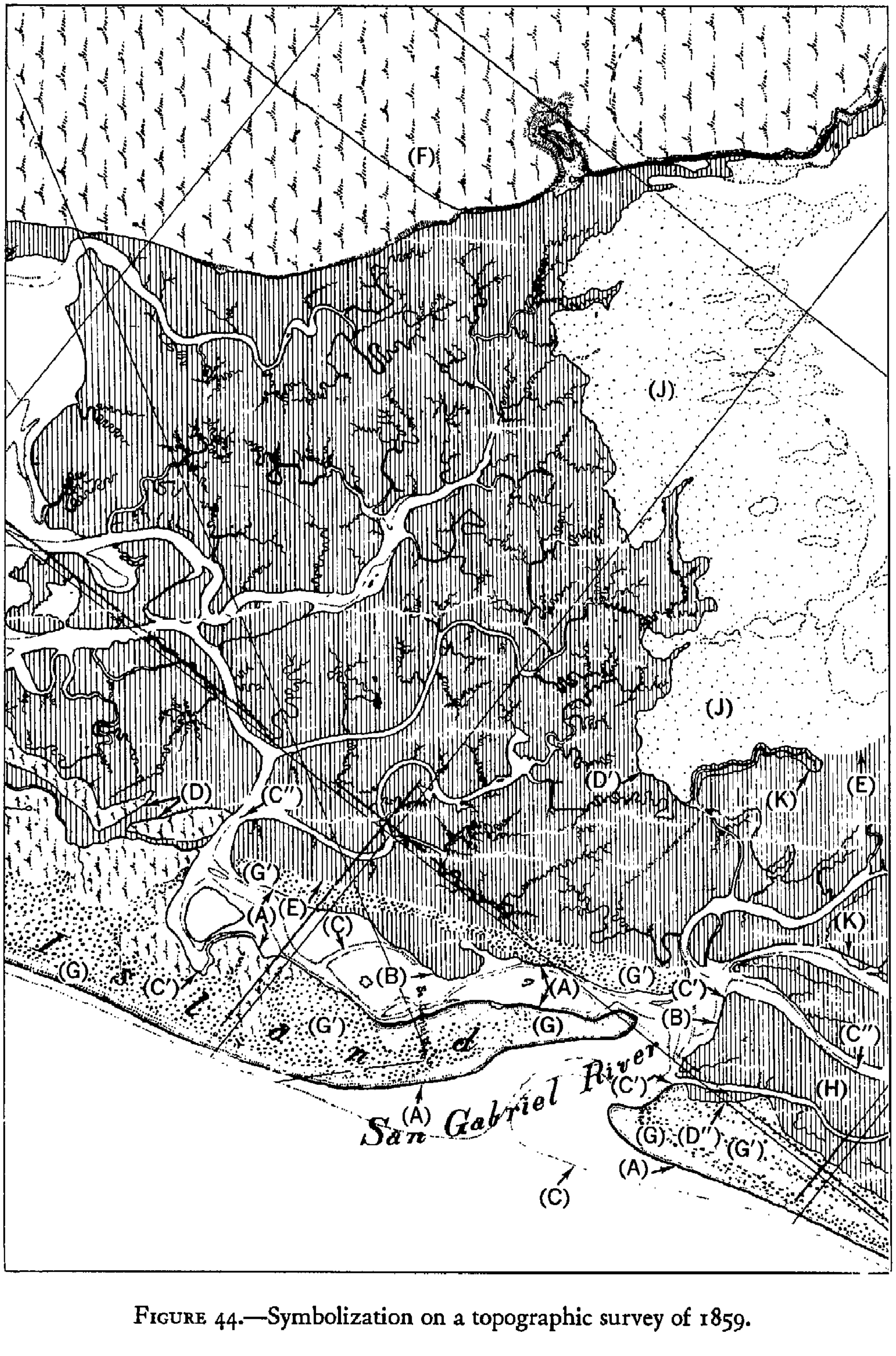


FIGURE 44.—Symbolization on a topographic survey of 1859.

grass at intervals) it was also used on several other early surveys in the locality and in the vicinity of San Francisco Bay.

(*i*) The area marked (*J*) is an alkali flat. The symbol used is an uncommon one and so far as known is unique in this area. On a later topographic survey in the same locality (*see* Register No. T–1283 (1872)), the same symbol was used in the same area but with the addition of the words "Alkali Flat," thus making the character of the area unmistakable.[57]

(*j*) The line at points (*K*), it is believed, represents a rather definite break between the higher marsh area and a lower marshy area. This is borne out by a comparison with Register No. T–1283 (1872) on which the area to the eastward of the small stream is shown as alkali flat and the line marked (*K*) appears in about the same position as the dividing line between marsh and alkali flat. Probably the marsh in that area was quite high and changed in the interval between the two surveys from a slightly marshy area to an alkali flat.

## 4511. *Representation of Marsh Areas*

Many inquiries are received in the Bureau regarding marsh areas on topographic surveys. These usually relate to the elevation of the marsh with respect to the planes of mean high water and mean low water, and to the symbolization used.

The importance of knowing the elevation of the marsh arises from the fact that prima facie the state is the owner of submerged lands under inland navigable waters, and of the tidelands (lands between high- and low-water marks). Marsh land covered at high water falls into the category of tidelands and hence belongs to the state, while such land that has built up to the meadow stage and is above the plane of mean high water is part of the upland and belongs to the riparian owner. What the condition of the marsh was as of a given date thus assumes special significance. This has been dealt with in 4433.

As to symbolization of marsh areas, the practice was not always uniform. On the first topographic survey (Register No. T–1 (1834)), the marsh area was shown tinted. On some of the early surveys, salt marsh was shown without the tufts of grass (*see* 451(*h*)). This was a draftsman's omission rather than a change in the symbol, or another form of vegetation. This has been verified by examining adjoining surveys executed by the same topographer during the same period, and therefore must have represented the same practice. On one survey grass tufts are omitted while on the other they are included.[58]

In 1938, the representation of marsh and other swamp areas on planetable and photogrammetric surveys was standardized with the issuance of a field memorandum. Covered in this memorandum are instructions for showing the outer edge of the marsh where it is continuous, and where it is broken and

57. An alkali flat is an alkaline, marshy area in an arid region. In the dry season, when all the water has evaporated it is a barren area of hard mud covered with alkali (a soluble salt or mixture of soluble salts). MOORE, A DICTIONARY OF GEOGRAPHY 9 (1949). *See also* STAMP, A GLOSSARY OF GEOGRAPHICAL TERMS 16 (1961).

58. *See* Register No. T–1471*a* (1879) and Register No. T–1538*a* (1880).

mostly flooded at high water, and for showing the junction between the marsh and the fast land in the interior.[59]

### 452. Specialized Symbolization

In the photogrammetric mapping and nautical charting of the Laguna Madre area of Texas, and similar areas elsewhere, where very little of an astronomic tide exists and the variation in water level is primarily due to meteorological conditions, the following special symbolizations and notation were used to represent existing conditions as nearly correct as possible:

(1) On the manuscript topographic maps (black and white copies), a solid, heavy, black line was used for the high-water line where the feature was definite and marked by visible evidence on the ground; where indefinite, without visible evidence on the ground, a broken line was used to indicate the approximate inshore limits of areas subject to inundation. The approximate low-water line was represented by a dotted line.

(2) On the nautical charts, the solid, black line was used where it was so shown on the topographic map, and a light, broken line was used to indicate the approximate inshore limits of areas subject to inundation. Inshore of these two lines, a buff tint was used to show land above high water. Between either of these lines and the low-water line (this was shown as a dotted line) a green tint was used. Offshore of the low-water line, the area was left blank or a blue tint used.

(3) On the manuscript topographic maps, the following notation was added where the high-water line was omitted: "Water stages in this area vary widely with meteorological conditions. The high-water line has been omitted where it is indefinite and is not marked by visible evidence on the ground. The broken line indicates the approximate inshore limits of areas subject to inundation. The dotted line represents the approximate low-water line." (*See* Register No. T-9201 (1948–1950) and Coast Survey chart 894.)[60]

## 46. CHRONOLOGY OF CONVENTIONAL SYMBOLS USED IN THE COAST SURVEY

It has been noted previously that a topographic survey is a small-scale representation of the natural and artificial features of a portion of the earth's surface (*see* 124). The aim of the topographer, and in a more refined sense the map maker, is to give graphic expression to the dominant features of the landscape. While the survey or map is drawn to scale as far as general dimensions are concerned, the indication of details, except on the larger scales, is almost always pictorial. If the real proportion of such features were used on the small-scale maps, many of them would appear microscopic. It has therefore been necessary to adopt a carefully considered scheme of conventions in which the character

59. *Field Memorandum No. 1 (1938)*, *supra* note 23, at 241–245. This was still the practice generally in 1949. Swanson (1949), *op. cit. supra* note 25, at 340.

60. Letter of June 7, 1951, from Director, Coast and Geodetic Survey, to Humble Oil and Refining Co.

of every line and every symbol conveys a definite meaning. The system so adopted is called *conventional symbols.*

Conventional symbols permit the greatest amount of information to be compressed into the minimum amount of space, yet without loss of clearness or legibility. The survey or map becomes, in a sense, a shorthand script, the full meaning of which can be understood only through a thorough knowledge of the system employed. Although there was in general a tendency to use the same type of symbols for the field surveys as for the engraved maps or charts, the smaller scales of the latter sometimes necessitated a departure in certain representations. There was always greater freedom in delineation on the surveys than on the charts, the main purpose being to convey information emphatically and unmistakably, beauty of delineation being of secondary consideration.

The symbol idea used today probably owes its origin to the drawing of pictures on the map to represent a variety of purposes. Many of these represented ideas and beliefs rather than topographic features. In many of the Portolan maps of the 14th and 15th centuries, the atmosphere figured rather prominently and the bellying sails of galleons were used to represent wind and its direction.[61] The superstitions of the old Saracen geographers regarding the coast of Africa resulted in fringing it with sea monsters and deformed humans. By 1775 there was in use in France a rather complete set of conventional symbols to represent the various features of the terrain (*see* fig. 45). Many of these resemble our modern symbols and it is quite likely that in the early surveys of the Bureau, before the adoption of standards, the representation of topographic features was modeled after these.

Since a survey or map is in reality a bird's-eye-view of the landscape, conventional symbols have for the most part been devised to suggest a shape which the object would assume if viewed from above. There are some exceptions to this rule, as where the object to be represented is better emphasized in elevation than in plan. (The early symbols for lighthouses and windmills followed this pattern, as does the present symbol for palm trees.)

Conventional symbols cover a wide range of features and it would be outside the scope of this publication to compare the practices relating to all of these during different periods of the Survey's existence. Therefore, only those symbols will be considered that are fundamental to the interpretation of our surveys and charts, particularly as they pertain to alongshore features. Fortunately, the character of these symbols have undergone few changes, once a standard was adopted. Isolated departures will be encountered in the field

61. Jervis, The World in Maps 41 (1936).

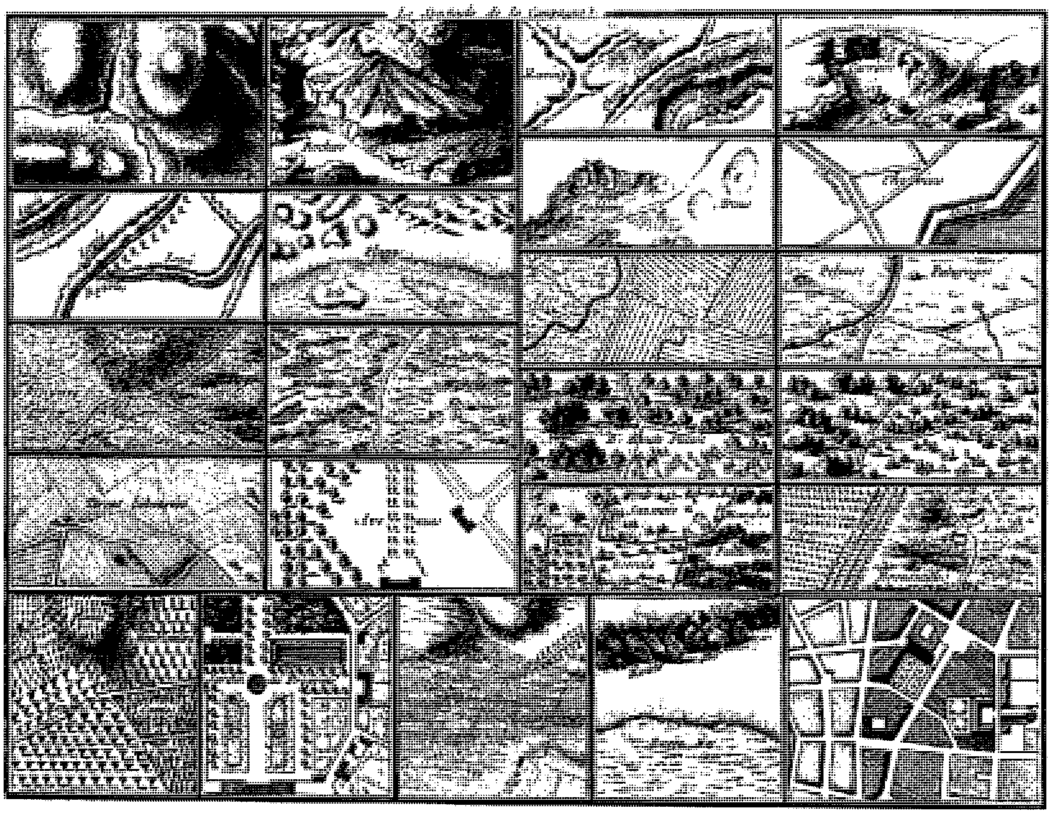

FIGURE 45.—Topographic symbols used in France in 1775.

surveys due to difficulty of securing complete uniformity where field parties are scattered over a wide area. Such was not the case with the published charts, since they were prepared in one central office where close supervision could be exercised.

In this chronology, no attempt is made to reproduce all the symbols or plates that were in use during any given period, but rather to provide continuity without duplicating identical symbols. This has been accomplished through the use of explanatory notes and cross-references. All the references to annual reports and other publications of the Bureau are those for which at least file copies are available, and it would be possible to reproduce these symbols should this become of importance in a particular situation.

### 461. EARLIEST PUBLISHED SYMBOLS (*Circa* 1840)

The earliest reference to conventional symbols in the topographic literature of the Coast Survey is found in the instructions for topographic work, issued about 1840 by Superintendent Hassler, where it is stated: "In the representation of all topographical details you will follow strictly the conventional signs furnished you" (*see* 42, par. 31). This reference was evidently intended to apply to features associated with the works of man (except for rock symbolization), because features such as upland, meadow, marsh, woods, etc., were dealt with in other paragraphs of the instructions. As far as is known, figure 46 shows the earliest topographic symbols published by the Bureau. While undated, the record of the plate shows that it was engraved around 1840 and is probably the "conventional signs" referred to by Hassler. The symbols for the most part deal with bridges, roads, fences, and navigational aids. Of special interest are the symbols relating to rocks and ledges. These are discussed in the chapter on hydrographic surveys (*see* 565).

### 462. Rules for Representing Certain Topographical and Hydrographical Features, etc. (1860)

In 1860, a publication was issued entitled "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey." This was in pamphlet form and consisted of a series of instructions—from the Superintendent to the Assistant in Charge of the Office—pertaining to the drawing and engraving of Coast Survey maps and charts on the scale of 1: 80,000. Every detail of the finished chart was covered by these rules, from the symbols and dimensions for the topographic and hydrographic features to the style and gage of lettering. These rules were based on a report by Henry L. Whiting, a field engineer in the Survey, and were the result of an effort to revise and standardize the existing practice, in the light of the experience gained both in the field and in the Office, and to meet new developments in the methods of reproduction, particularly the introduction of photography.

Prior to this, and more particularly in 1845 and the years immediately following, the subject of drawing and engraving the maps and charts of the Survey was studied in detail. While great pains were taken to introduce uniformity and system, many departures had occurred in the intervening years. The reactions of the maritime public to the first published charts of the Bureau also needed reflection. It was in this atmosphere that the rules of 1860 were formulated. The rules comprised 37 printed pages, of which pages 7 to 19—covering generalization of topographic and hydrographic details and cartographic routine for reproduction by photography—were for the most part reprinted as Appendix 20 to the Annual Report of 1860.[62]

62. The only complete copy of these rules now extant is filed in the Coast Survey library and is identified as Accession No. 61834.

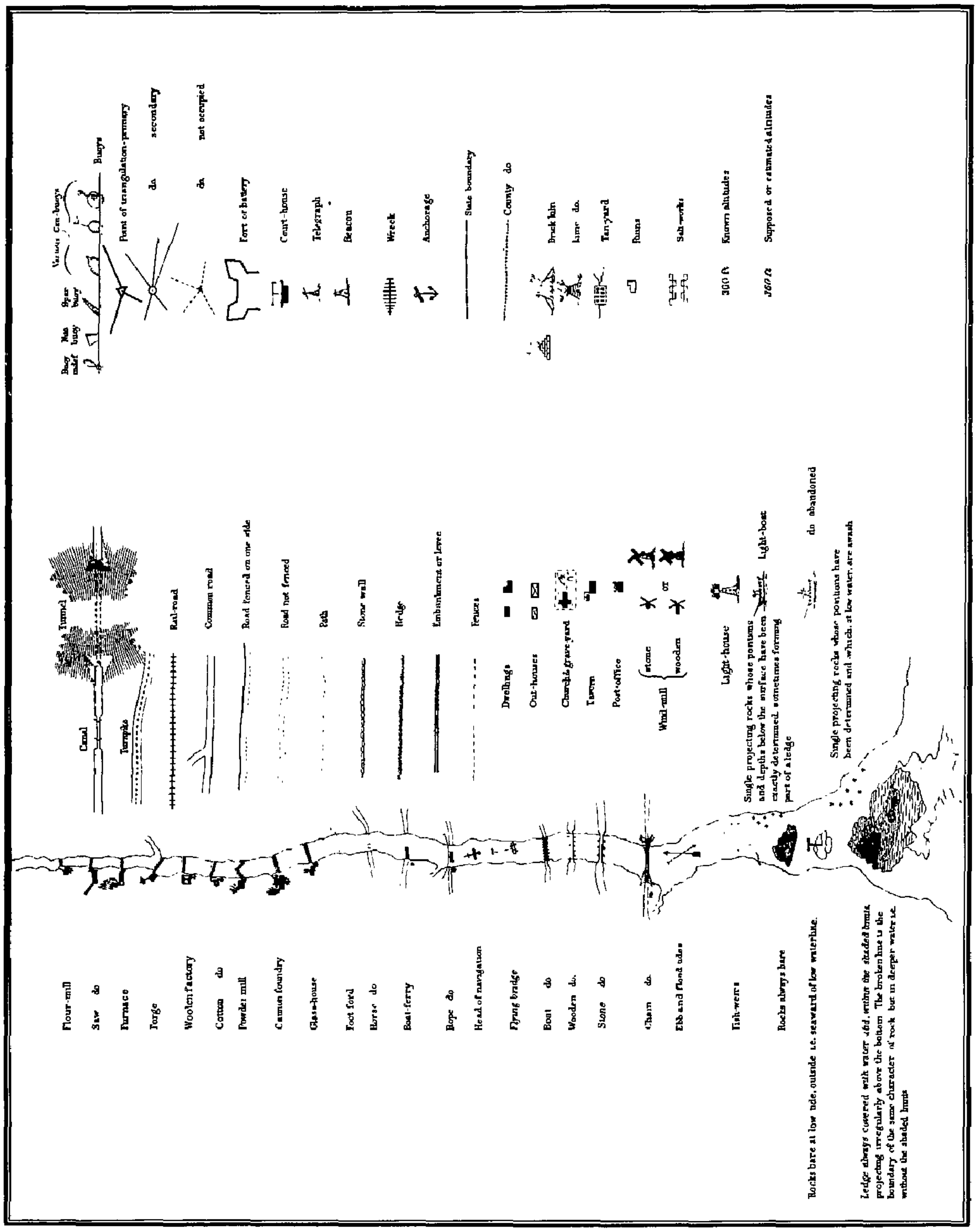

FIGURE 46.—Earliest conventional symbols published by the Coast Survey—*circa* 1840.

Attached to these rules were two paste-up sheets of printed conventional symbols, some of which were cut-outs from printed charts and others were apparently prepared to illustrate the symbols adopted (*see* figs. 47 and 48). These are no doubt the "Samples" referred to on page 4 of the rules.[63] In addition to the samples referred to, there are several symbols included within the text as paste-ups or as original drawings. Of particular interest are the symbols for salt marsh and the dividing line (a pecked line) between such marsh and the fast land (*see* p. 9 of the rules).

While the rules of 1860 were primarily for the guidance of the office, the fact that they were prepared by Whiting, whose experience in field topography was, in the words of Superintendent Bache, "greater than that of any other assistant in the Survey,"[64] would indicate that in all probability they represented the current thought of the field engineers of that period in the interpretation of topographic features and in the method of representing them on the survey sheets.

### 463. Specimen Topographic Symbols (1865)

The Annual Report for 1865 contained the first comprehensive treatise on the planetable (*see* 412). Accompanying this treatise was a specimen sheet (Sketch No. 32 in the report) at a scale of 1:10,000, showing all the leading characteristics of country, together with the conventional symbols adopted and used by the Survey at that time. While the drawing is of necessity a composite, nevertheless all its separate features are from actual surveys. This is the earliest illustration of conventional symbols, of which we now have knowledge, which were prepared specifically for the guidance of the field engineer. Figure 49 is a photographic reduction of the topographic work, and figure 50 is a reproduction of the symbols only.[65]

### 464. Specimens of Topographical Drawing (1879 and 1883)

In 1879, an important change in topographic procedure was inaugurated. It had heretofore been the practice for topographers to ink their own topographic surveys. There was an obvious advantage in this practice since the

63. These symbols have been identified as similar to the rougher samples submitted by Whiting in his manuscript report to the Superintendent of the Survey (filed in the volume (289) of correspondence marked "Civil Assistants H–Z, 1860"), of which the printed pamphlet is practically a verbatim copy.

64. Annual Report, U.S. Coast Survey 20 (1860).

65. Of special interest is the checkerboard symbol for "salt works." This has been encountered on various surveys along the southern coast of Massachusetts made between 1845 and 1851 (*see*, for example, Registers Nos. T–191 (1845) and T–402 (1851)).

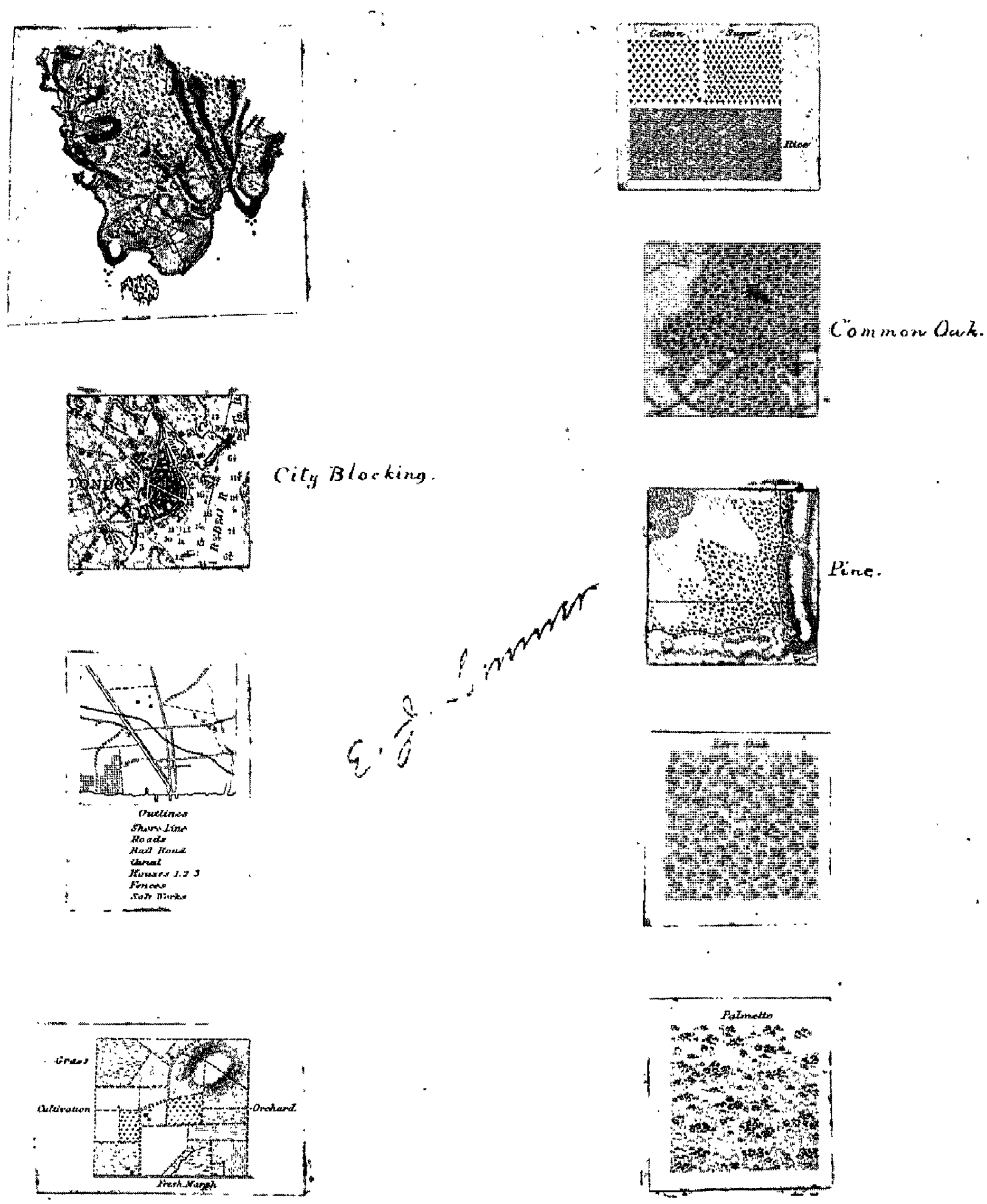


FIGURE 47.—Conventional symbols used in 1860.

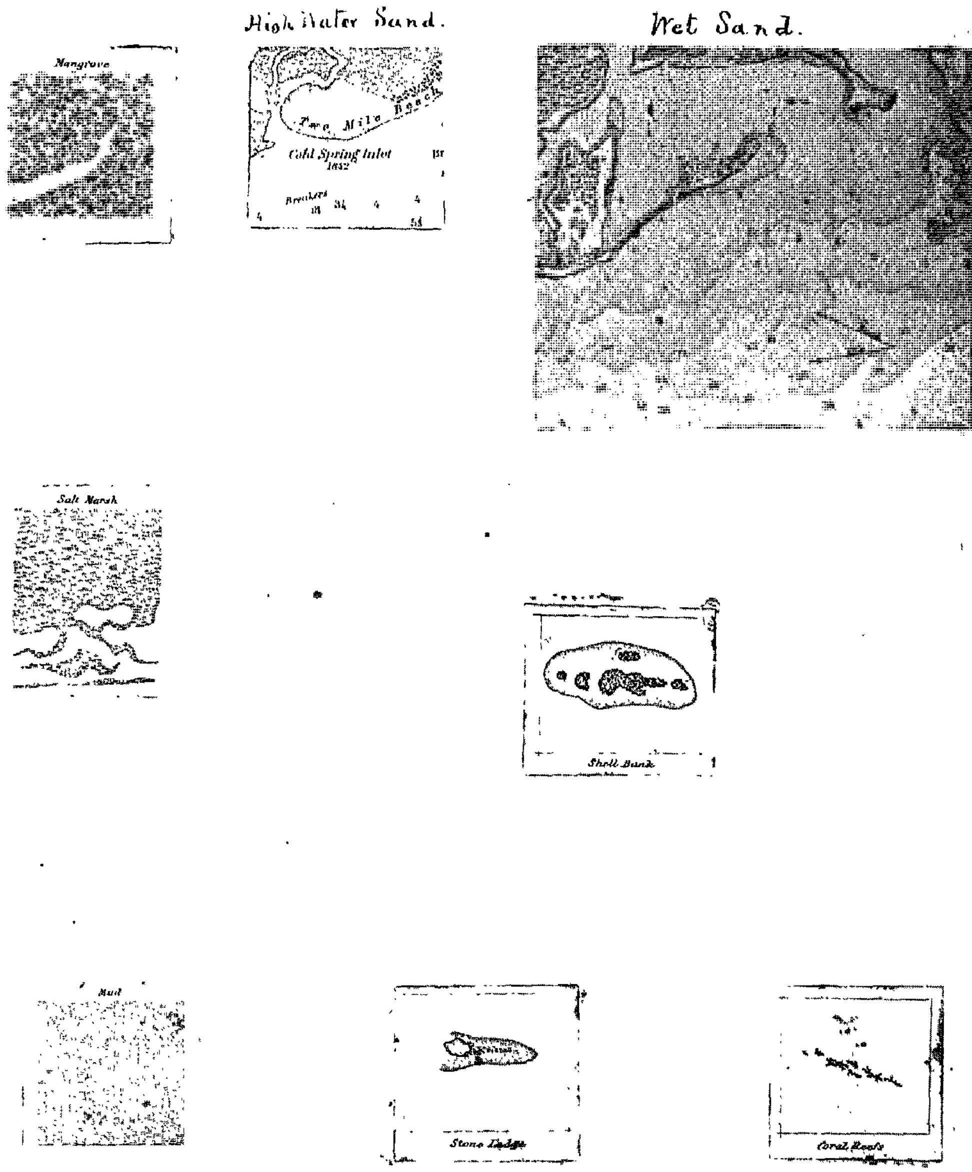


FIGURE 48.—Conventional symbols used in 1860.

706-026 O-64-15

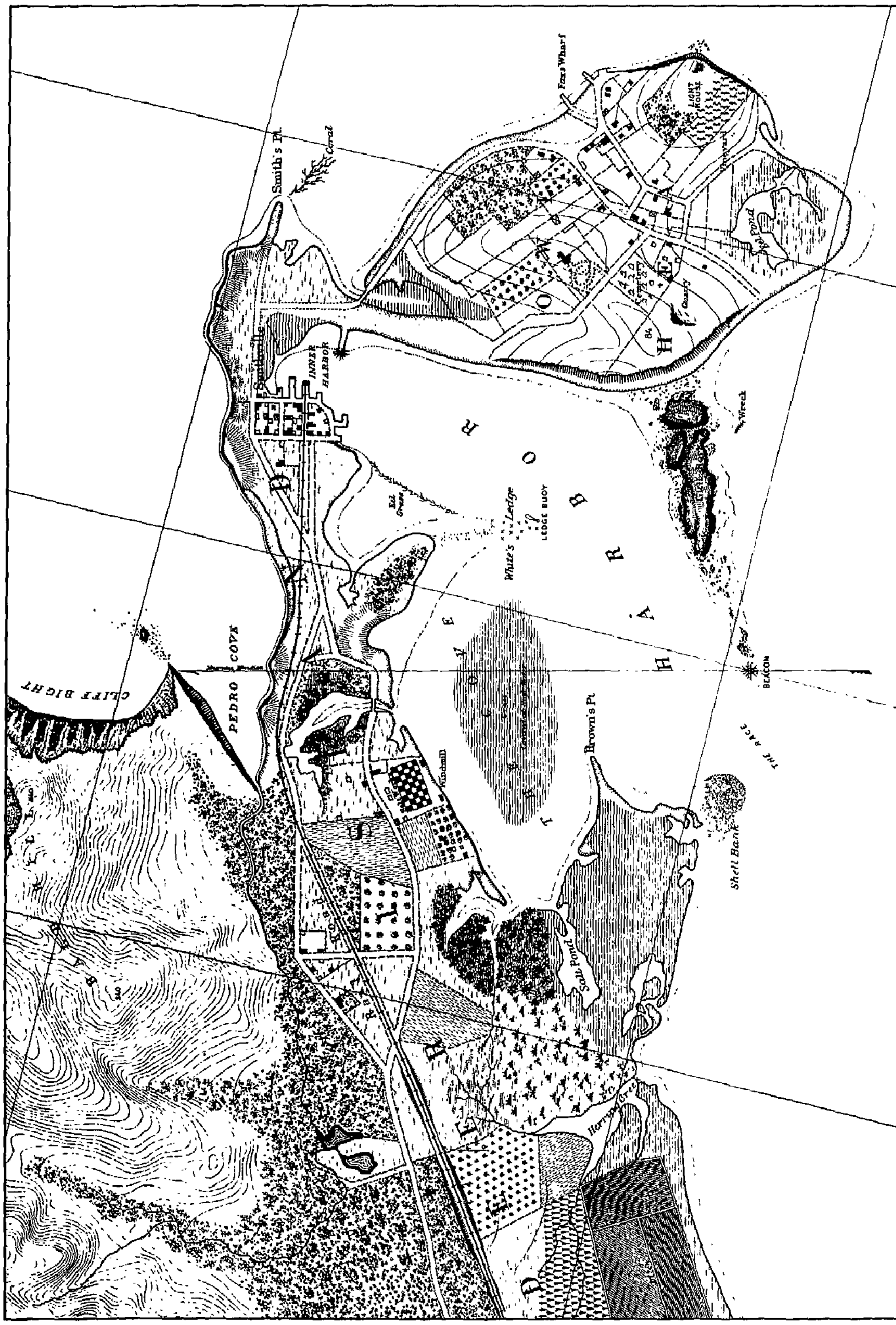


FIGURE 49.—Composite topographic survey of 1865 showing the leading characteristics of country. The separate features are from actual surveys.

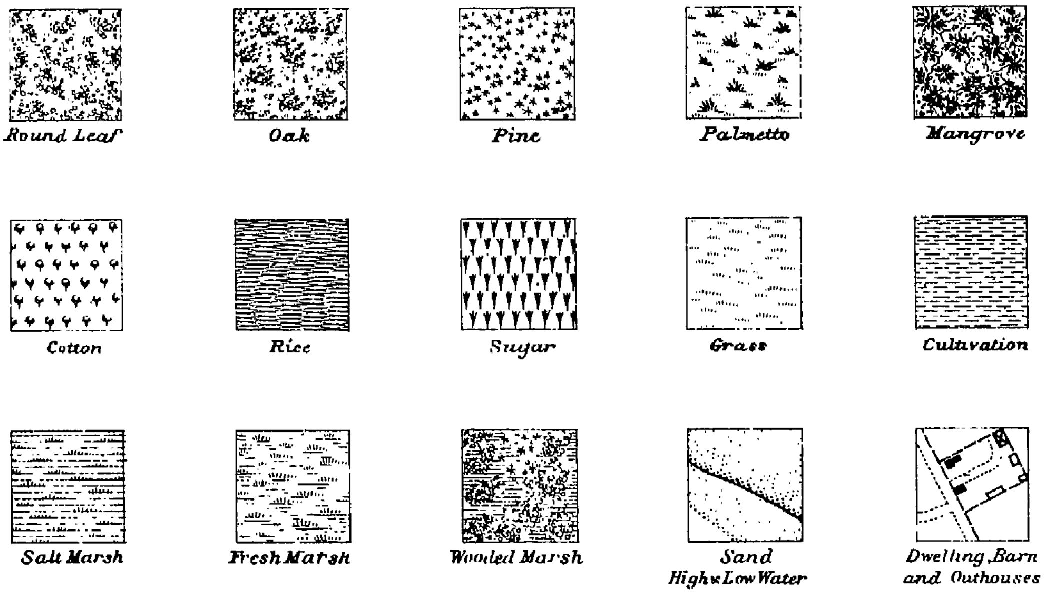


FIGURE 50.—Conventional symbols used in 1865.

final drawing was done by one familiar with the character of the ground. On the other hand, there was an accompanying disadvantage in that the various topographic surveys lacked uniformity of style, since good surveyors were not always good draftsmen. As long as the maps were not drawn for the purpose of direct reproduction this was not a matter of great moment, but with the advent of photolithography which made practicable the publication of maps directly from the original drawing, either on the same or on a reduced scale, it became desirable to have the original drawing made in a suitable and uniform style. Specimen drawings were therefore prepared, on the scale of the original sheets, of the various topographic features to be represented, to serve as guides for the office draftsmen who were thereafter to ink the planetable surveys.[66]

66. Annual Report, U.S. Coast and Geodetic Survey 71–72 (1879). In the preparation of these drawings, a selection was first made of those features, natural and artificial, that were most prevalent along the coasts of the United States. In some instances, departures from the existing form of representation were introduced and this became the practice for the future. Fresh marsh representation is one such case. Regarding this the report states: "Fresh marsh is also represented in a style different from that heretofore in use. Its representation had previously been by irregularly distributed tufts of grass, underlined by free hand with water lines, which, drawn with taste, is perhaps the most artistic representation of the feature; but which is seldom represented the same by any two persons. It was therefore thought best to introduce a style that could be definitely described and required. For this purpose, lines of the same strength and the same distance apart as those of the salt marsh are ruled and irregularly broken, then interlined and tufted by free hand with light short lines grouped irregularly, as shown in the first of the series of sketches accompanying this paper." *Id.* at 191.

These drawings were published in two series, the first appearing in the Annual Report for 1879 (p. 191). This comprised 8 lithographed plates with contours shown in color. The second series appeared in the Annual Report for 1883 (p. 368), and comprised 8 additional plates in color, but the plates of the first series were also included, making a total of 16 plates.[67]

The practice of office inking of planetable surveys was diligently followed during the first few years after its inauguration. Later, there was a return to the old practice of the topographer inking his own survey. In the planetable manual included in the Annual Report for 1898 (p. 460), this observation appears: "It is expected that every topographer shall have learned to draw sufficiently well to ink his sheet in a clear and distinct manner."[68]

It is not always an easy matter to determine from an inspection of the survey sheet whether it was inked by an office draftsman or by the topographer, because on many of them only the name of the latter appears. However, in the early years of this practice, itemized statements were included in the annual reports giving the locality of the survey and the name of the draftsman who inked it.[69] Later, and in particular the years subsequent to 1912, information regarding the inking was included either on the sheet proper or on a title sheet attached to the Descriptive Report (*see* 1242).

### 465. Conventional Signs for Field Sheets (1892)—The Topographical Conference

In the early part of 1892, a topographical conference was convened in the Bureau for the purpose of studying the state of the science and art of topography and looking toward improvement and standardization of the methods of survey and representation of the results. The conference was composed of the most eminent topographers of the Survey, and one of the subjects which came before it was "The establishment of uniformity in the use of conventional signs."

The procedure adopted by the committee delegated to study this matter was "to take as a basis the whole range of conventional signs heretofore used on the Survey, cancelling some of them, adding some, and modifying others." The symbols adopted were made a part of the conference report, the entire report being embodied in the Annual Report for 1891. Four plates of symbols

67. Selections from these plates have appeared in the various planetable manuals issued between 1897 and 1928.

68. This date did not exactly represent a sharp cleavage in the two practices, and in the annual reports to and including 1908 mention is still made of the inking of topographic sheets as one of the functions of the Drawing Division.

69. *See,* for example, Annual Report, U.S. Coast and Geodetic Survey 101–102 (1883).

were included in the report, two of which are reproduced here (*see* figs. 51 and 52). Of special interest is the symbol for submerged marsh which appears for the first time. This is probably intended to represent marsh areas mostly flooded at high water (*see* 445 and fig. 49).[70]

### 466. TOPOGRAPHICAL SYMBOLS (1898)

The Annual Report for 1898 (Appendix 8) contained "A Plane Table Manual," by D. B. Wainwright. This was published as a separate in 1899 and was the first manual to include a set of standard topographic symbols. These symbols are the same as those adopted by the topographical conference in 1892 (*see* figs. 51 and 52), except for the salt-pond symbol, which was shown stippled (the same as is used today), and the cypress-swamp symbol which was changed to resemble a wooded marsh but with more pine stars and the grass tufts removed.[71]

### 467. CONVENTIONAL SIGNS (1905)

The Annual Report for 1905 (Appendix 7) contained a revision of the 1899 planetable manual (*see* 466). (This was also issued as a separate.) The conventional signs included in this revision did not differ materially from those

70. Annual Report (Part II), U.S. Coast and Geodetic Survey 576, 706 (1891). The symbols not reproduced here covered rapids, falls, dams, ferries, houses, barns, sheds, roads (various kinds), fences, aids to navigation, sunken rocks (a simple cross), and rocks awash (four lines crossing). Also included, but not reproduced here, were the symbols for a topographic station (a small circle with dot in center) and a triangulation point (a small triangle with dot in center). In the "General Instructions for Hydrographic Work," published in 1883, a plate of conventional signs and symbols was included covering some topographic features. These are for the most part the same as shown in figs. 51 and 52, except for the symbols for live oak, cultivated land, and mud, which were omitted from the symbols recommended by the conference. The symbol for a rock awash in the 1883 instructions was three lines crossing, which is the same as the symbol used today (*see* fig. 64). In the "General Instructions for Hydrographic Work," published in 1894, four plates of topographic symbols were included. Two of the plates are identical with figs. 51 and 52, and need no further comment. The other two plates correspond to those included in the Annual Report for 1891 (*see* above), except for the following changes: The symbol for a topographic station was extended to hydrographic stations as well, and the symbol for a triangulation point was changed from a triangle to a triangle with an inscribed circle. Also, the rock-awash symbol was represented by three lines crossing instead of four lines, thus following the symbol contained in the 1883 instructions. Other departures are in the aids to navigation.

71. Of the 1892 symbols not reproduced here (*see* note 70 *supra* and accompanying text), some slight modifications were also made in the windmill symbol (changed to a formé cross), the fence symbol, and the symbol for a road fenced on one side. Also included in the report were nine of the specimen topographical drawings (without color) that were made part of the Annual Report for 1883 (*see* text at note 67 *supra*). In 1900, Special Publication No. 6, entitled, "Notes Relative to the Use of Charts," was published. In it were included five plates of topographic and hydrographic signs. Four of these are identical with the symbols adopted by the topographical conference in 1892 (*see* 465 and figs. 51 and 52), except as modified by the 1898 symbols and the addition of a symbol for "tundra"—similar to a grass symbol (*see* fig. 52), but with the addition of one or two horizontal lines under some of the tufts. (The tundra symbol was not carried in subsequent planetable manuals.) The fifth plate was of hydrographic signs.

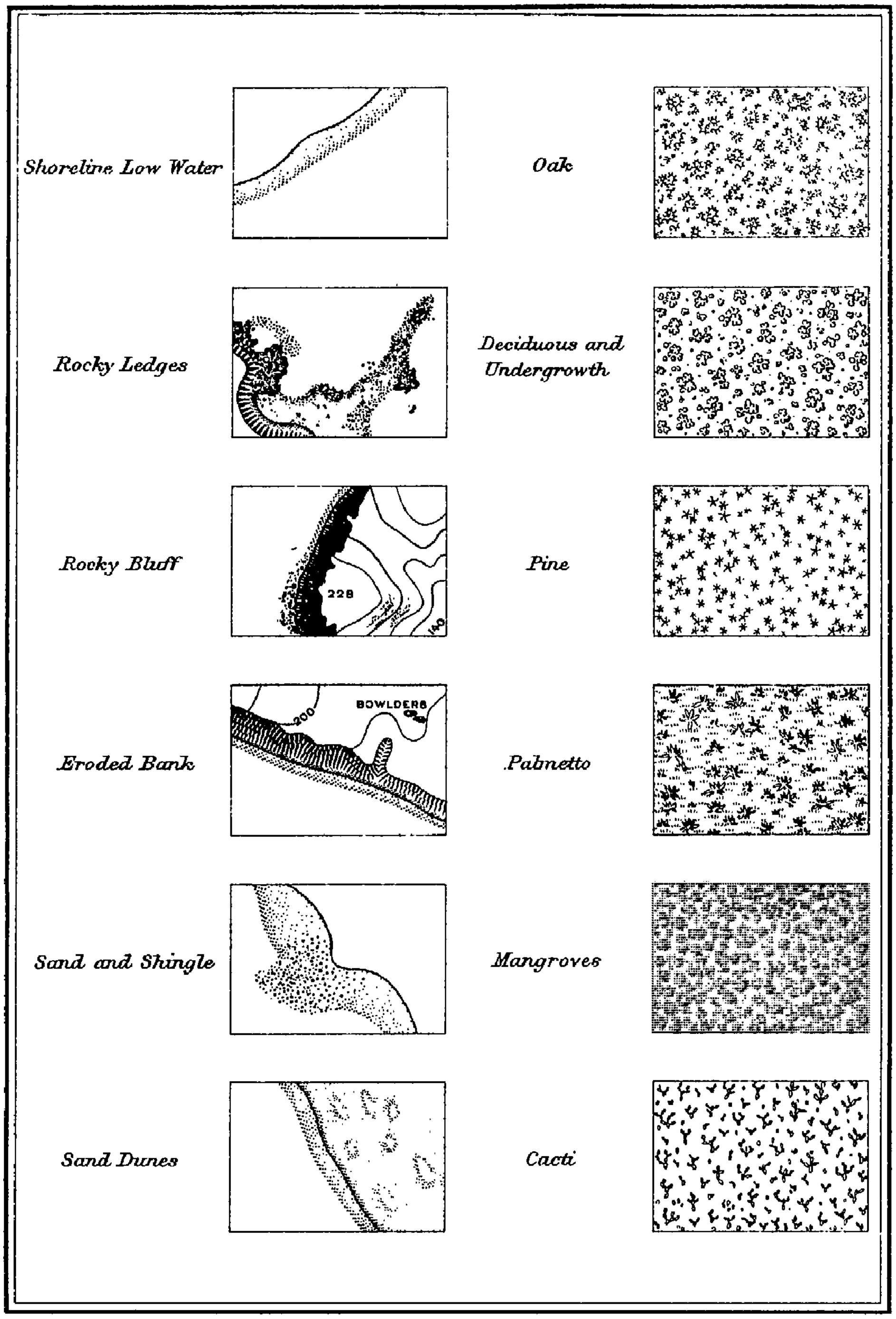


FIGURE 51.—Conventional symbols used in 1892.

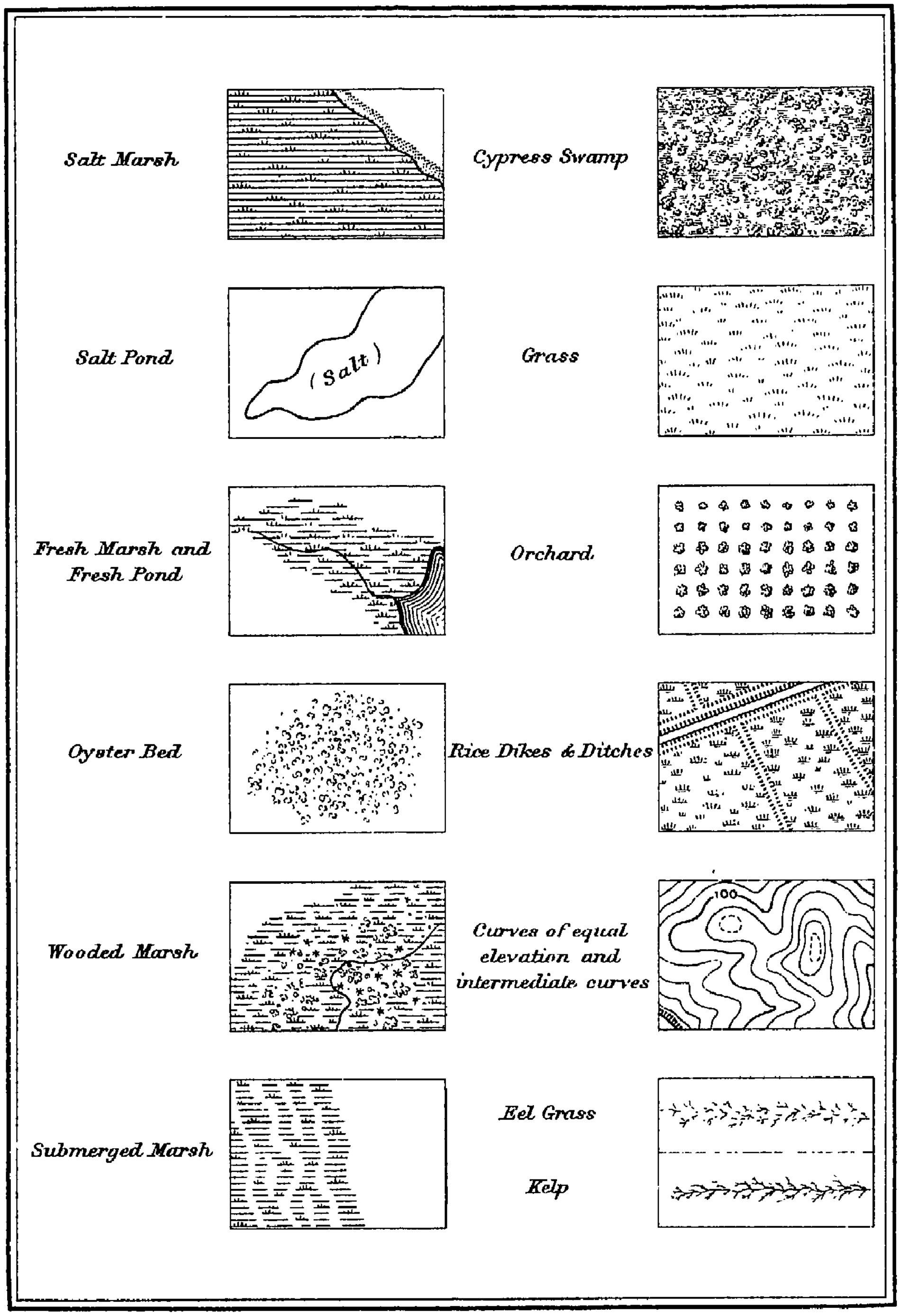


FIGURE 52.—Conventional symbols used in 1892.

published in 1900 (*see* note 71 *supra*), but symbols for "palms," "mud," and a "covering and uncovering rock" (three lines crossing) were added. Also included were nine plates of specimen drawings of topographic features from the 1883 Annual Report (*see* text at note 67 *supra*).[72]

### 468. Conventional Signs (1911)—The United States Geographic Board

The United States Board on Geographic Names was created by President Harrison on September 4, 1890, for the purpose of standardizing usage in regard to geographic nomenclature in the executive departments of the Government, particularly on the maps and charts issued by the various agencies. On August 10, 1906, President Roosevelt enlarged the duties of the board to include advisory powers concerning, among other things, the unification of the symbols and conventions used on maps. Because of the board's broader scope, its name was changed to United States Geographic Board.[73]

In 1911, the board adopted and promulgated a set of conventional signs covering all topographic and hydrographic features shown on maps and charts. This was the first complete set of symbols ever to be published by a government agency.[74] Many new symbols were added and modifications made of existing ones. The symbols for "sand and shingle," "oak," "oyster bed," "rice dikes and ditches," and "tundra" were omitted. The 1915 and 1916 reprints of the 1905 planetable manual (*see* note 72 *supra*) and the 1922 manual (*see* 4121(*d*)) all contained reproductions of these symbols except the special military ones. They are not being reproduced here because they differ but little from those published in the 1928 planetable manual, the last to be issued by the Bureau (*see* 469).

### 469. Standard Symbols (1925)—The Board of Surveys and Maps

President Wilson created the Board of Surveys and Maps on December 30, 1919, for the purpose of coordinating the activities of the various map-making agencies of the Government and to standardize results. The advisory powers

72. The planetable manual of 1905 was reprinted in 1915 (with corrections) and 1916 as separates. The reprints were issued subsequent to the adoption by the U.S. Geographic Board of a set of conventional signs (*see* 468). These symbols were substituted for those in the 1905 revision of the 1899 manual, and are the "corrections" noted on the 1915 reprint.

73. Sixth Report of the United States Geographic Board (1890–1932) V, VI (1933).

74. The symbols were grouped under the following classifications: Works and Structures; Boundaries, Marks, and Monuments; Drainage; Lettering; Relief; Land Classification; Hydrography, Dangers, Obstructions; Aids to Navigation, etc.; and Special Military Symbols.

which had been granted in 1906 to the U.S. Geographic Board (*see* 468) were rescinded and transferred to the newly created board.[75]

In 1925, the board published a set of "Standard Symbols" following the classification system of the Geographic Board. The greatest changes made by the Board of Surveys and Maps were in the addition of symbols for aerial navigation and in the extension of the military symbols. With the exception of the latter and a few others not applicable to topographic surveys nor to nautical charts, these symbols were all included in the Topographic Manual of 1928, the last planetable manual to be published by the Bureau.[76] In the symbols pertinent to the subject matter of this publication few changes were made from those in use in 1915 and 1922, the modifications being principally in the addition or abandonment of a symbol for a particular feature (*see* 468). Inasmuch as the 1915 and 1922 symbols are not reproduced in this publication, the following footnote comparisons in the different classifications will provide continuity to the chronology of symbols used in the Coast Survey.[77] The pertinent symbols from the 1928 manual are reproduced here in a slightly rearranged form (*see* figs. 53, 54, and 55).

Another edition of the Board of Surveys and Maps symbols was published in 1932. The only change from the 1925 edition, insofar as the symbols heretofore discussed are concerned, was in the addition of a symbol for "overflowed land" (regularly spaced, horizontal, open lines broken at intervals).

75. Executive Order 3206. Its name was changed to Federal Board of Surveys and Maps by Executive Order 7262 of Jan. 4, 1936. President Roosevelt abolished the board on Mar. 10, 1942, by Executive Order 9094, and transferred its functions to the Bureau of the Budget.

76. SWAINSON, TOPOGRAPHIC MANUAL, SPECIAL PUBLICATION NO. 144, U.S. COAST AND GEODETIC SURVEY (1928).

77. WORKS AND STRUCTURES—*Symbols added:* good pack trail, narrow gage railroad, railroad crossing, ford trail, telephone line, cliff dwellings, abandoned canal, canal lock (large scale), and intermediate bench mark. *Symbols discontinued:* metaled wagon road, railroad station, telegraph line along road or trail, infantry and cavalry ford, hospital, post office, telegraph office, waterworks, and city, town, or village. DRAINAGE—*Symbols added:* probable drainage (unsurveyed) and wells or water tanks. RELIEF—*Symbols added:* contours (approximate only), form-lines (no definite interval), hachures, cuts, fills, mine dump, tailings, and washes. LAND CLASSIFICATION—*Symbol added:* woodland (impenetrable). *Symbol discontinued:* wooded marsh. HYDROGRAPHY, DANGERS, OBSTRUCTIONS—*Symbols added:* breakers along shore, fishing stakes, and coral reef (symbol modified). *Symbol discontinued:* eel grass (symbol for kelp was made applicable also to eel grass). Other symbols under this classification included in the earlier manuals but omitted from the 1928 manual because they do not refer strictly to topographic surveys are limiting danger line, whirlpools and eddies, submerged derelict, cable, currents, no-bottom soundings, and depth curves.

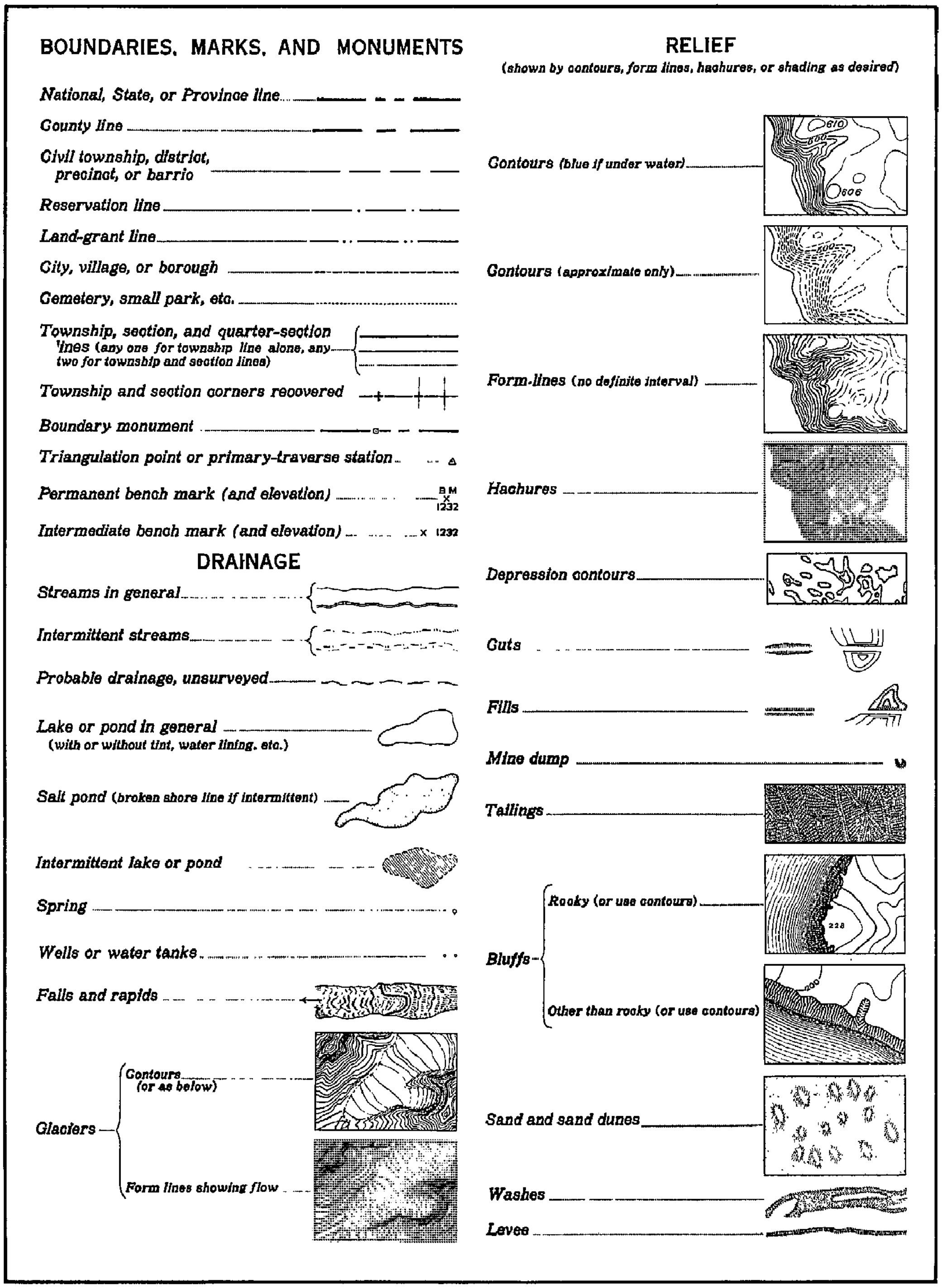


FIGURE 53.—Conventional symbols used in 1925.

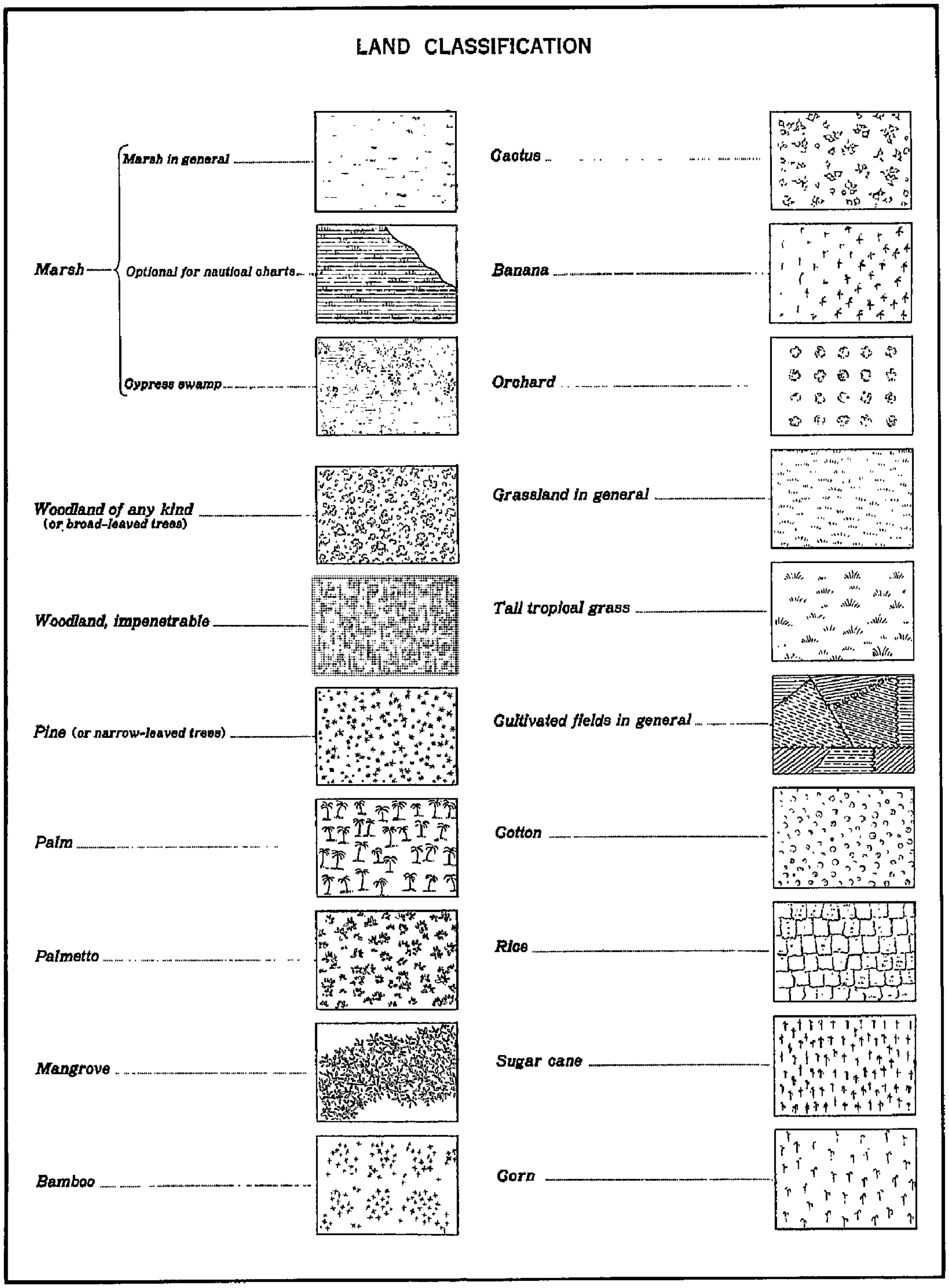


FIGURE 54.—Conventional symbols used in 1925.

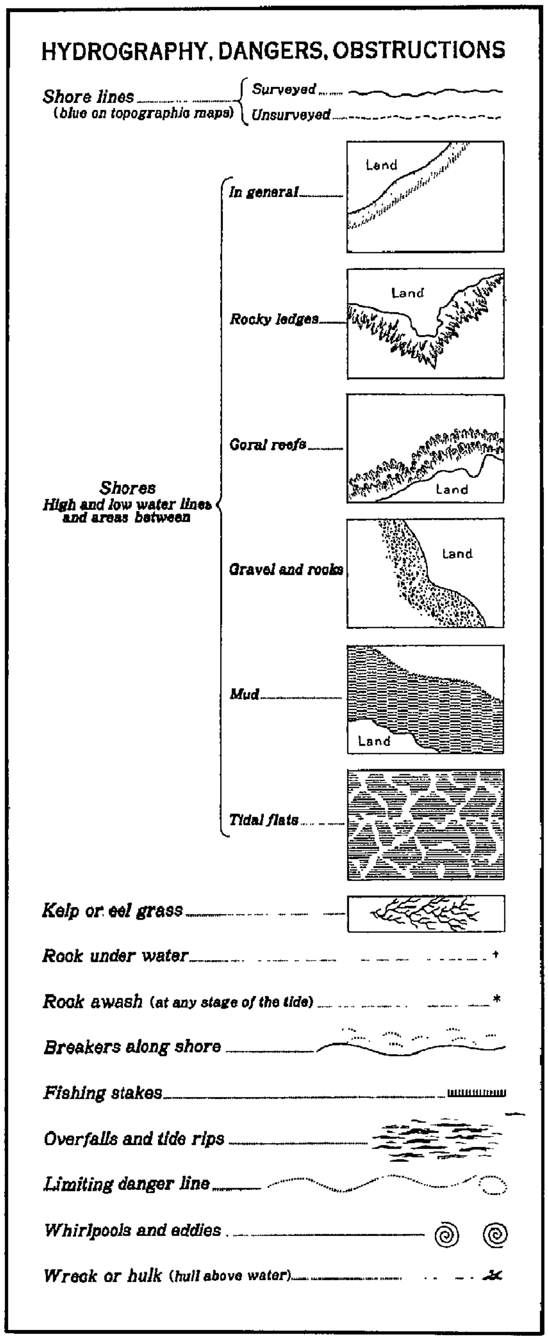


Figure 55.—Conventional symbols used in 1925.

CHAPTER 5

# Analysis and Interpretation of Hydrographic Surveys

## 51. GENERAL STATEMENT

This chapter deals primarily with the early inshore hydrographic surveys of the Coast Survey because it is in this area, and of this period, that most of the problems of interpretation arise. This is especially true when they are used for the establishment of waterfront property boundaries. In the evaluation of these surveys, methods and practices in use at different periods will be described and analyzed, and these will be tied in with particular surveys. But it should be borne in mind that complete uniformity in all the surveys of a given period was never fully achieved, so that the practice as evidenced by a cited survey in the text is not necessarily representative of all the surveys of that period and variations will generally be found. Nevertheless, it does indicate a practice that was in use, and to that extent will assist in a better understanding of the practices and procedures as developed through the years.

Except for the very earliest period of the Bureau's work, there were always certain standards of accuracy to which the work had to conform. If the work was done at all, it was done with that accuracy. But accuracy must not be confused with detail. For example, the absence of soundings in a particular portion of a hydrographic survey would simply mean that no soundings were taken there, possibly because it was not considered of sufficient importance to navigation to justify surveying it, or for some other reason. But where soundings are shown, it can be assumed that they are just as accurately taken, although perhaps not as complete where no navigation is possible, as they are in the main channel.

Broadly speaking, hydrographic surveying may be defined as the process of developing upon a survey sheet all that portion of the earth's surface which lies beneath the water. It aims to delineate with accuracy the submerged contour lines of channels, banks, and shoals, in a manner similar to features delineated by topography on the visible land, and to collect specimens of bottom material and water samples. It also includes that part of physical hydrography which takes into account tide and current phenomena, and in the modern surveys it embraces temperature and salinity characteristics of the water insofar as they relate to the accurate measurement of depth by echo sounding.[1]

Although the hydrographic surveys of the Coast Survey are made principally for use in the construction and maintenance of nautical charts, they have many collateral uses. Both the high- and low-water lines are frequently of importance in establishing political and civil boundaries; an accurate knowledge of the foreshore is essential for successful amphibious operations; and offshore surveys extending over the continental shelves and slopes are continually revealing significant underwater features which serve as landmarks for the navigator and provide scientific information of value to oceanographers, geologists, marine biologists, and other students of the earth sciences.

The hydrographic survey is in many respects similar in character to the topographic survey (*see* fig. 56). The delineation of the sea bottom may be regarded as the survey of a series of shorelines occasioned by successive changes in elevation of the water level, but with this important distinction: The plane-table topographer maps the visible portions of the terrain, always using the land before him as a model, whereas the hydrographer maps features concealed from his view. The hydrographic engineer must therefore rely upon his experience and knowledge of bottom formations in order to determine the best plan of development for a given area (*see* note 9 *infra*) so that no important feature will go undetected.

1. The velocity of sound in sea water is a function of the temperature, salinity, and depth of the water through which the sound impulse passes. Echo-sounding instruments are calibrated for a standard velocity and any variation from the actual velocity is applied as a correction to reduce the observed depth to true depth. During the period between 1924 and World War II, when a method known as Radio Acoustic Ranging was developed and used in offshore surveying for the determination of the survey vessel's position (*see* fig. 7), temperature and salinity observations were also necessary for the computation of the horizontal velocity of sound. ADAMS, HYDROGRAPHIC MANUAL 556, 573, SPECIAL PUBLICATION No. 143, U.S. COAST AND GEODETIC SURVEY (1942). The latest Hydrographic Manual was published in 1960 as "Publication 20–2," under a new numbering system (*see* note 24 *infra*). Since then a number of changes have been made in the text, these being designated as "Change No. 1 (April 1, 1963)." The pages affected have been reprinted in 1963 and are available from the Government Printing Office in packet form. The manual is now designated as "Third (1960) Edition" (*see* note 22 *infra*). Although obsolete in many respects, due particularly to rapid developments in hydrographic control systems and echo sounders, the 1942 manual is still an excellent reference work (*see* 537). In subsequent sections, wherever reference is made to present practice, the 1960 manual will be cited, but, wherever pertinent, references will also be given to the 1942 manual.

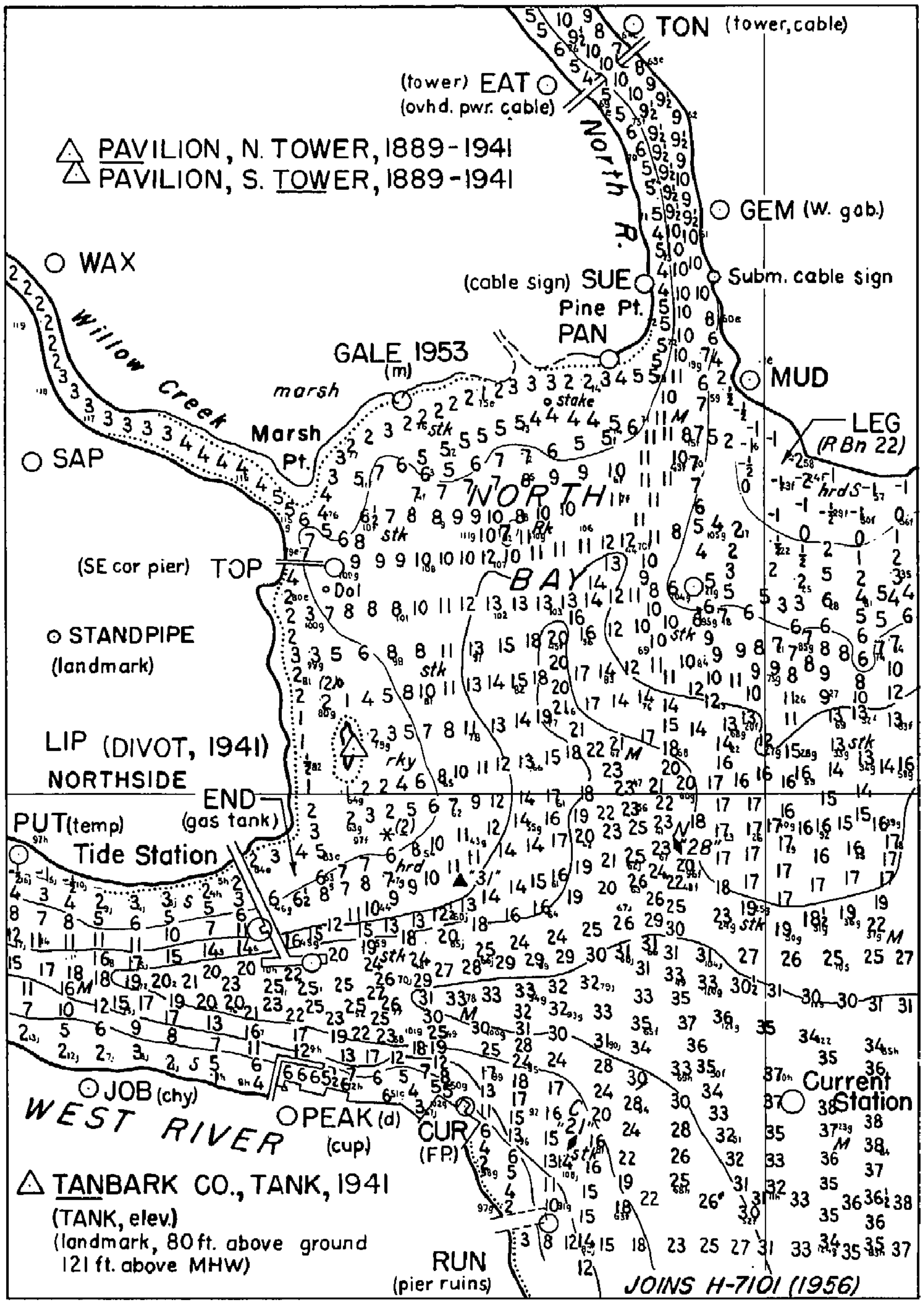


Figure 56.—Black and white copy of section of completed hydrographic survey showing specified plotting of topographic and hydrographic detail.

## 52. FIRST HYDROGRAPHIC SURVEY

The first hydrographic survey by the Bureau was made in 1934 (Register No. H–44), at a scale of 1:10,000, and covered the area of Great South Bay, Long Island, N.Y.[2] The sounding lines consist generally of a number of zigzag lines running between points on opposite shores, or radial lines from an anchored position of the survey vessel to points on shore. The spacing of lines are approximately 500 meters apart, and by modern standards would be considered as of no more than reconnaissance value.[3] No identification numbers for boat's positions are shown nor are the days of operation distinguished. (The sounding records for this survey could not be found and it was not possible to determine what method of identification was used nor how the boat's positions were ascertained.)[4] A geographic grid is shown on the sheet in pencil and the actual lines of the triangulation system are also shown. The high-water line is a transferred line from the contemporary topographic survey and the area between the high- and low-water lines is sanded. There are indications on the survey that the latter line was determined by soundings but none were plotted. All soundings are given in feet, the maximum being 44 feet, but only the 6-foot depth curve (a dotted line) is traced. (On Register No. H–45 (*see* note 4 *supra*), both the 6- and 12-foot depth curves are shown, the latter by a series of double dots.) A few bottom characteristics are given. The plane of reference is stated as "approximate mean low water," but this was added at a later date.

This survey, with some variations, can be considered as typical of the hydrographic surveys of the period. The first written instructions for hydrographic work had not yet been issued (*see* 53) and much in the way of procedures was no doubt left to the judgment of the individual hydrographer. This

2. Normally, the first hydrographic survey would have been indexed as Register No. H–1, but for some reason, not apparent now, this number is assigned to a later survey, made in 1837. The earliest survey filed in the Bureau archives as an original survey is Register No. H–1961 (1817). This is a replotting, on a reduced scale (1:20,000), of the survey of Boston Harbor made by the Navy Department. There is no absolute certainty when the plotting was done, but the "Comparative Map of Boston Harbor, Massachusetts" (Register No. H–1960 (1846–53))—which includes the survey of 1817 (in red), selected soundings from Register No. H–221 (1846–48), and other soundings—states that it was "Executed in the Office of the U.S. Coast Survey for the U.S. Commissioners on Boston Harbor" in 1860. The presumption therefore is that Register No. H–1961 (1817) was plotted some time prior to 1860.

3. Register No. H–7800, covering the same area and surveyed in 1950, has an average spacing of 100 meters for the general sounding lines and about one-third this spacing in the channels. This is an excellent example of a modern survey in which due regard has been paid to the development of important areas, such as channels and the low-water line, and would be of value for many collateral uses.

4. On Register No. H–45, which is a replotting in 1845 of Register No. H–44 but on a smaller scale (1:20,000), position numbers are shown in red and the identifying day letters by various shapes. The title note for the survey states it was plotted from the original notes.

was the early, formative period of the Coast Survey. Hydrographic methods had not yet been standardized nor were the importance of keeping lucid records fully appreciated. It is therefore not infrequent to find on some of the early surveys long lines of soundings controlled by few boat's positions, no record kept of the time of taking soundings in between positions, and a failure to reference the plotted work with the sounding volumes. This makes it extremely difficult at times to identify a plotted line of soundings in the original records. But some of the early surveys gave full identification information ( position numbers and day letters) and even included the date of survey on some of the lines (Register No. H–47 (1835)).[5]

## 53. INSTRUCTIONS FOR HYDROGRAPHIC WORK

For a correct evaluation of the early surveys, a knowledge of the field and office methods used and the changes made during different periods is essential. The early instructions for hydrographic surveying furnish the best source material for such evaluation. Because many of these are no longer available for distribution, they will be examined in this chapter and those matters pointed up that will assist in a better understanding of the early surveys. These will include such matters as standards of accuracy for soundings, methods of control for hydrographic surveying, planes of reference, low-water line delineation, and symbolization.

For the interpretation of the more recent hydrographic surveys, that is, those made since the early 1920's, when echo sounding was first introduced, the published manuals, which are still extant and to which reference will be made, can be used as guides. Where germane, present-day practices will be contrasted with earlier ones.

### 531. Earliest Instructions (*Circa* 1844)

The earliest instructions for hydrographic work were in manuscript form, of which the following is a copy:[6]

5. Often, in studying early surveys, a trial-and-error method of identification must be resorted to. By recording the sequence of soundings in question on a sheet of paper, a corresponding sequence is searched for in the sounding volumes.

6. The instructions, neither dated nor signed, are filed in the volume (17) of correspondence marked "Coast Survey, Scientific, 1844–1846."

706–026 O–64–16

THE SOUNDING SHEETS OF THE COAST SURVEY
TO BE FILLED UP IN THE FOLLOWING MANNER

1st. The projection parallels and meridians corresponding to the locality to be surveyed to be ruled and numbered.

2nd. The points of triangulation to be laid down from the manuscript tables and names printed.

3rd. The shore line and such plane table points and houses and ranges as may be useful in sounding to be transferred preserving the plane table names—when names are not given on the plane table sheet—those given in the sounding book to be placed on the sheet. All the topography may be omitted.

4th. The line of soundings to be so disposed as to render it probable that no inequalities in the bottom have been overlooked, and to extend to the low water line/except in the soundings of the coast/—The soundings to be reduced to the lowest water observed during the survey—The curve of the low water line to be drawn and the space between it and the high water line to be dotted. All shoals bare at low water to be dotted in the same manner—The curve at every fathom to be traced up to 4 fathoms—the character of the bottom to be marked with soundings. The position of beacons and ranges and buoys at ebb and flood to be marked—the set and drift of the tides to be shown particularly in the channel ways.

On the margin of the chart insert

The plane to which the soundings have been reduced—
The establishment of the port
Rise and fall of tides—/see form/
Magnetic Variation—

Title

U.S. Coast Survey
—— Sup' ——
Sounding Sheet No.
From *point* to *point*
from Jan. —— to Sept. —— 184—
Soundings by ———
Adjusted by ———
(Original)
or
/Copy/

The significant aspect of these instructions is their lack of detail as to method of surveying. Much was left to the judgment of the individual hydrographer who was probably guided to an extent by the methods used in some of the European countries. The preparation of definitive instructions applicable to all survey parties no doubt awaited the experience gathered by the chiefs of party during this early, formative period.

Another item of importance, in evaluating the surveys covered by these early instructions, is the plane of reference used for reducing the soundings—namely, "the lowest water observed during the survey." This plane would be lower than the plane of mean low water which was later adopted for all the surveys along the Atlantic and Gulf coasts. Where a plane other than mean low water was used in the original work, a correction note was usually added to the survey at a later date so the soundings could be brought to the plane of mean low water.

### 532. First Published Instructions (*Circa* 1860)

The first published instructions appeared under the title "General Instructions in Regard to The Hydrographic Work of the Coast Survey (Printed for the Use Only of the Hydrographic Parties)," and were signed by Superintendent A.D. Bache. No publication date appears, but a reference on page 10 to "Coast Survey Report for 1856" and a written date 1861 appearing on page 1, establish these as the limiting dates of publication, with 1860 as the probable date.[7]

The instructions consist of 28 printed pages, in a 6- by 9-inch format. References are made within the text to Appendixes 1 to 11 and to Plates 1 to 11 as accompanying the instructions, but in the only copy now available these are not included.[8]

Although in condensed form by comparison with later manuals, these instructions contain a considerable amount of detail with respect to soundings and tides.

From the standpoint of evaluating surveys of this period, it is important to note the emphasis that is placed on the sufficiency of soundings to show the configuration of the bottom. It is stated that "The best *test* of whether they are sufficiently numerous is to ascertain if *horizontal curves* can be drawn by them, without leaving doubt as to their direction in any case" (par. 2). It is also

7. In the printed pamphlet entitled "Directions for Observations of Tides" (*see* note 36 *infra*), the authority for the opening paragraph on page 3, which sets out the object of establishing permanent tide stations along the coast, is given as "Genl. Hydrog. Instruc., 1845, Par. 19." No copy of these instructions could be found. It is noted, however, that the published paragraph is practically a verbatim copy of a portion of paragraph 19 of the *circa* 1860 instructions (*see* above). Inasmuch as the tidal pamphlet has no publication date (*see* note 36 *infra*) and the earliest published instructions are also undated, it is concluded that either the "1845" date is incorrect or the instructions referred to are identical with the *circa* 1860 instructions. The fact of the identical language and paragraph number would seem to support the first alternative. This assumption is also borne out by the fact that the varied practices on the surveys made around 1845 do not support the existence of detailed instructions, such as existed in 1860, but rather the existence of generalized instructions as those of *circa* 1844 (*see* 531 and 563).

8. The appendixes refer to printed forms for recording soundings, angles, tides, and currents, and descriptions of tide and current instruments. The plates refer to illustrations of a hydrographic signal, a sounding chair for a steamer, tide gauges, specimen tide curves, current apparatus, conventional signs, lettering, form and size of soundings, forms for describing bottom specimens, and current diagrams. Appendix No. 1 contained printed forms for registering the soundings, angles, etc. These are apparently the "sounding sheets" referred to in the instructions, one or more being taken out for the day's work and placed upon a board for convenience of recording, or bound in a book of the width of half the sheet. These were the original notes of which duplicates were required (par. 18). No record of this form of original notes could be found in the Coast Survey archives and it is possible they were destroyed after being transcribed in another form.

emphasized that the best direction for running lines is in the general direction of the curve and not across it, the reason being that "the changes of depth for a given change of position being then the least" (par. 6).[9]

The sounding accuracy is specified as tenths of a foot to 3 fathoms, with greater latitude beyond and reaching whole fathoms for offshore work. The allowable error at sounding-line crossings was not to be more than 3 percent of the depth, with a limiting error of 5 percent.[10] For sounding in depths up to 15 feet, a graduated pole was used with a disk on the lower end to prevent it sinking into muddy bottom (par. 15). Beyond this depth, the leadline was used. Comparisons of the marked leadline with a measured length were required to be made three times a day for use in correcting the soundings taken during the day.

Reference is made to "*Diagrams* of the work which is laid out, corrected to represent the actual working" (par. 5). This no doubt refers to what is now termed a "boat sheet" (*see* 551) on which the system of sounding lines was laid out in advance of the work and the lines corrected to correspond to the actual running of the lines as the work progressed. This designation was still included in the 1894 instructions (*see* 535).

Three methods of position determination are given: (1) by running out ranges and timing the soundings; (2) by observing angles with a sextant from the boat on three signals; and (3) for offshore work, by measuring angles to the survey vessel with theodolites at two shore stations and, for verification, by measuring the angle at the vessel between the two shore stations.[11]

The section on "Tides" provides for the establishment of permanent tide stations (with self-registering or other forms of tide gages) at suitable places along the coast for the study of tidal phenomena, and of temporary tide stations for use in the reduction of the soundings to the same plane of reference. *Mean*

9. This requirement was eliminated from the 1878 instructions (*see* 533). Subsequent experience has shown that a system of lines normal to the depth curves provides the most convenient and economical development of any area, but it is often advantageous to adopt some other system for various reasons. The selection of the most appropriate systems is governed by the type of control used, the configuration of the area, and its location with respect to an anchorage or base of operations. Three systems of sounding lines are in general use—parallel straight lines, radiating lines, and concentric arcs (*see* fig. 57). Jeffers, Hydrographic Manual 137, Publication 20-2, U.S. Coast and Geodetic Survey (1960, 3d ed.) (*see* note 1 *supra*).

10. This requirement, it is stated, is based on "Observations made expressly for the purpose have shown that in the smooth water and moderate depths of harbors the accuracy attainable is to fractions (say tenths) of a foot, and in off-shore soundings to fractions of a fathom" (par. 2).

11. The method of observing theodolite angles from stations on shore and measuring verification angles on the boat was used in the early surveys for inshore work. *See*, for example, Register No. H-106 (1840), where the sounding record contains notations on accidents to the flag signal, missing angles taken from the vessel, and occasions when the angles were only taken on shore at the times given by the vessel. *See also* H. Rept. 43, 27th Cong., 3d sess. 38 (1843).

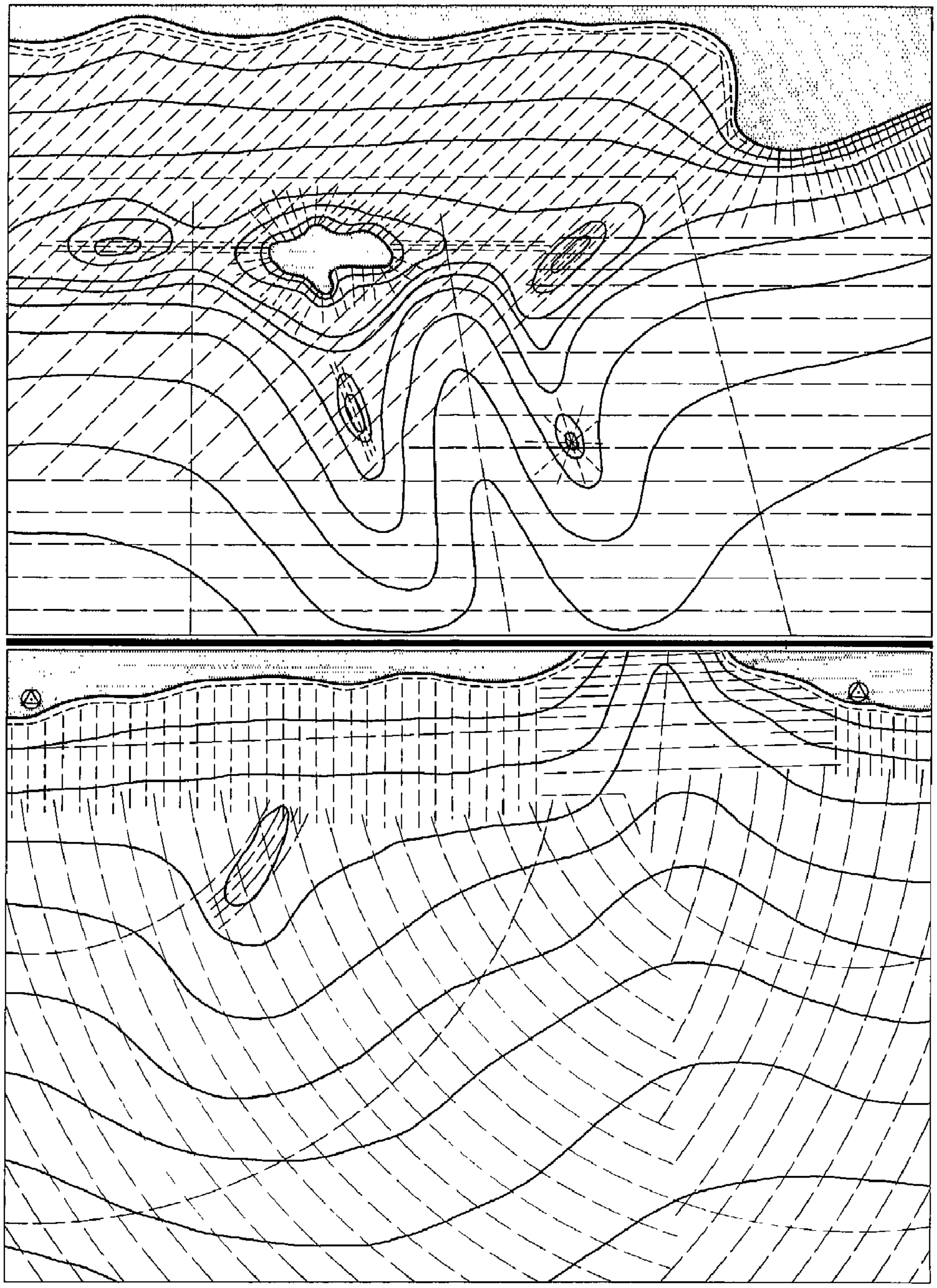

FIGURE 57.—Systems of sounding lines for developing underwater features. The solid lines represent depth contours and the broken lines represent appropriate systems of sounding lines for the various conditions encountered.

*low water* is specified as the plane of reference except on the Pacific coast where the *mean of the lowest low waters* was to be used (par. 26).[12]

Under the section on "Office Work," it is stated that "The original note books of observations, and the duplicates, should be *bound* and *lettered* according to the specimens of the work of 1845" (par. 67). These specimens could not be traced, but it is possible that the field parties used sheets in the form of unbound note books which were later bound in a permanent volume. It is also stated that every "finished" hydrographic sheet when turned into the office must show "The lines of soundings, with the angles marked to distinguish them from the soundings" and with identification letters for the day of the month and numbered in reference to the day, the soundings to be in black and the angles and references in color (par. 72*d*).[13]

The requirement for depth curves was to show the 6-foot curve in green, the 12-foot curve in red, and the 18-foot curve in blue, all to be shown as continuous lines (par. 72*e*). (This color scheme has been continued to the present day.) The requirement was also for the shoreline to be shown in a continuous black line if obtained from the topographic survey, and in a broken line if sketched by the hydrographic party (par. 72*c*). (This practice was still followed in 1894.)

Shoals bare at the plane of reference were to be shown with their heights above the plane (par. 72*i*). This general instruction was variously interpreted by the field parties, and soundings above the plane were shown on the smooth sheets in at least three different forms (*see* 5613).

Of additional interest in these early instructions are the references to trolling for rocks with a single boat or with two boats (par. 9), to obtaining bottom specimens and preserving them in small vials in order "to trace the formations along the coast in which particular kinds of *soil* occur" (par. 16),[14] and to obtaining the correct geographic names in an area (pars. 48 and 49).

12. On several surveys made around 1858 and thereafter along the Pacific coast, the plane of reference is noted as the mean of the lowest low waters of each 24 hours (*see* 5642). This has been interpreted to be the same as mean lower low water for all practical purposes (*see* Descriptive Report for Register No. H–464 (1853)). This practice was apparently continued until the issuance of the 1878 instructions (*see* 533, and note, for example, Register No. H–1340*a* (1876) and Register No. H–1508 (1881)).

13. As far as could be determined the instruction for showing the angles at positions was not universally adhered to. This requirement may have been intended to refer to the position numbers and day letters only. A similar provision was included in the 1878 and 1883 instructions but was omitted from the 1894 instructions. The instruction for "binding" and "lettering" the original note books appears to have been followed (*see* 553), but the originals were the only ones generally retained and are now in the Coast Survey archives. One case of the "duplicate" soundings was found, this being for Register No. H–268 (1851). This volume is also marked "Fair Journal" (*see* 5531) and is identical with another volume marked "Original Soundings." All entries in these volumes are in ink.

14. This provision was included in the later instructions through those for 1894.

## 533. Instructions of 1878

Although these instructions are titled "General Instructions in Regard to Inshore Hydrographic Work," they actually cover offshore work as well (par. 146). In general they are an attempt at greater standardization, with some earlier procedures modified. They were issued during the superintendency of Carlile P. Patterson. In commenting on these instructions, cognizance will be taken only of those items that fall within the purpose of this publication, pointing up significant departures or additions from previous instructions.

A section on "The Projection" was added and included information on the recovery of triangulation stations, on the erection and location of signals for hydrography, on the naming of signals, and on the method of recording angles used in fixing the location of signals. The projection was generally furnished by the Washington Office and included the shoreline and triangulation and other forms of control points. Triangulation points were indicated by a point enclosed in a triangle and all other control points (topographic or hydrographic) were indicated by dots inclosed in circles (par. 2). Black ink was presumably used for all such symbols, but this was not specified. Reference is made to "angle books" in which all angles taken for locating signals were to be entered as well as those taken from shore stations for locating the position of the survey boat while sounding (par. 13). Additional signals that were located by "cuts" during the sounding work were to be recorded in the sounding volume and later transcribed into the angle book.

In the section on "Soundings," emphasis is placed not only on the location of the dangers to navigation but also on the development of the bottom configurations as an aid to the mariner in recognizing his position by casts of the lead.[15] Four systems of sounding lines are described and illustrated to replace the system described in the 1860 instructions (*see* text at note 9 *supra*).

More detailed information than was contained in the 1860 instructions is given for limits of error at sounding-line crossings based on observations made expressly for the purpose.[16]

A subsection on "Minus Soundings" (par. 26) was included for the first time. This applied to both shoals and flats and therefore took in the low-water

15. This idea would seem to be the forerunner of the present-day method of depth-contour charting (*see* 6241).

16. Lines of soundings at their crossings were not to exceed, "in depths of 15 feet and under, two-tenths of a foot; between depths of 15 and 30 feet, three-tenths; 30 and 48 feet, five-tenths; between 48 and 72 feet, three-fourths of a foot; between 72 and 96, one foot and a half; and between 96 and 150 feet, two feet. In the sea-depths the limit of error should not exceed 1 percent. With proper care and close attention, these limits of error are quite attainable." (Par. 19.) This was continued in the 1883 instructions.

line. Soundings over these areas were to be taken at or near high water and all soundings above the plane of reference (heights) were to be shown as "minus soundings." (*See* 5613.)

Angles for position were to be observed often enough to insure that the line preserves its direction. This included position angles at the beginning and ending of a line, and whenever a marked change in depth or change in course occurred (par. 47).

As in the 1860 instructions (*see* note 8 *supra*), reference is made to printed forms for recording soundings, etc., in "books of a width of one-half the sheet." Details are given for making the various entries, including the angles observed for locating the boat's position while sounding. Soundings were recorded in "feet and tenths" or "fathoms and feet." [17]

Identification of the sounding lines were better standardized. Each day's work was assigned a day letter, using capital letters in color for the vessel and lower-case letters of different colors for the boats (*see* Register No. H–1573 (1883)). The requirement of showing the observed angles at positions (*see* note 13 *supra*) was still continued.

Under the section on "Tides," the plane of reference for soundings is given as the mean of all the low waters for the Atlantic and Gulf coasts, and the mean of all the lower low waters for the Pacific coast. (This was carried into the 1883 and 1894 instructions). The latter is a modification of the requirement in the 1860 instructions which called for the mean of the lowest low waters (*see* note 12 *supra,* and accompanying text).

The field plotting of the "finished" hydrographic sheet (now termed the smooth sheet (*see* 552)) is covered in the section "Plotting of Work During the Surveying Season." The requirement was for each plotted position to be marked by a prick point to permanently establish its exact location, the point being enclosed by a small circle, using red ink for the vessel's work and for each boat's work the color corresponding to its letter. The identifying number for each position was to be shown and the day letter given at least for the beginning and end of each line and where there was a change in course. The soundings, day letters, and position numbers were all to be left in pencil. (Par. 140.)

17. This form of sounding record, and method of recording, was continued in the 1883 instructions (*see* 534) except that no reference is made to "books of a width of one-half the sheet." Essentially, it was the same form that was used up to the publication of the Hydrographic Manual in 1942 when some changes were made to reflect new methods of sounding and position determination, and for other reasons. One of the changes made was in the order of recording the angles in three-point fix hydrography when instead of recording the right angle first and then the left angle, the reverse order was adopted. ADAMS (1942), *op. cit. supra* note 1, at 764. This is also the practice in 1963. JEFFERS (1960), *op. cit. supra* note 9, at 170.

## 534. Instructions of 1883

These instructions were titled "General Instructions for Hydrographic Work" and were issued during the superintendency of J. E. Hilgard. The principal difference between these and the 1878 instructions is the addition of a section on "Reports, Accounts, etc."

Under the section "Soundings," greater detail is given for making leadline comparisons with a measured distance. Standard markings for the leadline up to 20 fathoms and for the deep-sea line beyond were also included for the first time. A method was also given for running sounding lines on exact ranges (par. 47).

In the section on "Office-Work," a third hydrographic sheet, called a "sounding-sheet," is referred to for the first time for use in plotting the soundings each day so the chief of party could keep track of the work and lay out the next day's work. The boats' positions each day were transferred from the "boat-sheet" by tracing paper, and approximate reductions for tide used in case the plane was not yet established (par. 143).[18] Mention was also made of a "working-sheet" for the first time (pars. 140 and 148), which also seems to be the same as the "boat-sheet" and the "diagram" previously referred to, and of "fair journals" which were part of the records submitted by the field party (par. 153).

Duplicates of all records were required but these were not sent to the Washington Office until receipt of the originals was acknowledged (par. 157).

In addition to the new section on "Reports and Accounts," which was not included in the previous instructions, there were added for the first time a short section on "Deep-Sea Sounding Record," a table of bottom abbreviations (par. 158), and a page of "Conventional Signs and Symbols."

## 535. Instructions of 1894

The 1894 instructions were titled "General Instructions for Hydrographic Parties" and were issued under the superintendency of T. C. Mendenhall.

18. Apparently, the three sheets were: (1) the "finished" hydrographic sheet on which the final plotting of positions and soundings was made (par. 141) and turned into the office (this corresponds to what is now called a "smooth sheet" (*see* 552)); (2) the "boat-sheet" (this is the first mention of the term in any of the instructions for hydrographic work) on which apparently only the boat's positions were plotted showing the different sounding lines; and (3) the "sounding-sheet" (mentioned in the text) on which the soundings were shown. (The "boat-sheets" referred to in par. 143 would seem to be the same as the "diagrams" referred to in par. 21, otherwise it would have meant that four sheets were required. It is noted, however, that the term "boat-sheet" is not mentioned in the 1894 instructions, but "diagrams" and "sounding-sheets" are.) This practice of having a "sounding-sheet," while still mentioned in the instructions of 1894, was later departed from and the "boat-sheet" was used for plotting the soundings as well. The "sounding-sheet" referred to in these instructions was apparently something different from that referred to in the 1860 instructions (*see* note 8 *supra*).

They were the last to be issued in this form, as separate instructions for hydrographic work, until the first "Hydrographic Manual" was published in 1928 (*see* 537). Except for some differences, which will be noted in subsequent paragraphs, and the addition of sections dealing with certain administrative aspects of the work, the instructions are essentially the same as those of 1883.

One of the changes made from previous practice (*see* 533) was to designate a triangulation station by a dot surrounded by a black circle which in turn was inscribed in a red triangle. All other points were to be represented by dots enclosed in small circles, using red ink for those of topographic origin and blue for hydrographic origin. (Par. 2.)

In the section on "Soundings," four additional systems of running sounding lines are described and illustrated—a system of radial lines for use in searching for rocks and for development of bars, a system for developing an outlying rock, a system for developing an awash shoal or sand bar, and a system for developing a shoal that is under water (par. 19*e, f, g, h*).

An important addition was made to the instructions for hydrographic work by incorporating the following rules for the reduction of soundings, preparatory to plotting (par. 24):

1. The reduction for tide to the nearest tenth of a foot will be entered in the sounding book in its appropriate column.

2. The soundings will be taken with sufficient accuracy, depending upon the depth of water, to enable them to be reduced as follows, viz:

*A*. Deep-sea soundings—to nearest fathom.
*B*. Outside 15 fathom curve—to nearest half fathom.
*C*. Between 15 and 10 fathom curves—to nearest foot.
*D*. Between 10 and 4 fathom curves—to nearest half foot.
*E*. Between 24 and 12 foot curves—to nearest quarter foot.
*F*. Inside 12 foot curve—to nearest tenth foot.[19]

It was also stated that the admissible percent of error at sounding-line crossings was a maximum of 1.5 percent of the depth at that point. This was based upon observations made in smooth water (par. 25).

An addition to the previous instructions was the requirement that the chief of party compare his work with existing charts and publications to make certain that rocks and shoals have either been verified or disproved (par. 32).

A modification from previous instructions was the use of the sounding pole for depths of 10 feet or less instead of a limiting depth of 15 feet (par. 39).

A specimen of sounding pages for a leadline survey was also included. For the depths shown (3 to 6 fathoms), the soundings were entered in fathoms and

19. Occasionally, when a survey was made for a special purpose all depths were plotted in feet and tenths (*see* Register No. T–2196 (1895) which is a combination topographic and hydrographic survey of Port Orchard, Wash., for the Navy Department).

feet, the tide reducers in feet and tenths, and the reduced soundings in feet and tenths. (This is somewhat contradictory to the requirement given in *D* and *E,* above, which calls for a sounding accuracy that would permit the soundings to be reduced to the nearest half foot and quarter foot, respectively.)

Reference is no longer made to a "boat-sheet," but the "working-sheet," the "sounding-sheet," the "finished-sheet," and the "diagrams" are still mentioned (*see* note 18 *supra*). Several additional plates of conventional symbols are included.

In addition to the colors previously prescribed for the 6-, 12-, and 18-foot depth curves, brown is prescribed for the 24-foot curve, and purple for the 30- and 60-foot curves (par. 168*n*).

### 536. General Instructions for Field Work (1908, 1915, 1921)

Between 1908 and 1928, the instructions for hydrographic work were part of a volume covering all field work of the Survey. Three such volumes were issued—in 1908, 1915, and 1921. The first was titled "General Instructions for the Field Work of the Coast and Geodetic Survey." The last two carried similar titles but were further identified as Special Publication No. 26.[20] These were complete rewrites of the previous instructions, but the procedures by this time were fairly well standardized and fewer changes are noted in successive instructions.

#### 5361. *Instructions of 1908*

In the 1908 instructions, the following essential additions or departures were made:

(*a*) Position angles were required to be observed at sudden changes of depth, at all changes of course and of speed, when the boat gained full headway, and when the boat slowed down in approaching shoal water (pars. 230–232). These requirements were intended to give greater certainty to the locations of the soundings on the sheet so as to avoid irregular and improbable depth curves.

(*b*) A new form of sounding record was introduced but actually it represented but little change from the previous one (par. 259(*b*)).

(*c*) The practice of duplicating records was eliminated, except when specially directed (par. 263). References were no longer made to "diagrams," "sounding-sheets," or "working-sheets," but only to "boat-sheet" (par. 283).

(*d*) Soundings were to be recorded generally in fathoms and integral feet, and "only in exceptional cases need fractions of feet be recorded" (par. 264).

20. The 1921 issue is labeled as the second edition of Special Publication No. 26. Some copies were printed with a 1920 date on the cover but with an identical authority date (Mar. 1, 1921). As far as could be determined the two volumes are the same in every respect and the 1920 date must be presumed to be in error.

(*e*) In the reduction of soundings, certain changes were made—tide reducers and leadline corrections to be entered to tenths of feet, but the latter could be omitted if not more than one-half of 1 percent of the depth; reduced soundings to be entered to the nearest foot, ordinarily omitting decimals; tide reducers to be omitted for depths over 50 fathoms except where the range of tide was in excess of 2 percent of the depth; and for important critical soundings depths could be plotted in feet and fractions (par. 277).

(*f*) The planes of reference to be used for soundings on the various coasts were specified with particularity for the first time as follows: the mean of the low waters for the Atlantic and Gulf coasts and for Porto Rico; the mean of the lower low waters for the Pacific coast, Alaska, and the Hawaiian and Philippine Islands; 2 feet below the mean of the lower low waters for Puget Sound; and 3 feet below the mean of the lower low waters for Wrangell Narrows (pars. 279–281).

(*g*) Boat's positions were no longer to be indicated by small circles but by pen dots in color (par. 293).

(*h*) The low-water line was to be indicated by a dotted line and minus soundings were to be enclosed within this dotted line, the sanding of the area between high and low water being specifically prohibited (par. 286(*c*) and (*d*)).

(*i*) Colors were prescribed for additional depth curves extending to 1,000 fathoms. Some change in colors were made from previous practice—the 24-foot curve to be shown in yellow, the 30-foot curve in red, the 36-foot curve in green, and the 60-foot curve in yellow. (Par. 288.)

(*j*) The depth units for plotting the soundings were prescribed as follows: all soundings to be in feet only, except in deep water when fathoms could be used, but the whole of any one sheet had to be in one unit (par. 303). (The latter was a significant change from previous practice.) On sheets plotted in feet no fractions were to be shown except that in critical places on navigable bars and in channels fractions of feet (¼, ½, and ¾) could be shown where important (par. 304). On sheets plotted in fathoms, quarter fathoms could be used to 7 fathoms and half fathoms from 7 to 10 fathoms (par. 305).[21]

(*k*) Use was made for the first time of the term "smooth sheet" instead of "finished hydrographic sheet," as formerly used (pars. 284, 285, 290).

(*l*) For lines beginning or ending near the shore the requirement was that the estimated distance in meters to the shore, reef, or breakers be stated (par. 259(*e*)). This was the first appearance of this requirement, although it was generally required that a distance be estimated where no position angles were obtainable.

## 5362. *Instructions of 1915*

The 1915 instructions were for the most part a verbatim reprint of the 1908 instructions. Some new provisions were added, others modified or amplified, and still others omitted. Of the changes made, the following bear on the interpretation of hydrographic surveys:

(*a*) In the reduction of soundings, greater detail is given for the entry of tide reducers. Thus, tide reducers for depths over 7 fathoms or for open ocean areas were to be entered

21. When plotting in feet, fractions less than 0.8 were omitted, and those of 0.8 or more were plotted as the next whole foot. Rules were also given for converting fractions. Thus, when plotting in quarters, 0.1=0, 0.2 and 0.3=¼, 0.4 to 0.6=½, 0.7 and 0.8=¾, and 0.9=1; when plotting in halves, 0.1 to 0.3=0, 0.4 to 0.7=½, 0.8 to 1=1; when converting from feet to fathoms and quarters, less than 1 foot=0, 1 foot and less than 2.5 feet=¼ fathom, 2.5 feet and less than 4 feet=½ fathom, 4 feet and less than 5.5 feet=¾ fathom, and 5.5 feet and over=1 fathom; when converting from feet to fathoms, for less than 4.5 feet=0, and 4.5 feet and over=1 fathom (par. 306).

in the sounding record to integral feet;[22] on bars and over inside water areas for depths less than 7 fathoms but more than 3 fathoms, to nearest half foot; and for depths of 3 fathoms or less, to the nearest tenth of a foot. The reduced soundings were to be entered in integral feet except on developments in less than 40 feet at critical points where the reductions were to take account of the fraction of a foot. (Par. 313.)

(*b*) The limiting depths for plotting fractions of feet or fathoms are given in greater detail as follows: feet and fractions at critical points in extensive enclosed waters and inside routes with 2 to 5 feet of water or less, but to whole feet at other places; fathoms and sixths to depths of 6⅚ fathoms; fathoms and quarters from 7 to 8¾ fathoms; and for greater depths in whole fathoms (par. 337). In critical places (under 40 feet) on navigable bars, in channels, in shallow enclosed waters, and in inside routes quarter feet were shown (par. 338).

(*c*) Where the first position of a sounding line was taken when the boat was at rest, an additional position was called for after an interval of 1 minute or when the boat had attained sounding speed (par. 354).

## 5363. *Instructions of 1921*

The 1921 instructions showed very few departures from those of 1915. The changes that were made have no special bearing on the interpretation of inshore hydrographic surveys except for the addition of yellow as the color for the zero curve when determined by soundings, and the provision that the 24- and 36-foot curves were to be omitted except in special cases (par. 321).[23] A small change was also made when converting feet to fathoms: for depths less than 4.9 feet, the fraction was dropped and for 5 feet and over the next whole fathom was used (par. 338). (*See* note 21 *supra.*) A change was made in the plane of reference for Puget Sound from 2 feet below the mean of the lower low waters to the mean of the lower lows (par. 315). The exact sizes of the symbols for the various control points are specified and black ink is specified for the names of triangulation points. The section on typical errors to be considered in studying discrepancies in the work (par. 353) was greatly expanded from the 1915 treatment.

22. This modified the 1908 instructions allowing tide reducers to be omitted for depths over 50 fathoms where the range of tide was less than 2 percent of the depth. The practice in 1963 calls for the omission of all corrections to soundings of over 101 fathoms where the algebraic sum of the tide correction and other corrections, excluding velocity corrections, is less than one-half percent of the depth. For depths less than 101 fathoms, special rules are applicable depending upon the depth range and character of the area or bottom. JEFFERS, HYDROGRAPHIC MANUAL 174 and Table 2, PUBLICATION 20–2, U.S. COAST AND GEODETIC SURVEY (1960, 3d ed.). Subsequent citations to this manual will omit the edition reference but should be understood to reflect the changes to Apr. 1, 1963 (*see* note 1 *supra*).

23. In the instructions, the zero curve is designated as the "mean sea-level curve," which was clearly an error and should have been "plane-of-reference curve." This was corrected in the Hydrographic Manual of 1928. This scheme of depth-curve colors is generally in use today except that the zero (plane-of-reference) curve is shown in orange and some intermediate curves have been added and colors are prescribed for depth curves extending to 3,000 fathoms. *Id.* at 15 and Tables 3 and 4.

### 537. The Hydrographic Manuals

Beginning with 1928, the instructions for hydrographic work were published under the title of "Hydrographic Manual." Three such manuals have been issued to date—in 1928, in 1942, and in 1960. The 1928 manual is identified as Special Publication No. 143 and went through a 1931 reprint and a 1935 reprint in the form of "Errata and Addenda" inserts. It is divided into two parts: Part 1 covers "General Requirements for Hydrographic Work," and Part 2 "Equipment and Methods Used for Hydrographic Work."

The Hydrographic Manual of 1942 was labeled a "Revision" and retained the same Special Publication number as the 1928 manual. Actually it was a radical departure from the previous one, being more comprehensive in scope and designed to serve not only as manual but as textbook for the new methods of hydrographic surveying then developed, or being developed, and for which there was a scarcity of published material. It contains 940 pages and is one of the most complete manuals ever published by the Bureau.

The 1960 Hydrographic Manual (identified as Publication 20–2 under a new numbering system) [24] was issued to reflect the many new developments in hydrographic control systems and in echo-sounding instruments which made the 1942 manual out of date in many respects. Although parts of the previous manual were carried forward into the 1960 text much useful information was not repeated. The 1960 manual is printed in loose-leaf form so that changes or new material can be added as necessary in an expeditious manner. (*See* note 1 *supra.*)

## 54. MAKING AN INSHORE HYDROGRAPHIC SURVEY

The work of actually surveying the water area on a given project usually followed the establishment of the triangulation control and the completion of the topographic mapping. Both of these operations furnished the latitudes and longitudes of the stations that were to be used in the hydrographic work for locating the boat's positions during the progress of the survey.

24. Beginning with Jan. 1, 1957, a new numbering system for Bureau publications was inaugurated based on identification of class of subject matter covered. The entire scope of Bureau activities is divided into 13 categories and all publications issued in a particular category carry the same numbered prefix. The prefix is followed by the number of the publication, each category having its own range of numbered publications. The word "Special" is no longer used in the designation. "General publications of Bureau-wide scope" are in the "10" category, "Hydrography" is in the "20" category, etc. Thus, the designation for the Hydrographic Manual of 1960 is "Publication 20–2," which indicates it is the second publication in the "Hydrography" category. *Change in Numbering of Bureau Publications,* 7 Journal, Coast and Geodetic Survey 121 (1957).

A working sheet (now termed a boat sheet) was prepared on which a projection (meridians of longitude and parallels of latitude) was laid down, the triangulation points plotted, and the high- and low-water lines and secondary control points transferred from the planetable survey. Occasionally, additional control stations were established by the hydrographic party. These were usually located by means of sextant angles from "cuts" taken in the boat or from angles at the station. The observed angles were either entered in the sounding volumes or in a separate angle book.[25]

Proposed sounding lines were plotted in pencil on the working sheet in accordance with a planned system designed for most effective development of the bottom features. The hydrographer attempted to follow these lines as he progressed with the work.

A typical field party, engaged on inshore hydrography and sounding with a leadline, usually consisted of the following: two engineers (one to direct the operations) to measure the angles for locating the survey boat's positions; a leadsman to take the soundings; a recorder to record the soundings and the observed angles; and the necessary crew to operate the boat. (*See* fig. 58.)

There are two essential operations in the prosecution of every hydrographic survey, both of which are carried on simultaneously: (1) the measurement of depths (soundings), and (2) the determination of the geographic positions (latitudes and longitudes) of the soundings so that they may be charted in correct relation to each other and to the surrounding topographical features.

### 541. Measurement of Depth

Various methods of measuring depths of water have been used in the hydrographic work of the Bureau. These included the use of a graduated pole for depths to 10 or 15 feet, the handlead and marked line for depths up to 15 fathoms, pressure tubes between 15 and 90 fathoms (Register No. H–4547 (1926)), various types of mechanical sounding machines for depths beyond the handlead limit, and echo-sounding devices for all depths.[26]

25. Different symbols were used for the different categories of control, but with no great consistency in the early years for a given category. Thus, triangulation stations have been variously shown by black triangles, by red triangles, by red triangles circumscribing black circles, by two concentric black circles (Register No. H–15 (1837)), by red circles (Register No. H–1437 (1879)), and by needle points alone without any symbols (Register No. H–44 (1834)). Topographic stations have been designated by black circles and by red circles, and hydrographic stations by black circles and blue circles. The modern practice is to use red triangles for triangulation stations, small red circles for topographic stations, and small blue circles for hydrographic determinations, and small green circles for stations spotted fom aerial photographs. Jeffers (1960), *op. cit. supra* note 22, at 206 and fig. 79.

26. In the survey of the Potomac River in 1959, a 16-foot sounding pole was used for all shoal-water sounding from the shore to a depth of 8 to 10 feet.

FIGURE 58.—Sounding with a handlead and line from a whaleboat in a survey of Baltimore Harbor on November 7, 1900.

Since this publication deals primarily with the early surveys of the Bureau and this chapter considers in the main inshore hydrographic work, leadline surveys only will be discussed.

The handlead and line consisted of a suitably graduated line (in fathoms and feet) to one end of which was attached a lead weight called a sounding lead, the bottom of which was scooped out to receive tallow or soap for picking up specimens of the bottom while sounding.[27]

Before the advent of the gasoline engine and the steam vessel, pulling boats and sailing vessels were used in hydrographic work. In measuring depths, the leadsman usually stood on a small platform, which projected over the side of the sounding boat, and while the boat was proceeding at slow speed he heaved the lead forward far enough so that when the lead struck the bottom it was vertically below him and he was able to obtain an accurate reading of the depth from the markings on the line. When the water surface was broken by waves or swells, the leadsman estimated the mean water level so that the depth as read was from the mean surface. (*See* fig. 58.)

27. Changes in the line caused by stretching or shrinking during the sounding operations were accounted for by applying corrections to the measured depths after comparing the leadline with a standard measure (*see* text following note 10 *supra*).

542. Determination of Position

As with the measurement of depths, various methods have been used in the past for determining the position of the sounding boat or the survey vessel (and in turn the soundings) while engaged on hydrographic work. There is a striking similarity between the development of position-fixing methods in the Coast Survey and the development of depth-measuring methods. Both have retained earlier methods, have discarded intermediate ones, and have reached a climax in the utilization of sound (in the case of depths) and electronics (in the case of positions) for their determination. These methods included, for the early period, sextant angles taken in the survey boat upon three stations on shore, theodolite angles taken at two shore stations upon a flag hoisted in the boat and measuring the angle in the boat between the two shore stations for verification, and by running out ranges from shore and fixing the positions by time (*see* 532).[28] These methods were still included in the 1894 instructions, but subsequently the 3-point fix method was primarily used, the method of angles from stations on shore being reserved only where extreme accuracy was demanded, as in harbor improvement surveys.

In the early years of the Bureau's history, when the Nation's commerce was carried in comparatively small, shallow-draft, sailing ships, it was unnecessary to extend the surveys offshore into deep water. With the advent of the steamer, however, and its subsequent increase in size, draft, and speed, the early requirements were radically modified, and the emphasis gradually shifted from shoal to deep water. The determination of position became more difficult and complicated. Many factors had to be taken into account which could be ignored when in sight of shore signals. This gave rise to a method of position determination known as "Dead Reckoning" which resembled very much the method used in navigation.

In 1914, and the years following, a more precise method of dead reckoning was developed and was termed "Precise Dead Reckoning." Every known element affecting the vessel's position was carefully observed by the survey party: the deviation of the compass, the effect of the wind in pushing the vessel sidewise through the water, the careful calibration of the log for the determination of distance, and, above all, the frequent observations for current to determine its velocity and direction. But notwithstanding the many precautions that were taken, there were still enough indeterminable factors to make

28. In the earliest instructions for hydrographic work (*see* 531), no mention is made of the method of position fixing, but in the volume (17) of early correspondence marked "Coast Survey, Scientific, 1844–1846," notice is taken that one of the methods used is to observe angles on the boat from two stations ashore (*see* note 11, *supra*). On Register No. H–268 (1851), the sounding lines were run between shore signals with the distances from the signals noted at the beginning and ending of the lines.

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the results anything but precise. In consequence, later surveys have revealed occasional errors in the earlier work of as much as 5 miles in the location of some of the offshore depth curves.[29]

With the advent of echo sounding in the 1920's and the realization of their great potential in aiding the navigator to better determine his position, more precise methods were developed for position fixing—for example, a buoy-control method and the method of Radio Acoustic Ranging (R.A.R.). During and following World War II, the latter two methods were replaced by electronic methods, to wit: Shoran, Electronic Position Indicator (E.P.I.), and Raydist.[30] But for the close inshore work, the 3-point fix method is still resorted to.[31]

## 543. The Surveying Operation

Having determined the system of sounding lines for best coverage and laid it down on the boat sheet, the hydrographic party starts work at any convenient point in the area to be surveyed. The two observers with sextants in hand, the recorder with a watch or clock and record book, and the leadsman with his "leadline," take their respective positions in the boat. The officer-in-charge directs the recorder to make a note in the sounding record, say, as follows: "Line begins at position 1, about 5 meters from shore." The observers measure

29. This method was first described in Seran, Precise Dead Reckoning in Offshore Soundings, Special Publication No. 73, U.S. Coast and Geodetic Survey (1921). Its later use in conjunction with other methods is described in Adams (1942), *op. cit. supra* note 1, at 232–238. The present use of dead reckoning in hydrographic surveying is described in Jeffers (1960), *op. cit. supra* note 22, at 198. In comparing such surveys with later, more accurate surveys, it is important to keep these limitations in mind, in order to avoid erroneous conclusions regarding changes in the ocean bottom. Unless the earlier survey can be correlated with the later survey by the superposition of characteristic submarine features, no intelligent deductions would be possible. Even on the dead-reckoning survey alone, exaggerated underwater slopes may be indicated as a result of soundings on successive lines not being in correct relationship due to the variation in the elements encountered on different lines. This is especially true when attempts are made to combine data from different sources subject to the same or even greater uncertainties. The relationships may become so complex as to challenge even approximate analysis. An excellent example of this is the outer Hudson River submarine canyon. Until accurately controlled surveys were made in the 1930's, this important physiographic feature was represented on the charts and in physiographic studies by an S-shape, an interpretation resulting from inaccuracies in locating the earlier soundings which connected the part of the valley immediately below the 50-fathom depth curve with the lower part of what turned out to be an entirely different declivity. *See* Patton, *The Physiographic Interpretation of the Nautical Chart,* 5 International Hydrographic Review 205, 218 (May 1928), and Smith, *Submarine Valleys,* 10 Field Engineers Bulletin 150, U.S. Coast and Geodetic Survey (1936).

30. The buoy-control and R.A.R. methods are described in Adams (1942), *op. cit. supra* note 1, at 109 *et seq.* and at 555 *et seq.*, respectively. Shoran and E.P.I. are described in Burmister, *Electronics in Hydrographic Surveying,* 1 Journal, Coast and Geodetic Survey 3 (1948), and Raydist is described in Hickley and Bolstad, *ER-Type Raydist System of Position Control,* 7 Journal, Coast and Geodetic Survey 45 (1957), and in Fish, *Raydist on Georges Bank,* Technical Bulletin No. 5, U.S. Coast and Geodetic Survey (1959). The present use of Shoran, E.P.I., and Raydist in hydrographic surveying is described in Jeffers (1960), *op. cit. supra* note 22, *passim.*

31. *See* Register No. H–8152 (1954–1955) where Raydist was used to within 1 mile of shore and the 3-point fix method from there inshore.

with the sextants the two angles between three signals on shore, the middle signal of which is common to both angles, and read the angles so measured;[32] the leadsman measures the depth with the leadline and calls out the number of feet, or fathoms and feet; and the recorder enters all these in the sounding record together with the time. The boat starts ahead at a constant speed on the predetermined course, and position angles are taken every 3 or 4 minutes, or as frequently as necessary, and soundings taken at every 15 to 20 seconds, or at irregular intervals where the depths are changing rapidly, the time of each sounding being noted to seconds. This procedure is continued until the end of a line is reached and the boat is maneuvered to a new line where the routine is repeated. As position angles are observed, the officer-in-charge plots each position on the boat sheet which enables him to make the necessary changes in course so as to follow the predetermined line.[33]

It is a fundamental principle in hydrographic work that the boat must maintain a straight line between adjacent positions and that if a change in the boat's direction is to be made a position must be taken at the time of change (*see* 533). In plotting the soundings, therefore, the assumption is made that the boat followed a straight course between consecutive positions, unless otherwise noted in the record.

When a sounding line ended or began near shore, it was customary to note in the record the estimated distance from shore, in addition to the observed position angles. This served as an independent check on the accuracy of the shoreline as surveyed by the topographer because the boat's position is deter-

32. For measuring angles from a moving boat, no handier instrument has ever been devised than the sextant. It is so called because a true sextant encompasses one-sixth of a circle, or 60°. Based on the optical principle on which the instrument is constructed, namely, that when a ray of light undergoes two successive reflections in the same plane, the angle measured is actually twice the angle through which the index arm has passed. Therefore, the markings are doubled at the time of manufacture. Thus, the 5° graduation is marked 10°, 10° is marked 20°, etc. The maximum horizontal angle that can be measured with a sextant is thus approximately 120°. The instruments, almost universally known as sextants, are actually quintants, constructed for the measurement of angles up to 144° or slightly larger. To measure the horizontal angle between two objects, the observer sights directly on the one on the left and brings the object on the right into coincidence with the one on the left by moving the index arm as needed. The angle is then read on the graduated limb. For a detailed description of the sextant and its use, together with the principle of its construction, *see* ADAMS (1942), *op. cit. supra* note 1, at 361–372. A briefer account of the sextant, including the micrometer drum type (a modern development), and its use in hydrography is given in JEFFERS (1960), *op. cit. supra* note 22, at 45 (*see* fig. 59).

33. The instrument universally used for plotting three-point sextant fixes is the three-arm protractor (metal or celluloid) (*see* fig. 60). It is in reality a graphic solution of the three-point problem and was in use at a very early date in the Coast Survey. It is referred to in the instructions for hydrographic work published around 1860 (par. 57) (*see* 532). It consists essentially of a graduated circle with a fixed center arm and right and left movable arms pivoted at its center so that the extension of each fiducial edge always passes through the precise center of the graduated circle. The observed left angle is set with the left arm and the right angle with the right arm. The protractor is then placed on the plotting sheet so that each arm passes exactly through the corresponding control station that was used in the measurement of the angles, that is, the center arm is made to pass through the center station, the left arm through the left station, and the right arm through the right station. The center of the protractor then marks the position of the sounding boat or vessel.

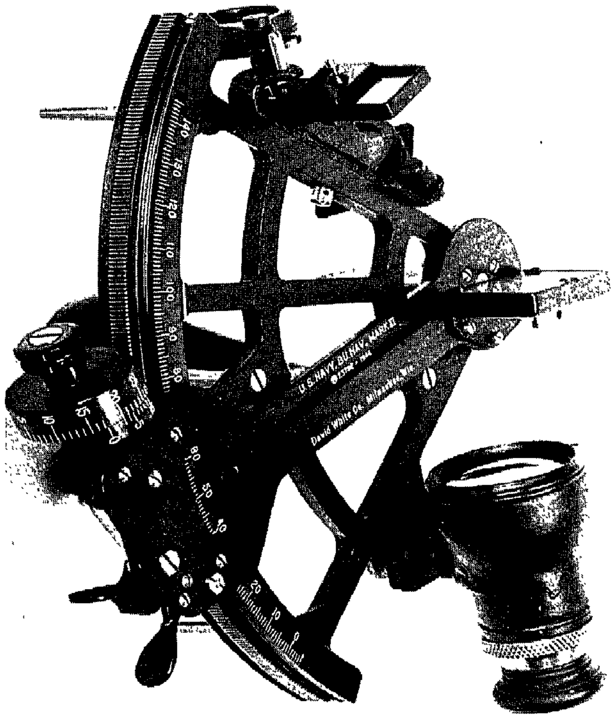

FIGURE 59.—Micrometer drum sextant with endless tangent screw.

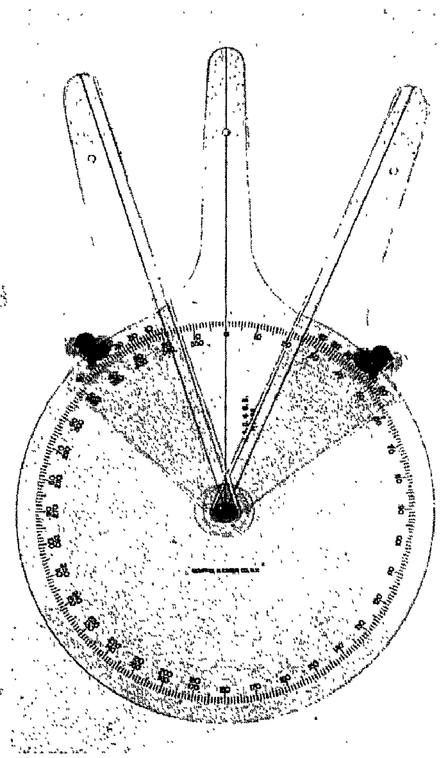

FIG. 60.—Three-arm plastic protractor.

mined by a different method, namely, by angles to objects that are often on the opposite shore. Any inaccuracy became apparent in the relative position of the boat to the shore. Also, if the boat was aground at the end of the line, or if the line ended on the beach, such notes were usually entered in the record. In marsh area, these were helpful in interpreting the nature of the marsh with respect to the planes of high or low water (*see* 4432).

During the progress of the survey, while soundings were being taken, the leadsman noted the character of the bottom either by "feel" or by bringing up small specimens that clung to the tallow on the bottom of the lead. The recorder entered in the sounding record notations such as hard, soft, sandy, rocky, grassy, or the like, as the case might be.

As a check on the accuracy of the work, most hydrographic surveys contain a number of sounding lines that intersect the main system either at right angles or at an oblique angle. When all soundings are reduced to the same plane of reference, the soundings on one system must agree, within certain limits, with the soundings which they cross on the other system, otherwise the work is revised.[34]

While the survey has progressed, the water has not maintained the same level due to the rise and fall of the tide, which is a continuing phenomenon. Soundings are entered in the sounding record as measured from the water level without regard to the height of the tide (*see* fig. 61). Each sounding as recorded is therefore corrected for the height of the tide at the time in order to refer the depth to the sounding datum or reference plane. If this were not done, uncorrected soundings shown on the hydrographic survey or on the nautical chart would be no more than a group of numbers without significance or coordination (*see* 564). Tide observations are therefore always made in conjunction with the hydrographic work.[35] They are obtained from readings on a tide staff or from an automatic tide gage operated during the progress of the survey (*see* Part 1, 2312, 2314).[36]

Tide observations serve a two-fold purpose: they provide the data for defining the plane of reference for the area, and furnish the data for determining the height of the tide at any time with respect to that plane. With this information, it becomes a simple matter to derive the corrections to be applied to the recorded soundings to reduce them to depths below the plane of reference. Thus, the plane of mean low water is derived by averaging all the low waters observed on the tide staff or on the automatic tide gage (*see* Part 1, 2312). If this represented a reading of 3 feet on the staff, then a sounding of 12 feet obtained at a time when the water level registered 8 feet on the staff—5 feet above the plane of reference—would have to be reduced by

34. On some of the hydrographic surveys, two systems of parallel lines were run in regular checkerboard fashion (*see* Register No. H–2229 (1895)).

35. This was always a requirement. There are some isolated exceptions as, for example, Register No. H–106 (1840), where no register of tides was kept and an arbitrary value was used for the height of high water above the sounding datum and the soundings corrected accordingly.

36. Instructions for tide observations were issued under the title "Directions for Observations of Tides," and carried the notation "Printed for the Use of the Tidal Observers from the Manuscript Instructions, 1852." This date is interpreted to be the date when the manuscript instructions were issued, rather than the date of publication of the pamphlet (*see* note 7 *supra*).

*Early Tide Observations.*—The first self-registering tide gage used by the Coast Survey is described in Appendix 38 to the Annual Report of 1853. The longest continuous tide records available from any one station are those from the Presidio at the entrance to San Francisco Bay and date back to July 1897, but the earliest automatic gage to be established was at Governor's Island, N.Y., and was kept in operation during the winter of 1844–1845. *See* Annual Report, U.S. Coast and Geodetic Survey 315 (1897). The earliest tide observations of any kind made by the Bureau were those of 1834 when a staff was established at the Lighthouse Wharf at Fire Island Inlet in Great South Bay, N.Y., in connection with the survey of the bay (*see* 52). The observations covered the period from Oct. 22 to Nov. 27, 1834. Copies of tide observations made in 1833–1835 in Cape Cod Bay and at Race Point, Mass., are on file in the Bureau archives, but it is not certain whether these were made by the Coast Survey, or by the Bureau of Topographical Engineers who made the hydrographic survey (*see* Map File, Accession No. 645). On a survey of a portion of San Francisco Bay (Register No. H–2246 (1895–1896)), five tide gages were used to control the area.

*Locality* COAST OF MAINE

*Date* JULY 23 1958

16-48145 2

| POSITION NUMBER | TIME MER 75 (h. m. s) | SOUNDINGS FEET ~~FATHOMS~~ | SOUNDINGS TENTHS | CORRECTIONS ~~LEAD LINE~~ ECHO FEET FATHOMS | CORRECTIONS TIDE REDUCER FEET FATHOMS | CORRECTIONS FEET FATHOMS | REDUCED SOUNDINGS FIELD FEET FATHOMS | FIELD TENTHS | OFFICE FEET FATHOMS | OFFICE TENTHS |
|---|---|---|---|---|---|---|---|---|---|---|
| 157 | 15 26 00 | 78 | | -0.5 | -2.5 | 0.0 | 75 | | | |
| | 20 | 70 | | | | | 67 | | | |
| | 40 | 62 | 5* | -0.4 | -2.4 | -0.2 | 59 | 5 | | |
| | 27– | 53 | 0 | | | | 50 | – | | |
| | 20 | 42 | 5 | | | | 39 | 5 | | |
| | ½ | 37 | 0 | | | | 34 | – | | |
| 158 | 40 | 40 | 5 | | | | 37 | 5 | | |
| | 28– | 32 | 0 | -0.4 | | | 29 | – | | |
| | 20 | 21 | 0 | -0.2 | | | 18 | 2 | | |
| | ⅓ | 8 | 4 | 0.0 | | | 5 | 8 | | |
| | 40 | ~~16~~ 13 | 5 | -0.2 | -2.4 | | 10 | 7 | | |
| | 29– | 11 | 5 | | -2.2 | -0.2 | 8 | 9 | | |
| 159 | 20 | 10 | 5 | -0.2 | | 0.0 | 8 | 1 | | |
| | 40 | 6 | 0 | 0.0 | | | 3 | 8 | | |
| | 30– | 4 | 5* | | | | 2 | 3 | | |
| | | 7 | 5 | 0.0 | | | 5 | 3 | | |
| 160 | 20 | 10 | – | -0.2 | -2.2 | | 7 | 6 | | |
| 161 | 16 57– | 12 | 2 | -0.2 | -0.8 | 0.0 | 11 | 2 | | |
| | | 12 | 0HL | | | | 11 | 2 | | |

*Sublocality* FRENCHMAN BAY

*Boat used* LAUNCH 182 ; d day

| BOTTOM / HEADING BY Boat COMPASS | POSITION NUMBER | POSITION CONTROL DATA | REMARKS |
|---|---|---|---|
| 010 | 157 | Leg 51 40 | Phase meter 60.1 |
| | | Nay 4 | Adjusted to 60.0 |
| | | Ole 24 03 | |
| | | Kim-Nay 32-16 | Cut to check |
| | | | ⊙ Kim |
| | | | * A scale |
| 005 | | | |
| | 158 | S 74 51 | |
| | | 30 51 | |
| | | | Nun No.2. 30m. port. |
| | | | Adjusted initial |
| | 159 | Got 52 45 | 51.S. Entering |
| | | Leg | Kelp |
| | | Ole 101 44 | |
| | | | *RK. bare 2ft. 10 |
| | | | m ~~oo~~ Kim. |
| | | | Leaving Kelp |
| | 160 | Leg 77 11 | Line breaks to |
| | | Ole | Search shoal. |
| | | Par 84 58 | |
| RK. | 161 | Leg 34 09 | Least depth on |
| | | Nay | sharp pinnacle RK. |
| | | Ole 63 55 | Item No.4 of |

presurvey review. Searched area with leadlines for 1hr. & 20 min. Bottom not visible. Scattered Kelp in surrounding area.

Figure 61.—Sounding record of echo soundings with three-point fix sextant control. (Double page of sounding record reduced about one-half.)

5 feet to obtain the depth of water below the plane of reference. A depth of 7 feet would therefore be shown on the survey sheet and on the nautical chart.

## 55. TERMS ASSOCIATED WITH HYDROGRAPHIC SURVEYS

In the use and interpretation of hydrographic surveys, it will be helpful to know the meaning and significance of certain terms associated with such surveys, particularly where they are to be used in waterfront boundary litigations. These terms will be explained in the light of present practice, with references to earlier practice where a significant difference exists.

### 551. The Boat Sheet

The name "boat sheet" is given to the work sheet which the hydrographer uses in the field during the survey operations for plotting the details of the work as it progresses. Its use enables the hydrographer to cover an area with lines of soundings in a systematic and economic manner, to judge the adequacy of the survey, and to ascertain where additional soundings are required.[37] The boat sheet is prepared in advance of beginning the actual hydrographic operations. It resembles the "smooth sheet" (*see* 552) and contains the same kind of information (*see* 54), but is necessarily less accurate because of the haste with which the positions are plotted, the use of predicted tides for reducing the soundings, and the exposure to which the sheet is subjected.

The second important function of the boat sheet is its use as a guide in the plotting and verification of the smooth sheet, and as an aid in clarifying uncertainties which may arise at such times. Occasionally, when a conflict cannot be completely resolved, a boat position may be transferred from the boat sheet to the smooth sheet and used in place of the recorded data on the theory that the hydrographer being in the boat at the time of the survey knew his position and plotted it on the boat sheet in accordance with the known facts. Often, the boat sheet contains supplemental details and notes which aid in interpreting the sounding records and which should be transferred to the smooth sheet.

The boat sheet is retained during the verification and review of the smooth sheet and for sometime thereafter. Eventually it is destroyed.

37. The first reference to "boat sheet" as such was in the 1883 instructions for hydrographic work (*see* note 18 *supra*), but there is reason to suppose that some form of work sheet was used from the earliest date. The "sounding-sheet," also first mentioned in these instructions, was in reality a form of boat sheet inasmuch as it was a preliminary to the "finished sheet" (*see* 534).

## 552. The Smooth Sheet

The "smooth sheet" is the name given to the hydrographic survey when reduced to plot form. It is essentially a record of the soundings taken during the field survey, but contains other data necessary for a proper interpretation of the survey, such as depth curves, bottom characteristics, names of geographic features, and control stations.[38] As a rule, the smooth sheet is plotted in the field as the survey progresses or after it is completed, all soundings being left in pencil. After verification and review in the Washington Office (*see* 5521), the smooth sheet becomes the official permanent record of that particular survey. It is as complete for the water area as it is practicable to make it, and subsequent reference to the original sounding records is necessary only for some special investigation. (*See* fig. 56.) In the figure, none of the colors used to represent the different features on the finished smooth sheet are shown (control stations including their names, depth contours, low-water line, and position numbers and day letters). The prescribed colors for these features can be seen by reference to figure 82 of Jeffers (1960), *op. cit. supra* note 22.

### 5521. *Verification and Review*

In the verification process, the hydrographic survey undergoes in effect a complete check of the field observations and of the accuracy of the smooth plotting. A thorough examination is made of the survey data as submitted from the field to ensure that the work has been completed in accordance with the general instructions for hydrographic work and with the specific instructions covering the particular survey. Subsequently, the soundings, bottom characteristics, and other details in the sounded area are inked.[39] The verification deals primarily with a specific survey and its accompanying records, and with correlating it to other contemporary surveys—the hydrographic surveys which adjoin it, and the contemporary planetable or photogrammetric survey. The consideration of prior surveys in the same area is deferred for the reviewing process. In the verification process, the boat sheet is constantly referred to as a check on the protracting and for supplemental details and helpful notes, some of which are added to the smooth sheet. When the verification is completed,

38. In the early instructions for hydrographic work, this is called the "finished" hydrographic sheet (*see* 532). The use of the term "smooth sheet" did not come into being until the instructions for field work were issued in 1908 (*see* 5361(*k*)).

39. In the 1860 instructions for hydrographic work reference is made to the soundings being shown in black on the finished hydrographic survey when submitted to the office (*see* text at note 13 *supra*), but this was modified by the 1878 instructions which required soundings to be left in pencil (*see* 533).

the survey is a complete and accurate record of all hydrographic information currently obtained in the area.

The review of the hydrographic survey is the final step in processing the field data. The survey then becomes available for application to the nautical charts and for many collateral uses.[40]

The purpose of the review is to consider the survey in its broader aspects, to correlate it with all prior surveys of the Bureau covering the same area and with any historical data that may have been received from other sources, and to lay the foundation for future surveys in the area because of indicated changes or inadequate development or for resolving conflicting information. This comparison may involve as many as 25 prior surveys among which may be surveys running back a hundred years or more. Although the hydrographic coverage on the early surveys did not generally measure up to the standards required by modern navigation, the investigation of individual features in many cases showed a remarkable thoroughness. It is not uncommon in unchangeable areas to carry forward to the new survey a shoal sounding from an early survey. Discrepancies between old and new surveys may sometimes be resolved by reference to the old original sounding volumes. This examination may reveal the use of an incorrect shore signal, an interchanged angle, a leadsman's error in reading the markings on the leadline, or an error in the plotting. The aim of the review is to make the survey complete with respect to all information on prior surveys. In comparing early hydrographic surveys with later surveys, it has often been found that apparent discrepancies in the inshore portions of such surveys, where there was no reason to suspect filling or scouring, were due to a failure to allow for a change of speed when the soundings were plotted. This was true in cases where no fix was taken as the boat approached the shore (*see* 5361(*a*)). A replotting of the inshore soundings making allowance for such change in speed corrected the discrepancy.[41]

40. Circumstances may arise where it becomes important to apply critical soundings, or even the entire hydrographic survey, to the nautical chart prior to verification and review. Modern chart practice provides for such contingencies. EDMONSTON, NAUTICAL CHART MANUAL 12, 39, U.S. COAST AND GEODETIC SURVEY (1956).

41. Some form of review of hydrographic surveys must have been practiced at an early period. This is based on the statement in the 1860 instructions (par. 49) which called for a comparison with "Charts made by former authorities" (*see* 532), and the 1894 instructions which called for a comparison by the field party with existing charts and publications (*see* 535). But as an active and systematic office operation it was not begun until the late 1920's and was fully standardized by the middle 1930's (*see* Review contained in Descriptive Report for Register No. H–5546 (1934)). For complete details regarding the verification and review of modern hydrographic surveys, *see* JEFFERS (1960), *op. cit. supra* note 22, at 228–239.

### 5522. *The Basic Survey*

In modern terminology, hydrographic surveys are classified as basic, revision, special, and reconnaissance. Reconnaissance surveys are discussed in 121. Revision and special surveys need no elaboration other than that they are usually confined to a restricted area where, in the case of the first (revision), changes are suspected, and, in the case of the second (special), it is to serve some special purpose. A survey in which additional work is accomplished in a restricted area (*see* 568) is in a sense a revision survey.

A basic survey is fundamental. To be so classified, it must be so complete and thorough that it does not need to be supplemented by other surveys, and it must be adequate to supersede, for charting purposes, all prior hydrographic surveys of the area. It must be adequately controlled by the best practicable means in current use; it must be sufficiently intense to discover and determine the least depths on all dangers to navigation; it must verify or disprove all dangers, critical depths, and other important features appearing on the charts or prior surveys; it must develop significant submarine features that may be useful to the navigator; and it must provide sufficient permanent control so that future revision surveys will require the establishment of a minimum of additional control.[42]

When all of these requirements have been complied with, the survey can be classed as a *basic* survey. However, from an office viewpoint the basic field survey becomes truly basic only after it has gone through the reviewing process (*see* 5521) and comparisons have been made with all prior hydrographic surveys of the area and all conflicts in important features have been resolved, or where impossible of resolution the earlier features have been brought forward to the later survey.

## 553. The Sounding Record

The *sounding record* is the most important record associated with a hydrographic survey. It is the official record of the soundings, and generally of the position data. It was always a requirement that the records be so complete and self-explanatory that it should be possible to be used "by any one acquainted with the subjects of them, without necessity for reference to the chief of party personally." [43]

Sounding records have undergone many changes in both form and detail. The earliest form was indeed crude when compared to the later forms and par-

42. Adams (1942), *op. cit. supra* note 1, at 267, and Jeffers (1960), *op. cit. supra* note 22, at 126.

43. General Instructions in Regard to the Hydrographic Work of the Coast Survey (*circa* 1860), par. 70 (*see* 532).

ticularly to those in use today. For example, the sounding records for Register No. H–15 (1835) exhibit the following characteristics: The entries are crudely made; the recordings on some of the pages run from the bottom to the top; no headings are given for the columns; time is recorded only when angles are taken but not for any of the intermediate soundings, although 20 soundings between positions are not unusual; the only information given on a page is the sounding entry, the tide reducers to half feet, the line number, and the angle number; no reduced soundings are shown; and the paper is of the roughest texture. The page size is approximately 6 by 10 inches and the volume averages 2 to 3 inches in thickness.[44]

Separate volumes were used for recording the angles for locating the boat's positions (*see* volumes for Register No. H–47 (1835)), which at this time were taken from two stations ashore.[45] The greatest difficulty is sometimes encountered in tying in the plotted soundings with the original recordings, which frequently presents a challenge to the engineer's resourcefulness. (*See* note 5 *supra.*)

By 1840, only a slight change had been made in the sounding record (*see* Register No. H–56 (1840)). The format remained the same but headings of "Fath.," "Feet," "Time," and "Angles" were added.

In the 1852 sounding records for Register No. H–336, covering the mouth of the Columbia River, additional headings were added for "Red. for Tide," "Reduced Soundings," and "Bottom" and "Ranges" in the angles column. However, no reduced soundings were actually shown. The book size was changed to 4 by 13 inches.

This form continued generally until the issue in 1894 of the instructions for hydrographic work which required a time entry for every cast of the lead whether sounding at regular or irregular intervals. This was an important addition because it permitted a more accurate plotting of the soundings on the smooth sheet, especially where the bottom was irregular.[46]

44. Based on the character of the information on the back of the sounding volume (a finished lettering job such as would be done in a book bindery) it appears that the original sounding data may have been entered on separate sheets and bound after receipt in the Washington Office.

45. The sounding records and angles for some of the very early surveys may be found to be incomplete and in some cases the records are no longer available (*see*, for example, Register No. H–44 (1834)). The soundings for several sheets were sometimes bound in the same volume which later caused considerable confusion when sounding lines on a survey sheet had to be identified. This may ofttimes account for failure to locate the sounding data for a particular sheet. (The soundings for Registers Nos. H–1 (1837) and H–3 to H–12 (1836–1837) are recorded in the same volume.)

46. The 1878 and 1883 instructions required only the time of sounding to be recorded when sounding at irregular intervals. As far as the actual records are concerned, there is no sharp dividing line for the adoption of this practice. Thus, the sounding records for Register No. H–1573 (1883), in Monomoy Passage, Mass., show times recorded for every sounding, yet those for Register No. H–1728 (1886), in Possession Sound, Wash., show times only when position angles were taken.

By the turn of the century, the form of sounding record was well standardized and no material change was made until publication of the 1942 Hydrographic Manual. This record is designed to give the complete story on the hydrographic operation and is adapted for use in leadline or echo sounding. The big change was in recording the left angle first, then the right angle, instead of the reverse, as had heretofore been done.[47]

The sounding records often contain notes made by the hydrographer at the time of the survey. These may not be reflected on the hydrographic sheet, but may help clarify an ambiguity that might arise many years later when the survey is used for a collateral purpose—for example, defining the low-water line of an early date. The actual depth of water deduced from the sounding records may differ by several tenths of a foot from the plotted soundings because of the rules pertaining to the plotting of fractions (*see* 5622).

### 5531. *Fair Journal*

This term was first used in the instructions of 1883 (*see* 534). It was apparently a smooth copy of the original sounding records and the records used to record the angles taken at shore stations, and may be the same as the duplicate mentioned in the same instructions. Very few of the fair journals are now available, the one examined being of the main ship channel of Boston Harbor, surveyed in 1879, but attached to the records of Register No. H–652 (1858). The size of this journal is 8 by 13 inches.

## 56. SIGNIFICANT FEATURES ON HYDROGRAPHIC SURVEYS

### 561. The Soundings

Without doubt the most important feature on a hydrographic survey is the soundings (or depths), for that is the purpose for which the survey is made. By means of the soundings, the locations of channels, of shoals and other dangers to navigation, and of characteristic formations of the bottom topography are determined. They are always shown in black ink on the smooth sheet. There has never been any departure from this practice, except in the case of transferred soundings from an adjoining contemporary survey or from an early survey (*see* 5522), "minus soundings" on some of the early surveys (*see* 5613), and

47. Adams (1942), *op. cit. supra* note 1, at 764 and fig. 172. The latest form of sounding record is essentially the same but with some slight modifications in the column headings (*see* fig. 61).

soundings resulting from additional work in the area (*see* 568), when they are shown in color.

Soundings are of two kinds—those below the plane of reference (the true depths), and those above the plane (actually heights and usually indicated as minus soundings). All soundings taken are not always plotted on the smooth sheet. This also applies to minus soundings. This fact should be kept in mind when it becomes necessary to study in greater detail a particular depth curve, such as the low-water line, or some other aspect of the survey. Reference should then be made to the sounding record.

### 5611. *Two Depth Units on Early Surveys*

On the early surveys, two depth units were generally used—feet and fathoms. This was true for both the Atlantic and Pacific coasts, but there was no uniform dividing line. Thus, on the Atlantic coast, on Register No. H–22 (1837), soundings of 4 fathoms and greater are plotted in fathoms, and soundings less than 4 fathoms in feet; on Register No. H–1 (1837), the dividing line is 10 fathoms; while on Register No. H–44 (1834), with depths to 44 feet, all soundings are in feet. On the Pacific coast, on Register No. H–268 (1851) (San Diego bar), with depths as great as 80 feet, all soundings are in feet; but on Register No. H–336 (1852), at the mouth of the Columbia River, the soundings are plotted in feet to 18 feet and in fathoms beyond. Where two depth units are used, the change to fathoms is often indicated by the addition of the abbreviation "fths" after the sounding (Register No. H–22 (1837)). On a combination hydrographic and topographic survey in Alaska (Register No. H–1737 (1886)), sanding with gradations is used for the area where the depth unit is in feet, leaving clear the area where fathoms are used.

Except for the early surveys, it can be stated generally that, with some isolated exceptions, the inshore surveys along the Atlantic coast used a single depth unit—feet. (This also applied to the Gulf coast surveys.) On the Pacific coast and in Alaska, the dual system was continued for a considerably longer period (*see*, for example, Register No. H–2246 (1895–96)). By 1908, the use of two depth units on one sheet was specifically prohibited in the published instructions (*see* 5361(*j*)).[48] On Register No. H–3212 (1910), feet only were used.

48. The manner of showing fractions of fathoms or feet on the smooth sheet did not always follow a uniform pattern, and soundings were sometimes plotted in whole feet, in feet and tenths, in feet and quarters, in whole fathoms, in fathoms and quarters, and in fathoms and feet. The 1908 instructions for field work incorporated specific rules for converting fractions and for plotting on the smooth sheet (*see* note 21 *supra*).

### 5612. *"No Bottom" Soundings*

*No bottom* soundings are those where the bottom was not reached because the general depths were too great for the method of measurement. Thus, if depths of 30 fathoms or so were suddenly encountered in an area where a 20-fathom leadline was being used, the lead would not reach bottom and a "no bottom" sounding at 20 fathoms would be recorded. They provide only negative information. On the smooth sheet they were sometimes shown by a line underneath the figure or by a line and a dot under the line (Registers Nos. H–268 (1851) and H–289 (1851)). Later, the symbol adopted was a line over the figure and a small circle over the line (Register No. H–1737 (1886)). This was also the practice in 1942 (*see* ADAMS (1942), *op. cit. supra* note 1, at 762).

### 5613. *"Minus" Soundings*

Soundings that reduce to heights above the sounding datum (plane of reference) are termed *minus soundings,* since ordinary soundings are depths below the sounding datum and are considered positive values. If viewed on the ground such areas would be above water when the height of the tide is at the plane of reference. Where minus soundings appear on a hydrographic survey, it presupposes the existence of a low-water line with all such designated soundings falling within the line (*see* 562).

The earliest general reference to the use of minus soundings, although not expressly stated as such, is in the *circa* 1860 instructions (*see* 532), where it is stated (par. 72*i*) that "Shoals bare at low water must be given with their height above the plane of reference, and great care must be taken to determine their limits. These limits correspond to the line of mean low water." The lack of greater particularity accounts for the fact that during the period covered by these instructions the soundings above the plane were variously represented on the survey sheets as *underscored soundings* (Register No. H–790 (1861)), as *minus soundings* (Register No. H–1064 (1869)), and as *red soundings* (Registers Nos. H–790*A* (1871) and H–1426*b* (1878–1879)).

The 1878 instructions for hydrographic work were the first to spell out the use of minus soundings (*see* text following note 16 *supra*), and such soundings are shown on Registers Nos. H–1759 (1886) and H–3423 (1913). This is also the present practice, with the addition that the soundings on both sides of the low-water line are plotted to the nearest half-foot.[49]

49. JEFFERS (1960), *op. cit. supra* note 22, at 219 (*see* fig. 56). Prior to this, manuscript rules had been promulgated clarifying the use of fractional feet in general and in the vicinity of the low-water line in particular. Shalowitz, *Units for Recording, Reducing, and Plotting Soundings,* 6 FIELD ENGINEERS

It is obvious, that where it becomes important to know the actual depths represented by plotted minus soundings, recourse should be had to the sounding records. This is especially true where the low-water line is the object of study (*see* 562).

### 5614. *"Zero" Soundings*

Prior to the period covered by the *circa* 1860 instructions, soundings above the plane of reference were either omitted from the hydrographic sheet (*see* text following note 4 *supra,* and 531), or were generally shown as *zero soundings,* without regard to the actual elevations above the plane of reference, the low-water line being traced to encompass the most seaward zeros (*see* Register No. H–421 (1854)).[50] In such cases, if it becomes important to know the *actual* position of the low-water line or the actual elevation of the ground above the plane of reference, without regard to the conversion rules adopted for plotting the soundings on the smooth sheet, the sounding records should always be consulted (*see* note 49 *supra* and 5622).

### 5615. *Identification Letters and Numbers*

For proper identification and as a means of reference to the original sounding records, sounding lines on the smooth sheet are identified by position numbers and day letters (in colors) corresponding to those used in the sounding records. Positions are numbered consecutively, starting with number 1 at the beginning of each day; and each day's work is identified by a letter or combination of letters assigned in alphabetical order, starting with the letter *A* on each hydrographic survey. Capital letters of one color are used to identify the hydrography surveyed from the ship or the major survey vessel of the party, and lower-case letters for the supplementary launches, a different color being assigned to each separate unit. The numbers and letters (including the colors) correspond to those used in the sounding records.[51]

BULLETIN 80, U.S. COAST AND GEODETIC SURVEY (Dec. 1932). Although this was the earliest that such requirement was spelled out, the practice has been observed on surveys between the years 1873 and 1931. (*See,* for example, Registers Nos. H–1217 (1873), H–2146 (1892), H–2985 (1909), and H–5129 (1930–1931) where soundings on both sides of the low-water line are plotted in half feet and in quarter feet.) There is no assurance, however, that this was the general practice for the period. In the Hydrographic Manual of 1928, the following equivalents were prescribed for plotting minus soundings: 0 to —0.5 ft.=0 ft.; —0.6 ft. to —1.5 ft.=—1 ft., etc. Prior to this, no rules were given for the conversion of minus soundings.

50. On a survey made in 1875 (Register No. H–1256), soundings inside the low-water line are still shown as zeros, but this is considered an exception rather than the rule.

51. JEFFERS (1960), *op. cit. supra* note 22, at 10.

On the earliest hydrographic survey (Register No. H–44 (1834)), no position numbers nor day letters are shown. However, on Register No. H–45, which is a replotting in 1845 of Register No. H–44, position numbers are shown in red and the day letters are identified by various shapes. A distinction was sometimes made on the early surveys between positions determined from the boat and those determined from shore stations. Thus, on Register No. H–22 (1837), positions from the boat are identified by blue numbers and those from shore by red ones. By 1857, the form of identification was standardized to use letters of the alphabet for the day of the month (Register No. H–573 (1857)). Still later, the major vessel's work was identified by capital letters and the auxiliary boats and launches by lower-case letters (Register No. H–1573 (1883)), the same as is done today.

On some of the early surveys, small circles were used to mark the positions (Registers Nos. H–1425*a* (1877–1878) and H–1425*b* (1878)). In such cases, the soundings were not plotted exactly at the positions but were offset slightly. This practice of using small circles began with the Instructions of 1878 (*see* 533) and continued generally until the publication of the 1908 General Instructions for Field Work, when it was specifically prohibited (*see* 5361(*g*)).

The frequency with which day letters were plotted has also undergone changes but without a progressive trend. Thus, on Register No. H–1425*a* (1877–1878), practically every position number is identified by a day letter, and on Register No. H–2129 (1892) they are shown for about every fifth position, yet on Register No. H–2411 (1898–1899), the day letters are given generally only at the beginning and ending of the line. With the publication of the Hydrographic Manual of 1928, the practice was standardized so as to require position numbers to be shown at each position, and the day letter at the beginning and end of each line, at every fifth position, and at the point of any decided change in direction of the line.[52]

## 562. The Low-Water Line

Next to the soundings, the low-water line is one of the most significant features on a hydrographic survey, at least from the standpoint of waterfront boundaries. The low-water line in any given area may be defined as the line where the established sounding datum or plane of reference for soundings

52. Hawley, Hydrographic Manual 18, Special Publication No. 143, U.S. Coast and Geodetic Survey (1928). This is substantially the practice followed in 1963. Jeffers (1960), *op. cit. supra* note 22, at 217 (*see* fig. 56).

intersects the shore (*see* 5622).[53] It is the curve of zero depth and its best delineation for hydrographic purposes results from soundings taken in its vicinity. But because of the difficulties attending its location by the topographer alone or by the hydrographer alone, it was recognized at an early period in the work of the Survey that the final delineation must be left to both (*see* 4461). This is still the practice in 1963.[54] Where possible, the inshore sounding lines were run at high water so as to define as much of the low-water line as possible, but on many stretches of open coast this was manifestly impossible—for example, in regions where the range of tide is extremely small, as in the Gulf of Mexico; or along a rocky coast where it is ofttimes dangerous for the survey boat to approach too close to shore, even at high water, as along many sections of the Pacific coast or along the northeastern Atlantic coast.

Where the hydrography failed to establish the low-water line, the line was transferred from the topographic survey, the chart compiler making the necessary adjustments for charting purposes.

### 5621. *Symbolization*

The low-water line on the early surveys was represented by either a dotted or a dashed black line, the weight of the line being an indication of its origin. If it was transferred from the topographic survey (in whole or in part) it was drawn lighter than if it originated with the hydrographic survey.

On the first hydrographic survey (Register No. H–44 (1834)), the area between the high- and low-water lines is sanded, and this seems to have been the requirement when the earliest instructions were promulgated (*see* 531). Register No. H–500 (1855) showed the area sanded, and it was still so shown on some surveys as late as 1892 (Register No. H–2129). On Register No. H–790 (1861), a specialized treatment was made of the area between the low-water line and the high-water line. The area of zero soundings was left open with a dashed black line indicating the offshore limits of the zeros, or the low-water line, and only the area of minus soundings sanded. A reference to the contemporary topographic survey (Register No. T–967 (1860 and 1864)) showed the area of minus soundings to be a marsh area, thus enabling a distinction to be made between those areas bare at low water and those with elevation zero at low water. Sometimes the low-water line was accentuated by a gray wash, as were low-water shoals (Register No. H–2315 (1897)).

53. This is to be distinguished from the *mean* low-water line, which is defined as the intersection of the tidal plane of mean low water with the shore—a specific technical concept not necessarily related to the plane of reference used for soundings in a particular area (*see* Volume One, Part 1, 631, 64).

54. *Id.* at 135–136, 208.

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No reference is made to the method of symbolizing the low-water line in any of the published instructions, including those of 1894. But generally it was shown by a dotted black line (*see* Registers Nos. H–2161 (1892–1893) and H–3214 (1910)). In the instructions for field work issued in 1908, the first mention is made that the low-water line is to be indicated by a dotted line (*see* 5361(*h*)). The instructions of 1921 changed this and required it to be shown in yellow where defined by soundings (*see* text at note 23 *supra*). The Hydrographic Manual of 1942 continued this practice but provided for two additional situations: (1) where the low-water line on the topographic survey was rodded in at low tide, it was shown as a black line of alternate dashes and dots; and (2) where the low-water line was reasonably well determined from notes in the sounding records and sketches made on the boat sheet by the hydrographer at the time of the survey, it was shown as a yellow dashed line.[55] The present requirement (in 1963) is to symbolize the low-water line by an orange color (*see* fig. 62). In the figure, the colors used for various types of control stations and for aids to navigation and landmarks on the hydrographic surveys have been omitted. For shoreline and low-water line, the colors used have been indicated by legend when other than black. The prescribed colors for all these features can be seen by reference to figure 79 of JEFFERS (1960), *op. cit. supra* note 22.

### 5622. *Use for Boundary Purposes*

Where the low-water line as shown on a hydrographic survey is to be used for boundary purposes, the original sounding records, if available, should always be consulted. This is especially important where the low-water line is defined by zeros, as was the early practice (*see* 5614). The sounding record will show the exact depths obtained on the lines crossing the low-water line, and by correcting them for height of tide a much closer approximation of the low-water line location will be obtained.

Even where the low-water line is defined by minus soundings, the original sounding records should be consulted for the reason that in plotting the soundings for charting use they were generally shown in integral feet, fractions of 0.7 foot or less being omitted; that is, 0.7 foot was actually plotted as zero, and 1.7 feet as 1 foot. Obviously, a more realistic location of the low-water line would be had if the actual depths were taken into account.

55. ADAMS (1942), *op. cit. supra* note 1, at 694. The use of the yellow dashed line actually antedated the 1942 Hydrographic Manual. The instructions (unpublished) for the review of hydrographic surveys promulgated in the middle 1930's called for this same treatment (*see* Register No. H–6141 (1935–1936)). A yellow line was used for the low-water line on some of the surveys even before the publication of the 1921 instructions (*see* Register No. H–3719 (1914)).

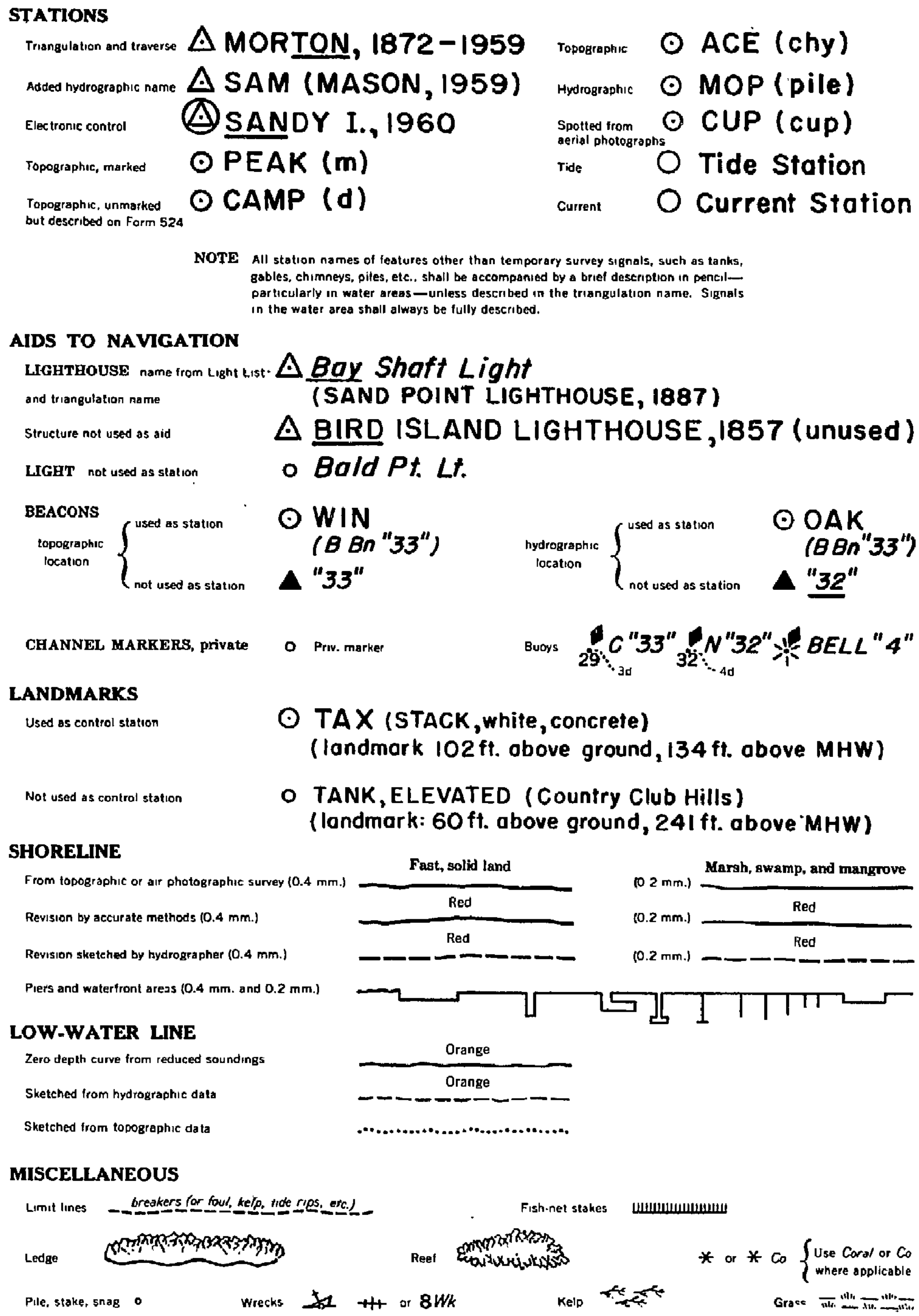


FIGURE 62.—Black and white copy of special symbols used on hydrographic smooth sheets. Colors are used on the completed sheet (*see* text).

Another factor to be kept in mind in using hydrographic surveys is the plane of reference adopted for the soundings (*see* 564). Along the Atlantic and Gulf coasts, it is the plane of mean low water, therefore, the low-water line shown on surveys along these coasts is the line of mean low water—the intersection of the plane of mean low water with the shore. Along the Pacific coast, the plane of mean lower low water is used and the low-water line on the surveys is the line of mean lower low water—the intersection of the plane of mean lower low water with the shore.

#### A. MEAN LOW-WATER LINE FROM MEAN LOWER-LOW-WATER LINE

If the tidal boundary to be extracted from a survey is mean low water where the plane of reference is mean lower low water, it can be accomplished by the following procedure: The basic principle involved in this process is that the low-water line is located to the landward of the lower-low-water line a distance that varies with the bottom slope and the difference in elevation between the two planes. Where minus soundings are plotted on the survey inshore of the mean lower-low-water line, the mean low-water line can be plotted on the sheet by first obtaining the difference in elevation between the plane of mean low water and the plane of mean lower low water from the tidal data (this is available in the Coast Survey). The mean low-water line can then be defined by drawing a curve through all the minus soundings corresponding to the difference in elevation between the two planes. Thus, if mean low water is 1.5 feet above mean lower low water, the line is drawn through the minus 1.5 feet soundings.[56]

Where no soundings are shown on the survey sheet inshore of the mean lower-low-water line, and none are available in the sounding records, the horizontal displacement in feet of the mean low-water line can be determined approximately from the relationship (in the example given) 1.5 feet times the cotangent of the angle of slope of the bottom (*see* fig. 63). This assumes a uniform bottom slope between the high- and low-water lines and can be computed from the horizontal distance between the two lines as scaled from the survey sheet (in this case 1,000 feet) and from the difference in elevation between the two planes as derived from the tidal data (in this case 9 feet). The mean low-water line can then be drawn parallel to the mean lower-low-water line. This

56. If the plotted minus soundings are in integral feet, they should first be converted to fractions based on actual values in the sounding records before delineating the mean low-water line. The same principle and procedure should be followed where the survey is on any plane other than mean low water. For example, for some of the surveys in Puget Sound, allowance would have to be made for the fact that the plane for the soundings is 2 feet below the plane of mean lower low water (*see* 5643).

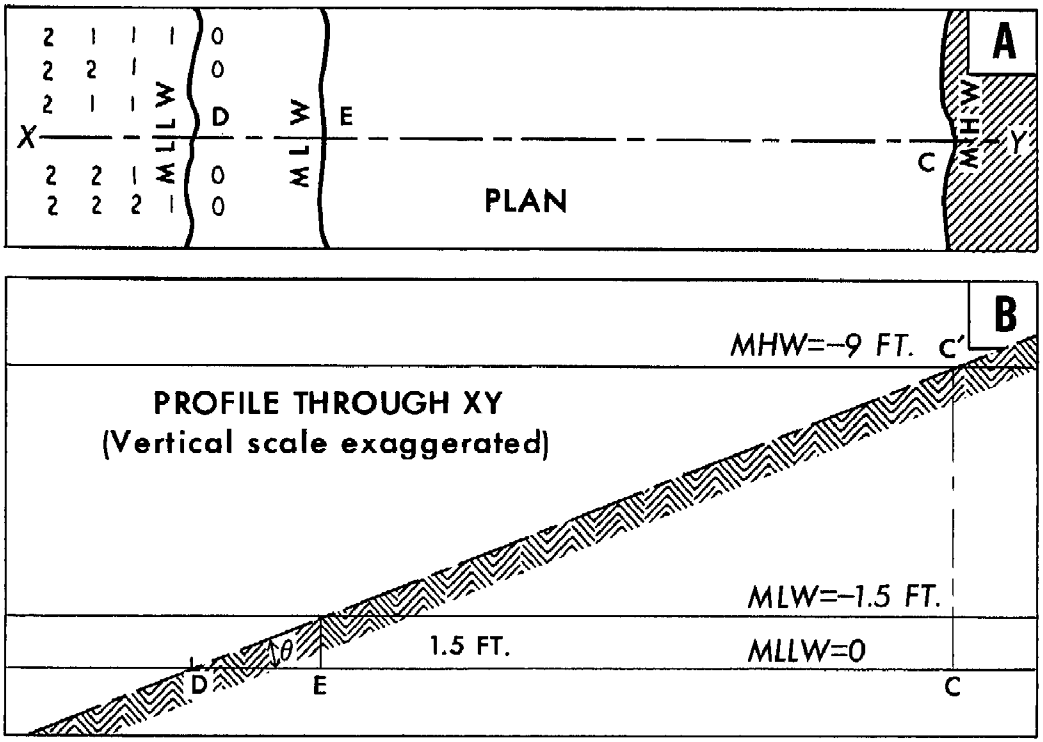


FIGURE 63.—Method of deriving a mean low-water line from a mean lower-low-water line on a hydrographic sheet where no soundings above the sounding datum are given.

will be better understood by reference to the figure, where the upper part ($A$) is a plan view of a portion of the hydrographic survey sheet and the lower part ($B$) a profile through $XY$ between the mean lower-low-water line and the mean high-water line. In the lower part ($B$) of the figure, the slope of the beach ($\theta$) is computed from the relationship $\tan \theta = \frac{9}{1{,}000}$, or $\theta = 0°30'56''$. From this and the value 1.5 feet (the vertical distance between the planes of mean lower low water and mean low water), the distance $DE$ is computed from the relationship $\frac{DE}{1.5} = \cot \theta$, or $DE = 1.5 \cot 0°30'56'' = 166.71$ feet.

## 563. DEPTH CURVES

*Depth curves,* or curves of equal depth, are shown on the hydrographic survey for the purpose of bringing clearly to the eye the general configuration of the bottom, and for emphasizing important navigational features, such as shoals and channels. They are also of value in studying the adequacy of a survey and whether additional examination is required in the field. While it cannot be stated with certainty when depth curves were first introduced, it is known that more than 200 years ago the Dutch engineer N. Cruquius used them to show the bottom of the Merwede River, and Philip Buache, a Frenchman, used them to outline the depths in the English Channel.[57]

Depth curves are comparable to contours on land, each curve representing an imaginary line on the ground (in the water area), every point of which is at the same depth below the sounding datum. The principles which govern the delineation of land contours are equally applicable to the drawing of depth curves.[58]

Some depth curves were shown on the earliest surveys of the Bureau, but the number to be shown and the symbolization to be used were not standardized until the instructions of 1860 were published. Generally the early surveys used groups of dots for the curves, the 1-fathom curve being represented by single dots, the 2-fathom curve by 2 dots, etc. On the first hydrographic survey (Register No. H–44 (1834)), only the 6-foot depth curve is shown, even though the depths range to 44 feet, and it is symbolized by a dotted black line. (This is the symbolization also used for the low-water line except that the area between the high- and low-water line is sanded.) On Register No. H–45, which is a replotting of H–44 on a smaller scale, the 12-foot depth curve is added as a series of double black dots.

The earliest instructions (*see* 531) called for depth curves to be shown for every fathom up to 4 fathoms, but the method of representation was not stipulated. This accounts for such variations as Register No. H–268 (1851), where the 6-, 12-, and 18-foot depth curves are all shown as dotted, black curves, while on Register No. H–336 (1852), the 3-fathom curve is shown in black ink by a series of 3 dots, and the 4-fathom curve by a series of 4 dots, but in red ink.

The 1860 instructions were the first to assign colors to the 6-foot curve (green), the 12-foot curve (red), and the 18-foot curve (blue), all to be shown in a continuous line (*see* text following note 13 *supra*). There has been no variation from this color scheme up to the present time (1963), but additional curves with designated colors have been prescribed from time to time and some

57. Veatch and Smith, Atlantic Submarine Valleys of the United States and The Congo Submarine Valley 72 (1939) (Geological Society of America Special Paper Number 7).

58. Although "depth curve" is the terminology that has always been used in the Coast Survey and is so used in the 1960 Hydrographic Manual (*see* Jeffers (1960), *op. cit. supra* note 22, at 154, 223), when their delineation is based on intensive development as exemplified by modern echo-sounding surveys, the term "depth contour" would seem to be appropriate as reflecting a more precise determination than "depth curve." Since the advent of echo sounding and the development of more precise methods of position fixing at sea, this term has appeared in the literature. *See*, for example, Veatch and Smith (1939), *op. cit. supra* note 57, at 49–84, particularly at 71.

modifications made.[59] On many of the earlier surveys, a color legend was given. Occasionally, where significant, an intermediate depth curve was shown in a dashed line. Thus, where the 3-foot curve was significant, a dashed green line was used (Register No. H–1197*b* (1874)), and where the 9-foot curve was significant, a dashed red line was used (Register No. H–1565 (1884)). Today, the 3-foot curve where used is symbolized by a continuous violet line, but no provision is made for a 9-foot curve.[60]

## 564. Planes of Reference

The plane of reference of a hydrographic survey is the tidal datum to which the soundings are reduced. It has already been noted that the rise and fall of the water surface due to the tide is a continuing phenomenon, so that soundings taken during the progress of the survey must be reduced to some fixed datum plane. If this were not done, the soundings would be meaningless in their relation to each other and no idea could be gained of the true topography of the sea bottom.

In studying successive hydrographic surveys for possible changes in the underwater topography, it is just as essential to bring them to the same sounding datum before comparisons are undertaken as it is to bring them to the same geographic datum (*see* Chap. 2). This is basic. And in the analysis of any individual hydrographic survey it is important to know the particular plane of reference used, especially if the low-water line is the object of study, since it corresponds to the plane of reference for the survey.

Because of the different characteristics of the tide on the coasts of the United States and in Alaska (*see* Part 1, 2321 B(*b*)), the planes of reference are not the same for all hydrographic surveys. This is true even today, but it was more true in the early days of the Survey before tidal concepts became crystallized and final standards were adopted.

One point should be kept in mind in connection with the use of different planes of reference: whatever the plane, the submarine topography, as delineated by depth curves, will remain the same. The plane adopted merely determines the elevation of the water surface from which the charted depths are to be reckoned. They will be greater or less depending upon the use of a higher or lower plane. But the relationship of the charted depths to each other will

59. Jeffers (1960), *op. cit. supra* note 22, at 15 and Tables 3 and 4.

60. *Ibid.* The colors prescribed for depth curves in the various instructions were not always adhered to in the earlier work. Thus, the 1894 instructions (*see* 535) called for the 24-foot depth curve to be shown in brown and the 30-foot curve in purple, but on Register No. H–2315 (1897), which is a survey of San Francisco Bay, the 30-foot curve is shown in brown and the 24-foot curve is omitted.

always remain the same. The lower the plane the less likelihood there will be of having negative corrections in the *Tide Tables* (*see* Part 1, 2321 B, 2322 A). Also, shoals in channels or elsewhere would be given greater emphasis through the charting of shoaler depths. It was this concept that motivated the use of the various low-water planes on the Pacific coast, as discussed below. The picture, however, is not wholly one-sided. The other concept is that of having depths on a chart reflect normal rather than unusual conditions. In some areas, where the channel depths approximate the draft of vessels, the use of a plane that fulfills the first concept would give a false idea of the navigability of these channels.

These two concepts for many years represented two schools of thought in the Coast Survey. Ultimately, the question became one of balancing off the advantages against the disadvantages. The second concept has prevailed and the plane of mean lower low water uniformly adopted for the whole Pacific area, including Alaska.[61]

### 5641. *Atlantic and Gulf Coasts*

During the first 10 or 15 years following the year 1834, when the first hydrographic survey was made, planes other than the ones finally adopted were in use. (On some of these surveys, no plane of reference was given originally but was added at a later date.) Thus, on the first hydrographic survey, made in Great South Bay (Register No. H–44 (1834)), the plane of reference is "approximate mean low water." [62]

The earliest written instructions for hydrographic work (*circa* 1844) called for "soundings to be reduced to the lowest water observed during the survey" (*see* 531). This, of course, applied at the time to the Atlantic and Gulf coasts only, since work on the Pacific coast was not begun until about 1850 and Alaska was not acquired until 1867. This datum corresponded approximately to low water spring tides, which was lower than the datum of mean low water. It was designated on the published charts variously as "lowest spring tides observed" (New York Harbor chart of 1845), "lowest water observed" (Little Egg Harbor chart of 1846), and "mean low water of spring tides" (Long Island Sound chart of 1855, Eastern Part). Other charts covering this period were

61. By using the *Tide Tables* in conjunction with the charted soundings, the navigator can readily ascertain the relatively few times when the tide may fall below the plane of reference and make proper allowance therefor.

62. One survey made in 1840 (Register No. H–108) bears the note that the plane of reference is mean low water, which was also added at a later date. Another survey made in the same year (Register No. H–106) states that no register of tides was kept by which the soundings could be reduced so a 6-foot tide was asumed and the soundings reduced accordingly.

referred to "mean low water" (Annapolis Harbor chart of 1846 and Boston Harbor chart of 1857). As far as is known, the plane of reference for soundings along the Gulf coast was always mean low water (Cat and Ship Islands chart of 1850, the first finished chart published along the Gulf).

The 1860 instructions established mean low water as the general plane of reference for soundings (*see* 532) except on the Pacific coast where a different plane was used (*see* 5642). This has been continued to the present day and applies to the Gulf of Mexico, Puerto Rico, the Virgin Islands, and the Atlantic entrance to the Panama Canal.[63]

### 5642. *Pacific Coast*

On the Pacific coast (California, Oregon, and Washington (including Puget Sound)), some of the early surveys (between 1849 and 1853) used the plane of mean low water or low water (*see,* for example, Registers Nos. H–288 (1849) and H–337 (1852)). The great majority of the surveys, however, make no mention of the plane to which the soundings were reduced (Registers Nos. H–250 (1851) and H–405 (1853)), and this is also true of the surveys extending to 1855. Between 1853 and 1855, the plane of mean lower low water or an equivalent expression, such as, mean of the lowest low water for each 24 hours, was used.[64] (*See* Registers Nos. H–421 (1854), H–456 (1855), H–463 to H–466 (1855), of San Francisco Bay.) Subsequently, the plane of mean lower low water was adopted for the coasts of California, Oregon, and the outer coast of Washington.[65]

The 1860 instructions called for the use of the mean of the lowest low waters as the plane of reference (*see* 532), but the 1878 instructions adopted the term mean lower low water for the Pacific coast (*see* 533) and this has been used ever since.[66] This applies also to the Hawaiian and Philippine Islands, but at the Pacific entrance to the Panama Canal, the plane used is the mean of the low water springs (*see* note 63 *supra*).

63. The publication of charts of the Canal Zone was transferred to the jurisdiction of the Navy Hydrographic Office in Sept. 1949 (*see* 1271B). Prior to that time the Bureau had made two hydrographic surveys at the Atlantic entrance (Registers Nos. H–2724 to H–2725 (1905)), using the plane of mean low water, and ten surveys at the Pacific entrance (Registers Nos. H–3360 (1912), H–3362 to H–3368 (1912), and H–4806 to H–4807 (1928)), using the plane of mean low water springs.

64. Letter of Oct. 23, 1911, from Chief, Tidal Division to Assistant in Charge of Office. *See also* Annual Reports, U.S. Coast Survey (Sketches 42–44, 46–48, 50–53) (1854), and page 97 (1855).

65. Letter of Oct. 23, 1911, *supra* note 64.

66. But a survey of 1897 (Register No. H–2315) still used the expression mean of the lower low waters for each 24 hours, and the 1901 chart of the Entrance to San Francisco Bay gave the plane as the average of the daily lower low waters. This, however, was not the general practice. Occasionally, the soundings were reduced from data based on a short series of tide observations, the number of days in the series being usually given on the survey. In such cases, the surveys generally contain notes indicating the correction to be applied to the soundings to bring them to the plane of mean lower low water (Register No. H–1887 (1888)).

## 5643. *Puget Sound, Washington*

Puget Sound, Wash., has had a rather varied history insofar as planes of reference for soundings are concerned, and has gone through almost a complete cycle. It began with the use of mean low water for the period between 1849 and 1853. In 1854, the plane used was the mean of the lowest low water of each 24 hours (*see* Annual Report, U.S. Coast Survey (Sketches 52, 53) (1854)), which is considered to be the same as mean lower low water. Some time during the late 1870's, the plane was changed to the mean of selected lowest low waters (Register No. H–1426*b* (1878–1879)). For the area of this survey, the plane was 3.2 feet below the plane of mean lower low water (*see* note on smooth sheet). In 1897, this was changed to the harmonic or Indian tide plane (Register No. H–2483 (1900)).[67] In 1902, the plane of reference was changed to 2 feet below the plane of mean lower low water, which plane was in use in 1911.[68] For Puget Sound this plane closely approximates the harmonic tide plane.[69] The plane of mean lower low water was again adopted with the publication of the General Instructions for Field Work in 1921, and this is the plane in use today (*see* 5363).[70]

## 5644. *Alaska*

Alaska too has had a varied history with respect to planes of reference in use. From its purchase in 1867 to 1897, the soundings were variously reduced to mean lower low water and the mean of a few selected lowest lows, according

67. The Indian tide plane or the harmonic tide plane, as it is sometimes called, has been used for a number of ports in India. It is also called the plane of Indian spring low water and corresponds approximately to tropic spring lower low water and is usually somewhat lower than low water ordinary springs. It is best derived from harmonic analysis. MARMER, TIDAL DATUM PLANES 129, 130, SPECIAL PUBLICATION No. 135, U.S. COAST AND GEODETIC SURVEY (1951). On Register No. H–2483 (1900) this plane is 2 feet lower than the plane of mean lower low water (*see* note on smooth sheet).

68. Letter (1911), *supra* note 64. One survey during this period was noted as being on the plane of mean lower low water (Register No. H–2985 (1909)), but this is noted in the accompanying Descriptive Report as an inadvertence and the soundings should have been reduced to the plane of 2 feet below mean lower low water, the plane adopted for the area. Register No. H–3423 (1913) showed the plane as 2 feet below the plane of mean lower low water.

69. Based on the computations for seven stations in Puget Sound, the mean difference between the harmonic plane and the plane of 2 feet below mean lower low water was found to be −0.03 foot. Letter of May 15, 1902, from Chief of Tidal Division to Assistant in Charge of Office.

70. It should be pointed out that the date of the published instructions does not necessarily represent the exact line of cleavage for the change from one plane to another. In some cases, surveys were already based on a new plane (probably as a result of specific written instructions to a chief of party) before the use of the plane was actually codified in the published instructions. In Puget Sound, for example, the first mention of a return to the plane of mean lower low water was in the 1921 instructions but the plane was already in use in 1917 (Register No. H–3999).

to the locality.[71] The first mention specifically of planes of reference for Alaska was in the General Instructions for Field Work of 1908 (*see* 5361(*f*)).[72] The plane of the mean of the lower low waters is there called for except in Wrangell Narrows where a plane 3 feet lower than the mean of the lower low waters had been used. This was continued in all the subsequent instructions and manuals to the publication of the 1942 Hydrographic Manual (*see* 537), which gave mean lower low water as the plane of reference for all of the Pacific Ocean, including Alaska (*see* 5645).[73]

More specifically, the first big change came late in December 1897 when the use of the harmonic tide plane was authorized for all Alaskan waters, except at the mouth of the Yukon where the plane of mean lower low water was continued because the harmonic plane was found impractical to use there. The harmonic plane was soon found unsuited for portions of the Bering Sea and for other localities, and in May 1902 this plane was replaced by a plane 2 feet below the mean of the lower low waters except in Norton Sound, where mean lower low water was used, and in Wrangell Narrows, where 3 feet below mean lower low water was adopted.[74] But in April 1903, this was again changed to mean lower low water except in Wrangell Narrows, Peril Strait, and Sitka Harbor.[75]

By January 1908, Peril Strait and Sitka Harbor were also brought within the plane of mean lower low water, leaving Wrangell Narrows the only exception.[76] In January 1929, this exception was also eliminated, thus establishing a uniform plane of mean lower low water for all Alaska and thereby bringing it into harmony with the plane of reference for the rest of the Pacific coast.[77]

71. Letter (1911), *supra* note 64. The first comprehensive survey of Alaska was begun in 1882 by the steamer *Hassler*. Prior to that time only sporadic surveys were made. The first systematic and continuous hydrographic surveys were begun in Southeast Alaska in 1901. Colbert, *Programming Field Operations in Alaska*, 2 JOURNAL, COAST AND GEODETIC SURVEY 3 (1949).

72. Prior to this only the Pacific coast was mentioned (*see* 533).

73. ADAMS (1942), *op. cit. supra* note 1, at 773. *See* text following note 76 *infra* for date of change in Wrangell Narrows.

74. Letter of May 23, 1902, from the Superintendent to the Assistant in Charge of Office, and Letter (1911), *supra* note 64. The 1902 letter states that "the plane of 2 feet below mean lower low waters may be taken as identical with the harmonic plane and that of selected lows."

75. Circular No. 45 of Apr. 8, 1903, and Letter (1911), *supra* note 64. The plane of reference for Peril Strait was 2 feet below lower low water (*see* chart 8282 of 1904), and for Sitka Harbor it was 2 feet below mean lower low water (*see* chart 8244 of 1904).

76. Letter of Jan. 8, 1908, from Superintendent to Assistant in Charge of Office, and Letter (1911), *supra* note 64. *See also* 5361(*f*).

77. Action of Chart Board on Jan. 16, 1929.

### 5645. *Summary of Present Planes of Reference*

The following is a summary of the planes of reference in use when the 1942 Hydrographic Manual was issued, and are currently in use in 1963:

(*a*) For the Atlantic Ocean and Gulf of Mexico—the mean of the low waters (MLW).
(*b*) For the Pacific Ocean—the mean of the lower low waters (MLLW), except for the Pacific entrance to the Panama Canal where it is the mean of the low water springs (MLWS).
(*c*) For certain of the larger navigable rivers and lakes, special planes have been adopted.[78]

In studying successive hydrographic surveys of an area that are based on different planes of reference, the mathematical relationships of the planes are available in the tidal records of the Bureau. Sometimes the surveys themselves or the accompanying Descriptive Reports (*see* 1242) contain notes giving the corrections to be applied to bring the soundings to the current datum (*see,* for example, Register No. H-1426*b* (1878–1879)). These should always be consulted.

### 565. Rock Symbols

Features on hydrographic surveys that often call for interpretation are the symbols used for the various types of rocks encountered during the survey operations. There are three such types, characterized as *bare, awash,* and *sunken.* The first (bare rock) is almost always delineated on the contemporary topographic survey; the second and third may be delineated on the topographic survey but are usually determined during the hydrographic operation.

By convention, and for general purposes, rocks are defined in relation to the tidal datums of the locality, as follows:

(*a*) *Bare rocks* are those extending above the plane of mean high water (*see* 5655(*a*)).
(*b*) *Rocks awash* are those exposed at any stage of the tide between mean high water and the sounding datum, or that are exactly awash at these planes (*see* 5655(*b*)).

78. Adams (1942), *op. cit. supra* note 1, at 773. The following planes of reference were in use in 1963: (*a*) Columbia River, from Harrington Point to the dam at Bonneville (charts 6152 to 6156 inclusive)—mean lower low water during lowest river stages (this is known as the Columbia River Datum); from the dam at Bonneville to Pasco (charts 6157 to 6164 inclusive)—normal pool level as established by Bonneville, The Dalles, and McNary Dams, which are 72, 160, and 340 feet, respectively, above mean sea level (MSL) and the adopted low water gradient established by the Corps of Engineers for the reach between Lake Celilo and McNary Dam (a profile is shown on each chart of the elevations on the adopted gradient); (*b*) Willamette River from Columbia River to Oregon City (chart 6171)—Columbia River Datum; from Oregon City to Newberg (charts 6171, 6172)—normal pool level at Oregon City, which is 50 feet above MSL (this is known as the Willamette River Datum); (*c*) Pend Oreille Lake, Idaho (chart 6170)—mean winter level of the lake, which is 2,048.15 feet above MSL; (*d*) Franklin D. Roosevelt Lake (charts 6168, 6169)—the normal lake level, which is 1,288.6 feet above MSL; (*e*) Lake Tahoe, Calif.-Nev. (chart 5001)—the lowest lake level, or 6,223 feet above MSL; (*f*) Sacramento River, Sacramento to Colusa (charts 5529, 5530)—reference plane established by the Corps of Engineers from Sacramento to Ord Ferry; and (*g*) Lake Mead, Ariz.-Nev. (charts 5457 to 5459 inclusive)—the mean lower lake level, or 1,100 feet above mean sea level.

(*c*) *Sunken rocks* are those covered at the sounding datum that are potentially dangerous to navigation (*see* 5655(*c*)).

The earliest rock symbols to be published by the Bureau were contained in a topographic symbol sheet engraved around 1840 and probably prepared to accompany the earliest instructions for topographic surveys (*see* fig. 46).[79] Between 1840 and 1960 (the date of the most recent Hydrographic Manual), a number of symbol sheets were published containing designations and notations for the various types of rocks. The progressive changes in the rock awash and the sunken rock symbols are shown in figure 64.

### 5651. *Bare Rocks*

Bare rocks were always represented by their shapes, if of plottable size, or by solid dots, if otherwise, and need no special comment from the standpoint of interpretation. They are identified more with topographic than with hydrographic surveys.

### 5652. *Rocks Awash*

It will be noted that on the earliest symbol sheet (*see* fig. 46), the symbol for what is now generally known as a rock awash (three lines crossing, one of which is horizontal) was confined to a rock that was awash at exactly low water, but for rocks seaward of the low-water line that were awash at any stage of the tide, a special symbol as used. This consisted of the symbol for a ledge formation with a "T" superimposed on it.[80]

Since these early designations, the rock-awash symbol has undergone several modifications. In the symbols published in 1892 and 1897 it was represented by four lines crossing, but in 1900 it reverted to three lines crossing, one of which was horizontal. In 1905, a distinction was again made, as in 1840, between a rock awash at exactly low water and one that covered and uncovered at an intermediate stage of the tide, except that a new symbol (three lines crossing encircled by a solid line) was introduced for the latter. But on Register No. H–2859 (1906) the symbol is encircled by a dotted line. (This rock being also shown on the topographic survey was in all probability bare at low water.)

79. The symbol sheet itself is not dated, but the record of the plate shows it to have been engraved around 1840.

80. As far as could be ascertained, there is no evidence that such symbol was ever used on any of the early surveys of the Bureau; however, the symbol without the "T" has been encountered. A symbol very similar to this was used in France to indicate an isolated rock which is never covered. HERRLE, A MANUAL OF CONVENTIONAL SYMBOLS AND ABBREVIATIONS 29, PUBLICATION NO. 121, U.S. HYDROGRAPHIC OFFICE (1903).

| Date | Sunken rock | Rock awash | Other rocks |
|---|---|---|---|
| **Topographic Surveys** | | | |
| 1840 | + Single projecting rocks whose positions and depths below the surface have been exactly determined, sometimes forming part of a ledge. | ✱ ✱ Single projecting rocks whose positions have been determined and which at low water are awash. | Rocks bare at low tide, outside, i.e. seaward of low water line. |
| 1860 | + Sunken rock | ✱ Rock awash | |
| 1892 | + Sunken rock | ✱ Rock awash | |
| 1897 | + Sunken rock | ✱ Rock awash | |
| 1905 | + Sunken rock | ✱ Rock awash at low water | Covering and uncovering rock |
| 1916 | + Rock under water | ✱ Rock awash (at any stage of the tide) | |
| 1922 | + Rock under water | ✱ Rock awash (at any stage of the tide) | |
| 1928 | + Rock under water | ✱ Rock awash (at any stage of the tide) | |
| 1949 | + Sunken rock | ✱ Rock awash | Bare rock (shape or dot) |
| **Hydrographic Surveys** | | | |
| 1883 | + Rock under water | ✱ Rock awash | |
| 1894 | + Sunken rock | ✱ Rock awash | |
| 1900 | + Sunken rock | ✱ Rock awash at low water | |
| 1928 | + Rock under water | ✱ Rock awash (at any stage of the tide) | |
| 1941 | + Sunken rock<br>Individually located | ✱ Rock awash<br>Individually located | Bare rock (shape or dot) |
| 1960 | + Sunken rock (depth unknown) | ✱ (4) Rock awash, elevation above sounding datum. | (2) or greater. Bare rock, elevation above MHW. |
| **Maps and Charts** | | | |
| 1911 | + Rock under water | ✱ Rock awash (at any stage of the tide) | |
| 1925 | + Rock under water | ✱ Rock awash (at any stage of the tide) | |
| 1932 | + Rock under water | ✱ Rock awash (at any stage of the tide) | |
| 1941 | + Sunken rock below chart datum; depth not known | ✱ (2) Rocks that cover and uncover, with height in feet above chart datum. | |
| 1956 | + Sunken rock (depth unknown) | ✱ (2) Rock which covers and uncovers, with height in feet above chart (sounding) datum. | Rock awash at the level of chart (sounding) datum. |

FIGURE 64.—Rock symbolization used on surveys and charts between 1840 and 1960.

In 1916, following the symbols adopted by the United States Geographic Board (*see* 468), the symbol was changed to three lines crossing, one of which was a vertical instead of a horizontal line. This applied to rocks that were awash at any stage of the tide and therefore eliminated the need for the 1905 symbol for a covering and uncovering rock. This was continued through the 1928 Hydrographic and Topographic Manuals.

### 5653. *Sunken Rocks*

The symbol for a sunken rock was always a simple cross. This was sometimes also referred to as "rock under water" (*see* fig. 64). No evidence could be found to substantiate the notation on the 1840 symbol sheet that the simple cross was used for "single projecting rocks, whose positions and depths below the surface have been exactly determined, sometimes forming part of a ledge" (*see* fig. 46). Comparisons with later surveys have shown that on topographic surveys such symbols frequently represented a generally foul area and that individually they indicated neither exact position nor depth. The simple cross encircled by a dotted line was also used on some of the early surveys, but not exclusively (Register No. H–405 (1853)). On later surveys, the symbol was omitted, and the legend "Rock" or "Rk" was shown with the depth (Register No. H–3719 (1914)).

### 5654. *Reconciling Rock Symbols*

In studying some of the early and later surveys some inconsistent treatments have been noted. Thus, on Register No. H–790 (1861), rocks exposed between the planes of high and low water are shown by the rock-awash symbol and by the sunken-rock symbol. Obviously, the latter symbol is completely inconsistent with an area that bares at the sounding datum. On Register No. H–1064 (1869), the sunken-rock symbol is used with a depth of ½ foot and accompanied by the legend "Rock," but on Register No. H–1525*b* (1881), the symbol is used with the note "Rock with 1 ft. uncovers at extreme low tides." On the later survey, Register No. H–2129 (1892), offshore rocks awash are shown variously by minus soundings with the name of the rock without any notation, or with the notation "R" alongside; and a sunken rock is shown by the actual depth and the name of the rock.

A striking fact in connection with rock representation on the early surveys is the relative absence of the rock-awash symbol and the wide use of the sunken-rock or bare-rock symbol. The 1840 symbols and legends shown in figure 64 offer a rational explanation for this condition. The awash symbol being used only for those rocks which were actually awash at low water, the number would be relatively small in comparison with the number of rocks above or below such plane. The large number of bare-rock symbols may be traceable to the fact that the symbol for bare rocks of small extent would have been indistinguishable from the symbol for a rock bare at low tide (without the "T"), so that many of the bare-rock symbols may actually represent rocks awash.

The stage of the tide also has a significant bearing on the symbolization of offshore rocks. A rock just awash at low tide may been seen only as a breaker at half tide and hence shown as a sunken rock on the topographic survey, while a rock awash at half tide would show as a bare rock at low tide. If the early topographer failed to take cognizance of the actual stage of the tide when locating such offshore features (this possibility is strongly suggested by the absence of descriptive notes on the topographic surveys), the symbolization would be erroneous. On the other hand, the disintegrating effect of surf on an exposed coast, the rise in sea level, or the emergence of the land, may also account for the apparent discrepancies in the rock representation on early and later surveys. What a century ago may have been a bare rock may today be only a rock awash and what was then a rock awash may now be a sunken rock.[81]

In attempting to reconcile two surveys of different periods, consideration should be given to the above factors.[82]

### 5655. *Modern Practice*

The present practice for rocks awash is to use the symbol of three lines crossing, one of which is parallel with the latitude line, without any encircling

81. Pierce, *Is Sea Level Falling or the Land Rising in S.E. Alaska?* 21 SURVEYING AND MAPPING 51 (1961). This paper is based on a special tidal survey in Southeast Alaska made by the Coast and Geodetic Survey in 1959 to determine the magnitude of the vertical changes suspected of having taken place in this area. It is stated that "many critical depths in the area have shoaled about one-half to one fathom since the original survey. Rocks that were previously charted as covered at all stages of the tide have in recent years been observed by local inhabitants as baring at low water." *Id.* at 56. Based on the tidal survey and on the evidence provided by studies of sea level along the coasts of the United States and other countries throughout the world that a slow general rise in the level of the oceans has taken place during the past 50 years or more, the conclusion was reached that, since sea level could not be falling in the limited area of the survey while rising in the great oceanic basins, "the movement in the Icy Strait-Lynn Canal area of Southeast Alaska, consequently, represents land emergence rather than falling sea level." *Ibid.* For the whole area investigated, the average change north of Icy Strait was at the rate of 0.09 foot per year. Southward, along the shores of Cross Sound and Icy Strait and the waterways in the general vicinity of Juneau the average change is of the order of 0.05 foot per year. *Id.* at 55.

82. Differences in symbolization have also been noted on successive hydrographic surveys separated in time by only a few years. Thus, on Register No. H–1616 (1884), a named rock (*Spike Rk*) is shown by a minus 1-foot sounding, but on Register No. H–1737 (1886), the same rock is shown by the rock-awash symbol.

line (*see* fig. 65).[83] Elevations of rocks awash above the sounding datum are indicated by slanting figures, in parentheses and underscored, as, for example, (*2*) (*see* fig. 65).[84]

For sunken rocks the practice is to use either the symbol or a sounding accompanied by the legend "*Rk,*" depending on the nature of the available information.[85] But the legend may be used with the symbol where there is danger that the latter may be overlooked. However, in no case is the depth and the symbol used for the same rock.[86]

The present practice also allows some flexibility, for cartographic purposes, in the designation of the different types of rocks with respect to the sounding datum and in their departure from the strict conventional definitions (*see* 565), in order that the charted symbols may reflect the most probable condition of the rock as seen by the mariner. On the hydrographic survey, therefore, the following rules are applied (diagrammatically shown in fig. 65):

(*a*) *Bare Rocks.*—Rocks with elevations of 2 feet or more above mean high water on the Atlantic and Gulf coasts, or 3 feet or more on the Pacific coast, are shown with the bare-rock symbol.

(*b*) *Rocks Awash.*—Rocks, the summits of which are in the zone between 1 foot above mean high water and 1 foot below the sounding datum on the Atlantic and Gulf coasts, are shown with the rock-awash symbol. On the Pacific coast the limits are 2 feet.

83. JEFFERS (1960), *op. cit. supra* note 22, at 209. In the 1942 Hydrographic Manual, a distinction was made in the symbolization for accuracy of location of the rock awash. If accurately located, either by the topographer or the hydrographer, the symbol was encircled by a dotted line, but if the rock was located by estimation or plotted from generalized symbolization it was not encircled. ADAMS (1942), *op. cit. supra* note 1, at 736 and fig. 169. The encircled symbol was also used in the past to emphasize a detached rock or the outermost rock of a cluster of rocks. On a number of the early hydrographic surveys, a simple cross with a dot in each quadrant has been identified as the symbol for a rock awash but no written authority for its use could be found. The symbol, however, has been used by Great Britain to indicate a rock awash at low water, by France and Germany for rocks awash, and by Spain for a rock or shoal awash. HERRLE (1903), *op. cit. supra* note 80, at 25, 30, 45, 65. Several such symbols appear on Register No. H–18 (1835). On one named offshore rock, an appended note states "on this rock 2 feet at ordinary low tides, bare at very low tides." On Register No. H–3 (1836–1837), such symbols have been identified, either by a notation on the survey or in the *Coast Pilot,* or by comparison with a later survey (Register No. H–5546 (1934)), as awash at the sounding datum (plus or minus 1 foot). In 1956, this symbol was used on the nautical charts to indicate a rock awash at the chart datum only. EDMONSTON (1956), *op. cit. supra* note 40, at 53.

84. JEFFERS (1960), *op. cit. supra* note 22, at 210. This was also the usage according to the 1942 Hydrographic Manual but with the alternate use of a note, such as, "uncovers 2 ft. at MLW." ADAMS (1942), *op. cit. supra* note 1, at 737 and fig. 189 (part IX). On some hydrographic surveys, the notations "awash ¼ tide," "awash ⅔ tide," etc., have been encountered (*see* Register No. H–4865 (1928)). This gives rise to some ambiguity because of the uncertainty of the end of the tidal cycle referred to. A study of the sounding records revealed unmistakably that such notations refer to the low stage of the tide, that is, "awash ¼ tide," means the rock was awash when the tide had risen to one-fourth its height above the sounding datum.

85. If the depth over the rock has been definitely determined, the sounding with legend is used, but where it has not been so determined, as where breakers have been cut in but no soundings taken, or where the depth does not represent the least depth on the rock, the symbol is used, with a notation "breakers," if so noted in the sounding record. JEFFERS (1960), *op. cit. supra* note 22, at 209–210.

86. ADAMS (1942), *op. cit. supra* note 1, at 736.

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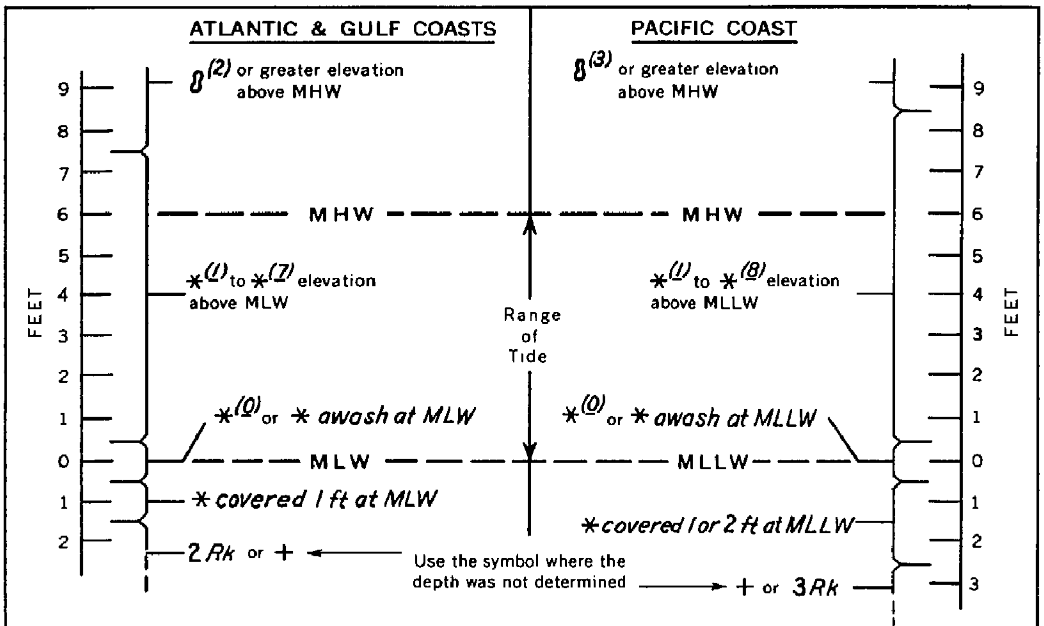


| | REFERENCE PLANE | SYMBOL COLOR Source Hydro. | SYMBOL COLOR Source Topo. | ELEVATION COLOR Source Hydro. | ELEVATION COLOR Source Topo. | ELEVATION UNDERLINED | SIZE Symbol | SIZE Elev. |
|---|---|---|---|---|---|---|---|---|
| $8^{(5)}$ | MHW | *RED | BLACK | *BLACK | RED | NO | SHAPE | 2 mm. |
| $*^{(5)}$ | ML(L)W | *BLACK | BLACK | *BLACK | BLACK | YES | 2.2 mm. | 2 mm. |

*Plotted in pencil and inked during Verification

FIGURE 65.—Rock symbolization and elevations referenced to tidal datums, and color characteristics for use on finished hydrographic smooth sheets.

(*c*) *Sunken Rocks.*—Rocks potentially dangerous to navigation, whose summits are below the lower limit of the zone for rocks awash, are classed as sunken rocks (*see* fig. 65).[87]

## 566. REEFS AND LEDGES

A *reef* is a rocky or coral elevation, dangerous to surface navigation, which may or may not uncover at the sounding datum. A rocky reef is always detached from shore, but a coral reef may or may not be connected with the

87. JEFFERS (1960), *op. cit. supra* note 22, at 209. These rules for symbolization on the survey sheet are substantially the same as given in the 1942 Hydrographic Manual with the exception that the limits for the bare-rock symbol was 1 foot or more on the Atlantic coast and 2 feet or more on the Pacific coast (more than 1 foot and more than 2 feet would have been more consistent designations). ADAMS (1942), *op cit. supra* note 1, at 735. The rules given in the latter publication were actually a codification of what had been the practice on hydrographic surveys since 1934. Shalowitz, *Treatment of Rock Symbols on Hydrographic Surveys*, 7 FIELD ENGINEERS BULLETIN 125, U.S. COAST AND GEODETIC SURVEY (June 1934).

shore. A *ledge* is a rocky formation connected with and fringing the shore, and generally uncovers at the sounding datum.[88]

On the earliest symbol sheet (*see* fig. 46), a rocky reef or a ledge bare at low water carried the same symbol as a rock bare at low water except for the absence of the superimposed "T". The sunken reef or ledge symbol was very similar but because of the possibility of it being confused with the one bare at low water, it was later superseded by the cluster of sunken-rock symbols (this was also used to represent foul ground) (Register No. H–1616 (1884)), and still later by a broken line enclosing sunken-rock symbols, or an appropriate legend.[89]

The rocky reef or ledge that uncovered at the sounding datum was shown by a distinctive symbol to simulate the appearance of continuous bedrock or coral formations (Registers Nos. H–1616 (1884) and H–2859 (1906)). This continues generally to the present time (*see* fig. 62).[90]

## 567. Bottom Characteristics

The determination of the character of the sea bottom—that is, its consistency, color, and classification—is an essential part of every hydrographic survey. Although only the immediate top layers are sampled, such information is nevertheless of value to the mariner for choosing an anchorage with the best holding ground and free of rocks; to the fisherman for selecting places where fish are likely to congregate and for avoiding types of bottom likely to damage his equipment; to the engineer engaged in dredging operations in harbors and channels and for any underwater construction; and to the student of the earth sciences for supplementing his knowledge of that part of the globe covered by water. In some instances, bottom data may still be helpful to the mariner in

88. Jeffers (1960), *op. cit. supra* note 22, at 209.

89. Swainson, Topographic Manual 8, 69, Special Publication No. 144, U.S. Coast and Geodetic Survey (1928). This was also the procedure in the 1942 Hydrographic Manual, no distinctive symbol being used for a submerged reef or ledge. Adams (1942), *op. cit. supra* note 1, at 736.

90. Jeffers (1960), *op. cit. supra* note 22, at 209. The conventional symbols included in the General Instructions for Hydrographic Work for 1883 and 1894 (*see* 534 and 535) seem to be a departure from this practice and follow more the symbol used in 1840 (*see* fig. 46) but connected by sanding and interspersed with bare rock shapes. The practice in 1942 was to show these features by symbol or by broken line and legend, depending on which method showed the feature clearly with the least amount of work. No distinction was made between the symbol for a rocky reef and a ledge. Where the reef was continuous at the sounding datum, the standard rocky-ledge or coral symbol, as the case may be, was used, but where it was generally submerged and projected only in spots above the sounding datum, rock-awash symbols were used to represent the protuberances, and sunken-rock symbols, the depressions. Adams (1942), *op. cit. supra* note 1, at 736 and fig. 189 (part II). *See also* Jeffers (1960), *op. cit. supra* note 22, at 209.

determining his position, although generally their value for this purpose has decreased because of the use of echo-sounding apparatus in navigation.

Obtaining the character of the bottom was always a requirement in the Coast Survey. It is shown on the first hydrographic survey (Register No. H–44 (1834)), and the earliest written instructions available (*see* 531) call for such information to be obtained. The first published instructions for hydrographic work (*see* 532) emphasized in considerable detail the manner and frequency of obtaining bottom specimens, the procedure for preserving them in small vials, and the method of classification in order "to trace the formations along the coast in which particular kinds of *soil* occur" (*see* text at note 14 *supra*).[91]

The character of the bottom is determined either by "feel" or by bringing up a sample with the leadline or with a special snapper device. The present classification of sediments is based on the size of the particles composing them. No mechanical analysis is used for typing a sediment. An estimate of its dimensions is made by eye and classification is based on an available table covering the range from "ooze" to "boulders."[92]

### 5671. *Application to Hydrographic Surveys*

Bottom characteristics have always been applied to the hydrographic surveys. In some of the early surveys, no abbreviations were used (Register No. H–288 (1849)). Abbreviations were standardized and first published in the 1883 instructions for hydrographic work (*see* 534), but were already used on surveys prior to this date (Register No. H–1197*b* (1874)). Identical abbreviations with some additions and some minor changes have been included in all subsequent instructions and hydrographic manuals.[93] Register No. H–1341*b* (1875) is an example of profuseness of bottom characteristics—fully 90 percent of the soundings plotted show the character of the bottom.

A complete designation of the character of the bottom at any particular geographic location usually included one or more adjectives descriptive as to size or consistency, one or more adjectives designating color, and one or more nouns naming the class of bottom material. The noun portion of the characteristic always began with a capital letter, sometimes followed by one or two

91. Identical provisions for obtaining and preserving such bottom specimens were included in the later instructions through those of 1894. Subsequently, no specimens were retained as a permanent record, except by prearrangement with a scientific institution or a commercial establishment.

92. *Id.* at 159 and Table 10. Where a more detailed study of the ocean floor is contemplated, as in modern oceanographic research, bottom samples are obtained by means of a coring device or by dredging. For a description of some of this equipment, *see id.* at 102–103.

93. *Id.* at 164.

lower-case letters; and the adjective portion with lower-case letters, two letters being used for color or shade and three letters for quality. The order of arrangement was as follows: descriptive adjective, color, noun. Thus, *"soft gray sand, shells, pebbles"* was designated by *"sft gy S Sh P."*

### 568. Additional Work

When a closer development of an area was required, or an investigation was to be made of a possible danger to navigation after the original survey was completed, the new work was considered as "additional work." In the early surveys, there was no uniformity in the method of showing such work on the smooth sheet. In some cases, the new soundings were plotted in color (Register No. H–103 (1840)), and in other cases the soundings were black, but the position numbers were in color (Register No. H–859 (1864)).[94] Marginal notes (in pencil, black ink, or colored ink) placed in the vicinity of the additional work gave the date and other information regarding the work.

In some instances, when the additional work was fairly extensive it was plotted as a separate sheet but given an "a" number. In such cases, the soundings were shown in black, with a few of the overlapping soundings shown in color on the original survey (Registers Nos. H–2662 (1902–1903) and H–2662*a* (1904)). But generally "a" sheets were reserved for contemporary, adjoining surveys that were part of one project (Registers Nos. H–5551, H–5551*a*, H–5551*b*, H–5551*c* (1934)).

The modern practice is to show the additional work in color and in a corresponding color give information in the title relative to the date of survey, the name of the chief of party, and the name of the surveyor (Registers Nos. H–7152 (1946–1949) and H–7079 (1945–1955)).[95]

### 569. Miscellaneous Features

Besides the features discussed above that are common to all hydrographic surveys, the following additional features have been encountered on some of the surveys examined during the research on this publication. They are in-

94. In one case, where additional work was done several years later, the soundings were in black but were distinguished from the original work by giving them a different form and slant (Register No. H–790 (1861)). On the same survey, additional work done at a still later date was shown in blue. Occasionally, the additional work was plotted on an overlay tracing and either attached in place to the smooth sheet (Register No. H–1573 (1883)) or marked "To Accompany H——" (Register No. H–2146 (1892)).

95. Jeffers (1960), *op. cit. supra* note 22, at 232.

cluded here because of their significance, and because of their possible historical interest.

(*a*) *Kelp.*—This type of marine vegetation is a common feature along certain portions of the Pacific coast and in Alaska. It is one of the most important of the seaweeds encountered on a hydrographic survey, one of its principal characteristics being that it generally grows in rocky bottom and therefore indicates a possible danger to navigation. The usual practice where the beds were extensive was to show a fringe of kelp (by symbol in black ink at the outer limit and to mark it "outer limit of kelp" (Register No. H–1508 (1881)).[96] But sometimes the full extent from shore outward was shown by symbol in green ink, as on Register No. H–1340*a* (1876).

(*b*) *Oil Well.*—It is a matter of interest that on a survey of Santa Monica Bay, Calif., made in 1876, at a point about 3 miles north of Point Vicente and about 1 mile from shore, an area 1 mile long and ½ mile wide was outlined and marked "oil well" (*see* Register No. H–1340*b*).

(*c*) *Salt Domes.*—In the Gulf of Mexico, submerged formations were located near the edge of the continental shelf on the hydrographic surveys made in 1937 (Register No. H–6293) and in 1939 (Register No. H–6501), and other surveys in the area of the 100-fathom curve. These formations resemble some of the buried salt domes along the coastal plains of Louisiana and Texas, where many oil reserves are located.

(*d*) *Notes on Hydrographic Surveys.*—Notes are sometimes found on the hydrographic survey which often have an important bearing on a collateral use of the survey. In deducing the probable method of drawing the boundary between the United States and Mexico in the Gulf of Mexico, a note on the survey sheet, regarding the non-discernibility of the entrance to the Rio Grande until "it bears per compass W ½ N" shed considerable light on the matter (*see* Register No. H–377 (1853)).[97]

96. This was also the practice called for in the 1942 Hydrographic Manual. ADAMS (1942), *op. cit. supra* note 1, at 744. The present practice (in 1963) is not to use the symbol except for small, detached areas of kelp (*see* fig. 62). Instead, a dashed, black line is used to mark the limits and the notation "kelp" added. JEFFERS (1960), *op. cit. supra* note 22, at 212.

97. This was part of a study made in response to a request from the State Department for information on the precise location of the U.S.-Mexican boundary in the Gulf. The result of the study was embodied in a Memorandum dated Aug. 29, 1957.

CHAPTER 6

# Interpretation and Use of Nautical Charts

Every maritime nation recognizes the need for surveying and charting its coastal regions in the interest of waterborne commerce. Without adequate charts, free and unrestricted intercourse by water would be impossible and the harbors would be as effectively closed to the commerce of the world as though blockaded by an enemy fleet. Charting the coastal areas of a nation, therefore, stands high on the list of obligations for the promotion of the comity of nations. In the commerce clause of the Constitution of the United States (Art. I, sec. 8, cl. 3) that obligation is fully recognized in the provision that Congress shall have the power "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes." As an incident of that power, there is the concomitant power to control and protect navigation, which necessarily includes the preparation and publication of nautical charts.

This national obligation and constitutional power was given force and effect in the early history of our country. The young Nation was concentrated along the Atlantic coastal plain; fisheries and shipbuilding were important industries, and waterborne commerce between the harbor cities was the medium for the movement and exchange of fish, shipbuilding materials, and other products. To promote that commerce and to develop trade with foreign nations, a survey of the coast, on which the nautical charts would be based, was authorized in 1807 (*see* Part 1, 121).[1]

## 61. EVOLUTION OF THE NAUTICAL CHART

The first hydrographic information available for the use of mariners was in the form of written descriptions of the coasts along which they sailed. They were crude beginnings and probably consisted of the merest details of headlands. As navigators ventured farther from home, this was supplemented by informa-

1. The act was approved on Feb. 10, 1807.

tion concerning harbors and channels and the dangers to be avoided along such routes.

As was pointed out in 127, the modern nautical chart may be described as a printed reproduction, on a reduced scale, of some portion of the navigable part of the earth's surface. It is constructed primarily to serve the needs of the navigator whose responsibility is the safety of lives and cargo. To effectively discharge that trust, the navigator must have at all times a full and complete knowledge of the coast; the depths of the water and the character of the sea bottom; the locations of reefs, shoals, and other dangers to navigation; the rise and fall of the tides; the direction and strength of currents; and the behavior of the earth's magnetism in areas that must be navigated. Modern nautical charts provide this information.

An important distinction thus exists between the nautical chart and maps in general; whereas the latter may serve as reference mediums, the nautical chart in its special and accurate delineation is an instrument to be worked upon in the solution of all problems relating to the navigation of a vessel, be they problems of position, direction, or distance.

### 611. The Work of Claudius Ptolemy

Although the modern chart is of comparatively recent origin, the period from Ptolemy to Mercator, covering the first 16 centuries of the present era, saw three great developments in cartography that have profoundly influenced contemporary chart making.[2] Claudius Ptolemy—Egyptian mathematician, astronomer, and geographer—who lived in the second century, stands without doubt in the front rank of early geographic thought. His *Geographia* represented the sum of all geographic learning and served as a groundwork for future cartographers. In it was embodied a catalog of places arranged according to their geographic positions, including the mathematical principles for the scientific construction of maps.[3] Ptolemy gave details for the construction of 26 maps and a general world map, and is credited with being the originator of the conic projection—at least his map of the world was constructed on a modification of this projection with meridians and parallels both curved. Ptolemy's other contributions to cartography were his insistence on the sphericity of the earth, and his invention of dividing it by means of meridians and parallels.[4]

2. The first marine charts of which there is actual record are those constructed by Marinus of Tyre during the second century. Adams, Hydrographic Manual 1, Special Publication No. 143, U.S. Coast and Geodetic Survey (1942).

3. Deetz, Cartography 4, Special Publication No. 205, U.S. Coast and Geodetic Survey (1943).

4. Brown, The Story of Maps 59, 68, 71, 73, 79 (1949).

Ptolemy's scientific teachings were lost to the medieval world, which was generally marked by stagnation and retrogression. There was a reversion to the theory of a flat earth, and the concept of latitude and longitude was entirely neglected. The superstition that Paradise was situated in the East caused the mapmakers of that period to give it a position in accord with its importance by placing it at the top of the map. The East remained conventionally at the top until the introduction of the compass in navigation around the 13th century.

### 612. Portolano Charts

The compass paved the way for a new type of chart which flourished towards the close of the middle ages and forms a notable exception to the prevailing darkness of the period. This was the second great influence on contemporary chart making. The Italian and Catalan mapmakers introduced the *Portolanos* or "handy plans." No projection was included, but in its place were networks of straight lines, each network radiating from a common center like the spokes of a wheel and corresponded to the points of the compass. These lines enabled the navigator to set his course at and to any point by aid of the magnetic needle. For limited areas, these charts gave nearly correct azimuths so that those of the Mediterranean in the 14th century closely approximated a modern chart based on the Mercator projection (*see* 613).[5]

The Portolanos marked the return of north to the top of the chart and were the first to carry a linear scale of miles. They were almost always drawn on parchment and with bright colors. The Portolanos achieved only an approach to mathematical accuracy, but it was enough to give the seamen of that period the confidence which they needed to sail the open sea. It remained for Mercator, 150 years later, to *solve* the problem of cartography for the navigator.

The influence of the Portolanos on chart making was felt for several centuries after their introduction, and Juan de la Cosa in 1500 still covered his chart with the spider-web lines (*see* fig. 66).[6] The Cosa chart is of great interest historically, being the earliest map now extant which shows the American coast. The chart was drawn on oxhide in bright colors and purports to cover the entire world; it joins Asia and America as one continent, the Pacific Ocean being then unknown.

5. The oldest Portolano of which the date can be accurately fixed covers the eastern Mediterranean and was drawn by Petrus Vesconte in 1311. Adams, *op. cit. supra* note 2, at 2.

6. Cosa accompanied Columbus on his first voyage as master of his flagship and as cartographer on his second voyage.

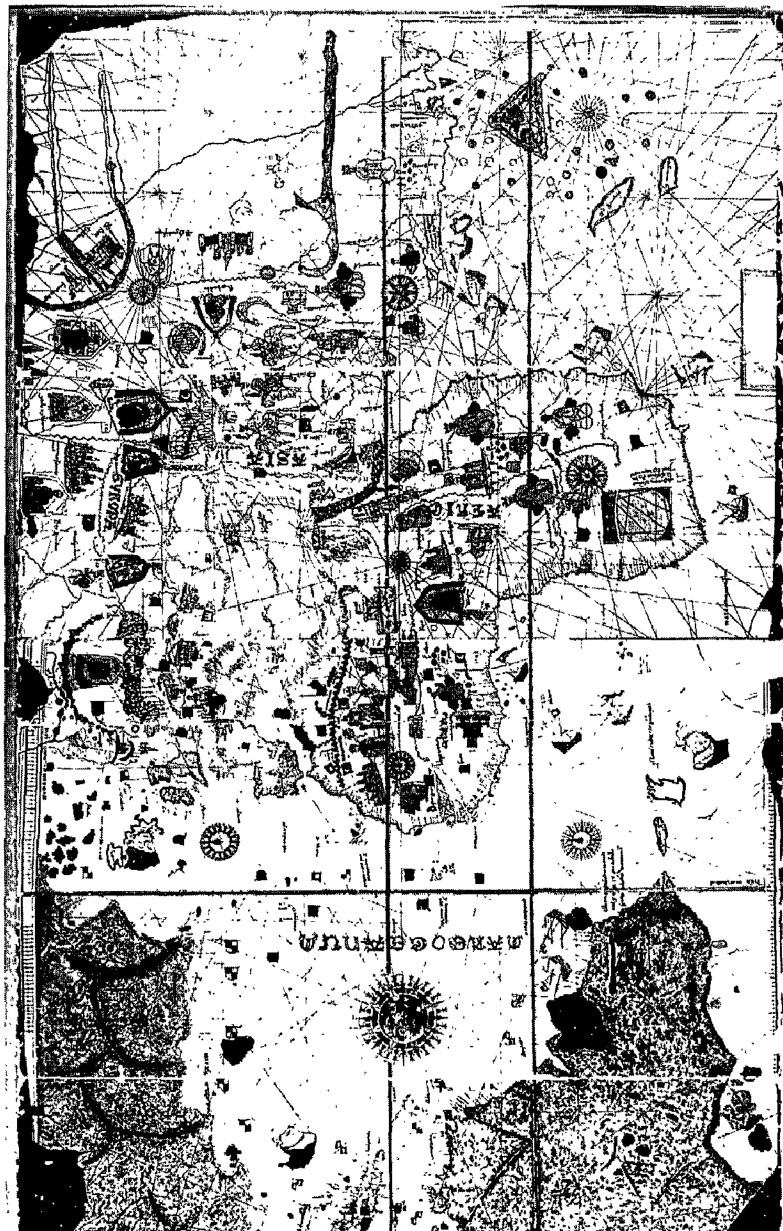

FIGURE 66.—The Cosa chart of 1500 was drawn on oxhide and in bright colors. The radiating lines, which characterized the Portolanos, enabled the navigator to set his course at any point by aid of the magnetic needle. The Cosa chart is the earliest map now extant which shows the American coast.

### 613. Mercator's Great Contribution

The third great influence on the modern nautical chart was the contribution of Gerhard Krämer (better known by his Latin surname Mercator, meaning merchant), the Flemish mathematician and cartographer who lived in the 16th century. Ptolemy, as we saw, introduced the latitude and longitude idea in maps. The Portolano chart makers of the 14th century neglected this concept and used the points of the compass as their "grid system." Mercator combined the scientific theories of the one with the practical advantages of the other and devised the well-known projection which bears his name. In his famous World Map of 1569 (*see* fig. 67), the latitude and longitude lines are straight, parallel lines intersecting each other at right angles. The meridians of longitude Mercator spaced equally throughout the map based on their distance apart at the equator. This caused a spreading of the meridians everywhere except at the equator, since meridians on the earth converge toward the poles. To compensate for this, Mercator conceived the idea of also spreading the parallels in exactly the same proportion as the meridians were spread.[7]

What Mercator sought to accomplish by this arrangement of meridians and parallels was to provide the navigator with a chart on which a straight line—the simplest of all lines—joining any two points would determine the constant course he must steer in sailing between those points. Such a line is known as a *rhumb line* (loxodromic curve). On the earth it cuts all the meridians at the same angle and is a continually curving line, always approaching the pole but theoretically never reaching it. A ship sailing a "rhumb" is therefore on one course continuously. The uniqueness of the Mercator projection lies in the fact that on it and it alone the rhumb line is a straight line (*see* fig. 87). This is the essential property which Mercator wished to preserve, and he subordinated other properties to this one.

Although it took nearly a century for navigators to appreciate this property of the Mercator projection, today the projection is looked upon as one of the most useful ever to be devised for marine navigation; it will likely be so considered as long as ships "sail the rhumb."

7. This means that if at any place on the map a minute of longitude is spread to twice its value on the earth, then the minute of latitude at that place is also spread to twice *its* value on the earth. In order to differentiate between the chart measurements along a meridian and the geographic distances in nautical miles which they actually represent, the chart measurements are conventionally referred to as *meridional parts*. For any latitude, the meridional parts are the number of nautical miles by which that latitude would be distant from the equator, if every degree and minute between them had been lengthened proportionately to the lengthening of the longitude. Thus, the meridional parts for latitude 60° (on a sphere) are 4527.37 minutes, but the actual number of nautical miles between the equator and latitude 60° is 3600. The difference of 927.37 miles is the amount by which the distance from 0° to 60° must be increased on a Mercator chart of the world in order that a mile of latitude at 60° may be in true proportion to a mile of longitude at that latitude.

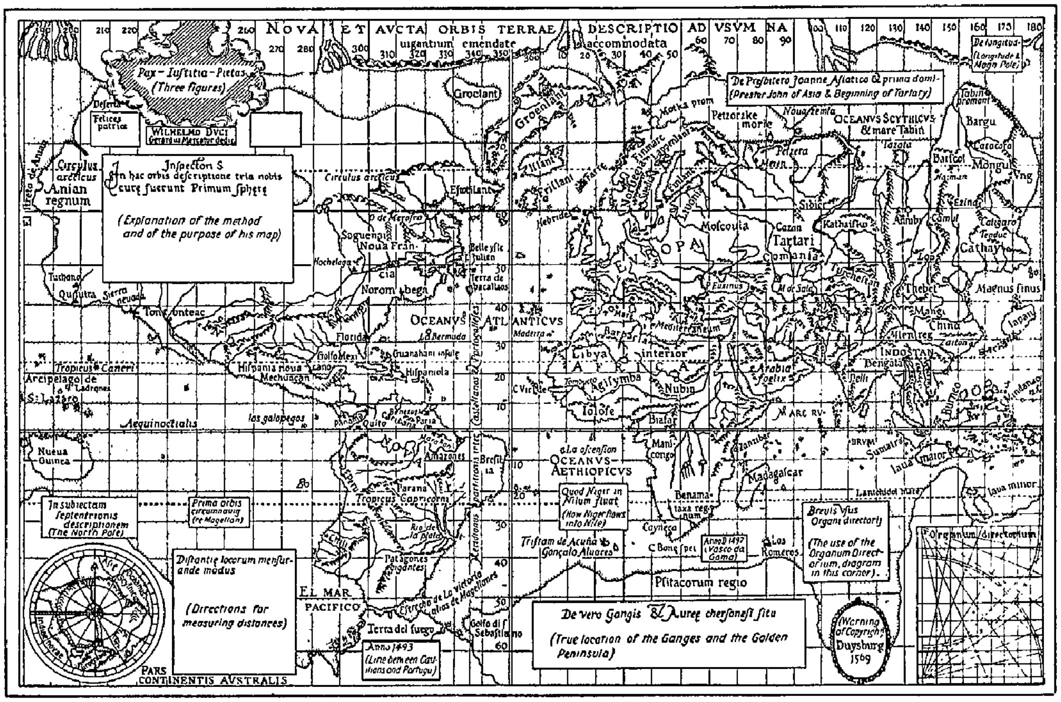


FIGURE 67.—Mercator's world chart of 1569 was characterized by two systems of straight parallel lines intersecting each other at right angles. The spacing between the parallels of latitude increase in a mathematical progression from the equator to the poles, making the *rhumb* line on the chart a straight line. (*Courtesy, Encyclopedia Britannica.*)

The Mercator projection belongs to that class of map projections known as "conformal," in which the property of correct shape is preserved for geographical features, rather than correct size. In contrast, there is the "equal-area" type of map projection, in which correct size is preserved rather than correct shape.[8] Another limitation of the Mercator projection is that a great circle (orthodromic curve)—the shortest distance between two points on the surface of the earth—would be projected as a curved line (*see* fig. 87). This means that radio bearings, which follow the paths of great circles over the earth, cannot be plotted as straight lines on a Mercator chart without correction.[9] Also, as one recedes from the equator, both north and south, the scale of the projection

8. For mapping extensive portions of the world, it is mathematically impossible to preserve both properties in the same projection. This follows naturally from the obvious fact that the surface of a sphere cannot be flattened without distortion. This is the underlying principle of all map projections. Any projection is at best a compromise and the choice usually depends upon the purpose which the map or chart is to serve.

9. Only true north and south bearings, and true east and west bearings along the equator do not require a correction. This problem is discussed further in connection with using nautical charts (*see* 691).

continually increases, reaching infinity at the north and south poles. This expanding scale makes the projection unsuitable for charting the polar regions and limits its use for ordinary geographic purposes where equal-area representation is desirable.[10]

But notwithstanding its limitations, Mercator's contribution will always remain one of the great landmarks in the development of nautical cartography. His projection plays a definite part in giving a continuous conformal mapping of the world. The restrictions of relative size may be more or less disturbing, but so are the tripartite or quadripartite arrangements, with discontinuities in oceans and continents, seen in other projections when extended to world proportions.[11]

## 62. THE MODERN NAUTICAL CHART

In evaluating and interpreting the modern nautical chart, particularly the charts of the Coast Survey, cognizance must be taken of the fact that what had previously been called a chart was largely the result of exploration or of limited surveys and was generally the work of individual effort and private undertaking. The Portolanos of the 14th century, the Cosa chart of 1500 (*see* 612), and the Atlantic Neptune charts of the late 18th century are all examples of the work of this exploratory period.[12] These, like all the early charts, suffered from two great defects—the want of detailed surveys and the lack of a rigid system of connection between the various ports.

10. Mercator recognized this shortcoming, and on his World Map of 1569 the north polar region is shown as an inset on a projection centered at the pole (*see* fig. 67). Mercator's original chart of 1569 contains numerous Latin inscriptions of both historical and technical interest. They give a résumé of the geographic knowledge of the time, and show how the chart should be used and the reasons which led Mercator to develop his system of map projection. The International Hydrographic Bureau has issued a full-size reproduction of this chart in 18 sheets, including a pamphlet giving the Latin text and English translations of the legends. TEXT AND TRANSLATION OF THE LEGENDS OF THE ORIGINAL CHART OF THE WORLD BY GERHARD MERCATOR, ISSUED IN 1569, INTERNATIONAL HYDROGRAPHIC BUREAU (1932).

11. Historically, it is known that Mercator derived his results by approximation, and that 30 years later Edward Wright developed a more accurate method of computation and tables for the construction of the projection which were made known in a publication entitled, "Certaine Errors in Navigation." Accurate values of *meridional parts,* however, did not become available until the calculus was invented more than a century later. DEETZ AND ADAMS, ELEMENTS OF MAP PROJECTIONS 104, SPECIAL PUBLICATION No. 68, U.S. COAST AND GEODETIC SURVEY (Revised 1944). This publication contains a comprehensive treatment of the Mercator projection, including a general table of meridional distances for the spheroid, and a method of construction.

12. The Atlantic Neptune collection is an atlas of charts compiled between 1775 and 1781 by Des Barres, the Royal Surveyor General for the colonies, from surveys by British naval vessels, from private surveys, and from records kept by the Lords of Trade.

It was not until the early part of the 19th century that governments began to recognize the wisdom of systematically surveying and charting their coastal regions as a necessary prelude to their commercial intercourse with other nations. This marked a new era in chart making and was the beginning of the accurate chart of today. In this country, as has been noted, the Coast Survey was created in 1807 to survey and chart the coasts of the United States, although actual work was not begun until a much later date.[13]

The modern nautical chart is the end product of many field operations—triangulation, topography, hydrography, tides and currents, and geomagnetism—and the office operations of compilation, reproduction, and maintenance.[14] Progressive improvement in the chart has therefore, in the main, been coextensive with the development of systematic surveying and of surveying techniques, including instrumentation and equipment.

## 621. A Geodetic Base for Charting

Triangulation provides the framework for the chart—it gives it rigidity and knits together all portions into a harmonious whole. Today, the whole of North America to the Bering Strait is coordinated on a single geodetic datum—the North American 1927 Datum—resulting in full coordination between the nautical charts of the Atlantic and Gulf coasts with those of the Pacific coast and Alaska. Even the distant, offshore islands in the Bering Sea are now connected with the triangulation network on the mainland of Alaska by a system of trilateration (a measurement of the sides of a triangle, as distinguished from triangulation in which the angles are measured), using electronic methods, the longest distance measured being 501 statute miles (*see* fig. 31). The successful completion of this project furnished a control net for hydrographic surveys from which accurate charting of this vast, strategic area can proceed with minimum danger to men and ships.[15]

13. The first chart published under the new governmental setup was of Bridgeport Harbor, Conn., in 1835.

14. Besides these Coast Survey sources, the best available data from other sources are also utilized. For example, information on aids to navigation is obtained from the U.S. Coast Guard (formerly, such information was furnished by the Bureau of Lighthouses of the Department of Commerce); controlling depths in dredged channels and depths in other areas where improvements are projected, and bridge and overhead cable clearances are obtained from the U.S. Corps of Engineers. In addition, charts frequently contain reported information, such as a shoal, a bank, an obstruction, etc., which, though perhaps of doubtful accuracy, must be charted as a matter of policy until such time as it can be verified or disproved.

15. For an account of the field work on this project and the accuracies obtained, *see* Pierce, *Datum Connection to the Bering Sea Islands,* and Meade, *Preliminary Adjustment of Shoran and EPI Observations in the Bering Sea,* 5 Journal, Coast and Geodetic Survey 3, 10 (1953).

## 622. Advent of Photogrammetry

The years preceding and following World War II saw the emergence and flowering of the science of aerial photogrammetry—the greatest advance in topographic mapping since the prototype of the modern planetable was developed by Johann Praetorius in the latter part of the 16th century (*see* fig. 68). Ground topographic methods are rapidly giving way to this more economical and more expeditious method of mapping from the air. The wealth of information and fullness of detail provided by an aerial photographic survey cannot be matched by any other practicable method of surveying. The development of multilens aerial cameras—together with stereoscopic plotting equipment for reducing the photographs to map form—gave considerable impetus to the mapping of difficult and inaccessible terrain, which could now be mapped with a minimum of ground control (*see* fig. 69).

The application of infrared photography to mapping of the high- and low-water lines will result in greater charting accuracy of these tide lines, particularly in areas that are difficult of access for identification of shoreline (*see* Part 1, 2232). Techniques have been developed for the use of this type of photography, in conjunction with tide observations, for charting riparian boundary lines based on tidal definition.[16]

The advent of photogrammetry in the Coast Survey has had two salutary effects on the nautical chart: (1) It has further increased the accuracy of the chart, particularly in inaccessible areas; and (2) it has brought within practicable scope the immediate revision of areas where natural or man-made changes have occurred—an important factor in safeguarding the sealanes.

## 623. Hydrographic Advances

From the standpoint of the nautical chart, the greatest advances made since the early days of charting have been in the field of hydrographic surveying. The correct charting of the water area is of supreme importance to the navigator because, unlike the land area, it involves features hidden from his view. Modern hydrographic methods permit the accurate delineation of the ocean floor with its intricate patterns of submerged valleys, shoals, ridges, and plateaus. These characteristic features serve the navigator as permanent submarine "land-

16. The low-water line survey of the Louisiana coast is an example of the application of these techniques to a difficult coastline where a high degree of accuracy was required. Full coordination between the photography and the height of the tide was essential to the execution of this project, and infrared photography provided a good contrast between land and water. For a full discussion of the technical problems encountered, *see* Volume One, Part 2, 17.

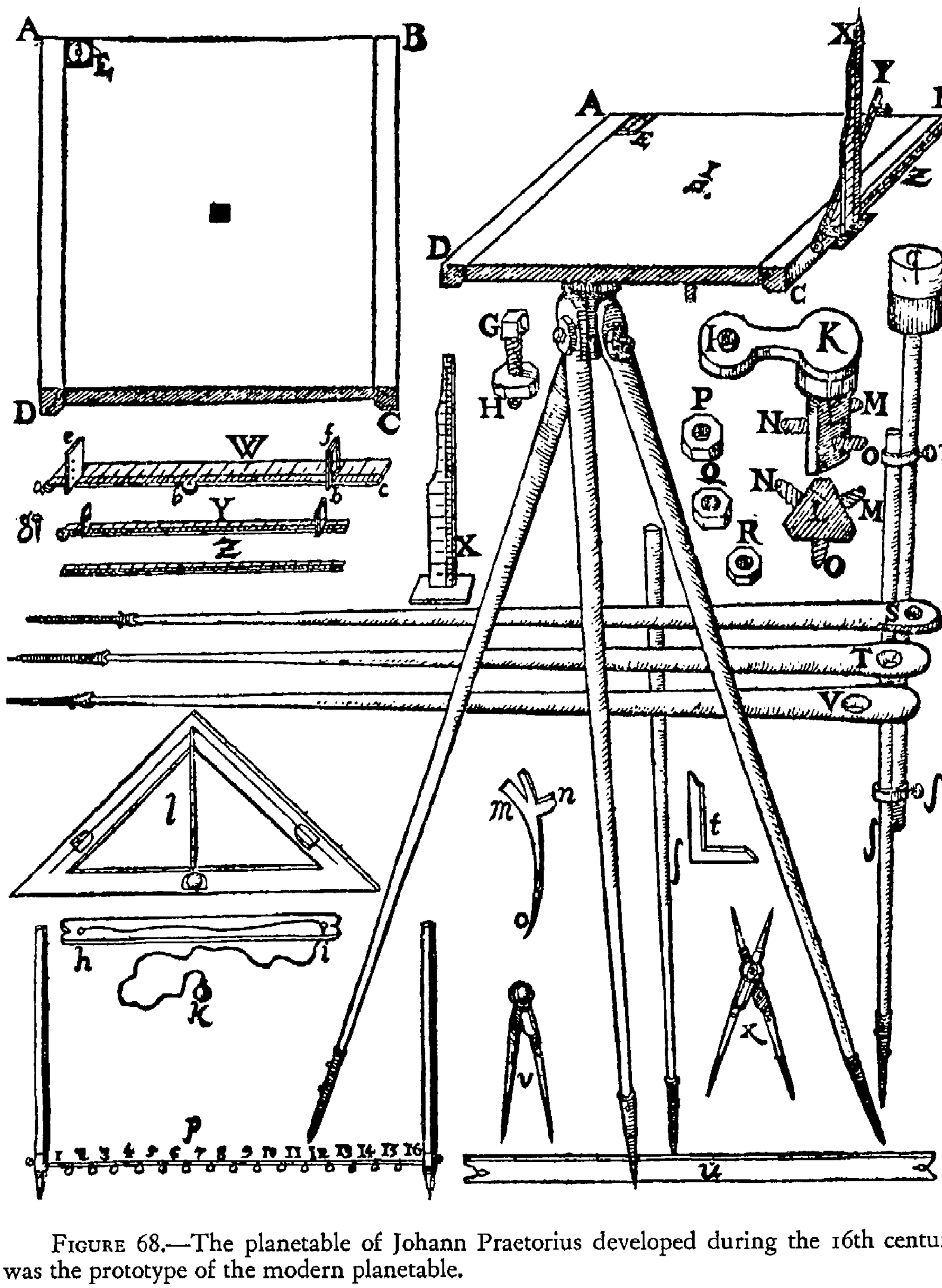

Figure 68.—The planetable of Johann Praetorius developed during the 16th century was the prototype of the modern planetable.

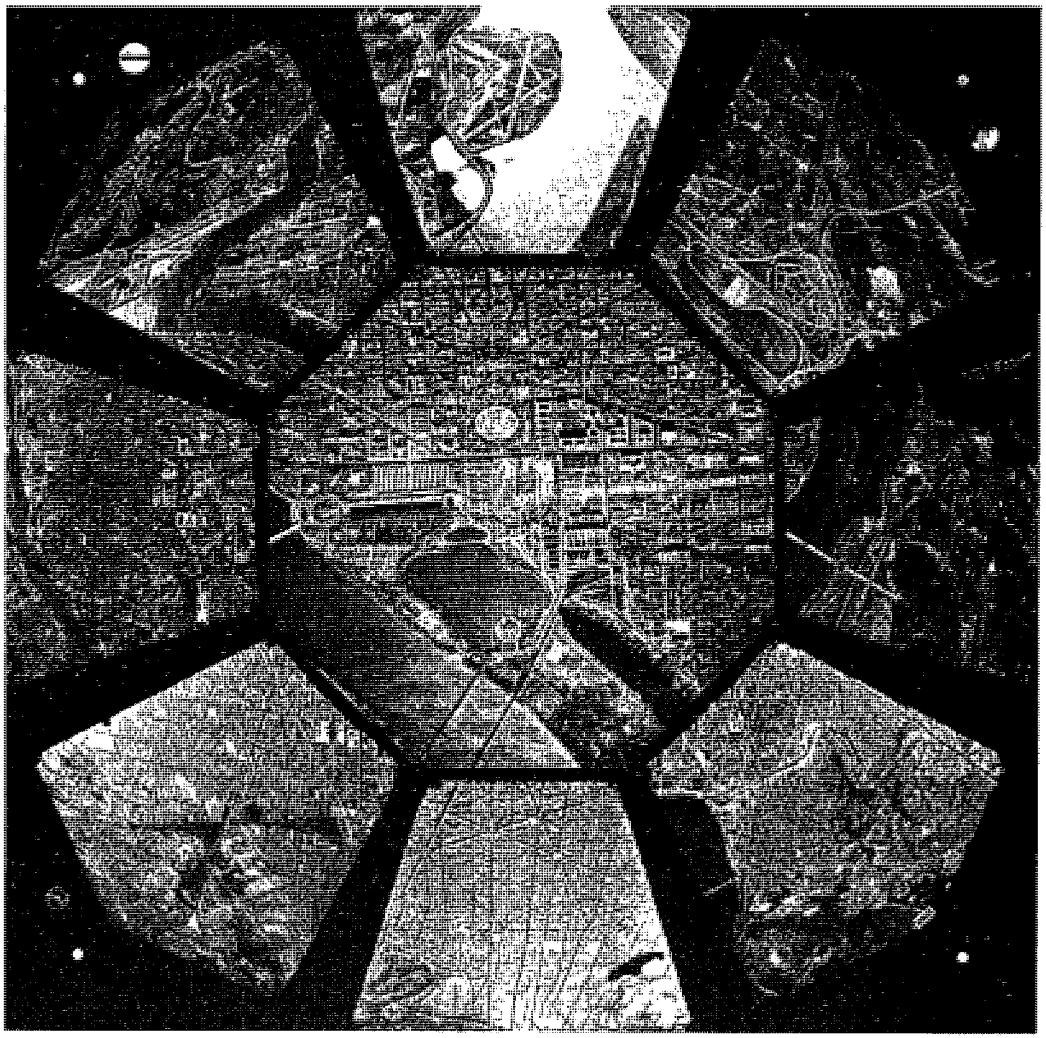

FIGURE 69.—Contact print from a nine-lens aerial camera negative, consisting of one vertical and eight oblique exposures. When transformed and rectified, each wing negative will be reversed and on opposite side of the film so as to form a single, composite print with geometrical characteristics of a single-lens photograph but with much greater angular coverage.

marks" for identifying his position at all times, irrespective of adverse weather conditions (*see* 6931(*b*)).

Developments in the science of hydrographic surveying, during the past three decades, have had a greater effect on the accuracy and usefulness of the nautical chart than the combined developments during the preceding hundred years. The old and well-known methods of sounding—the handlead and line

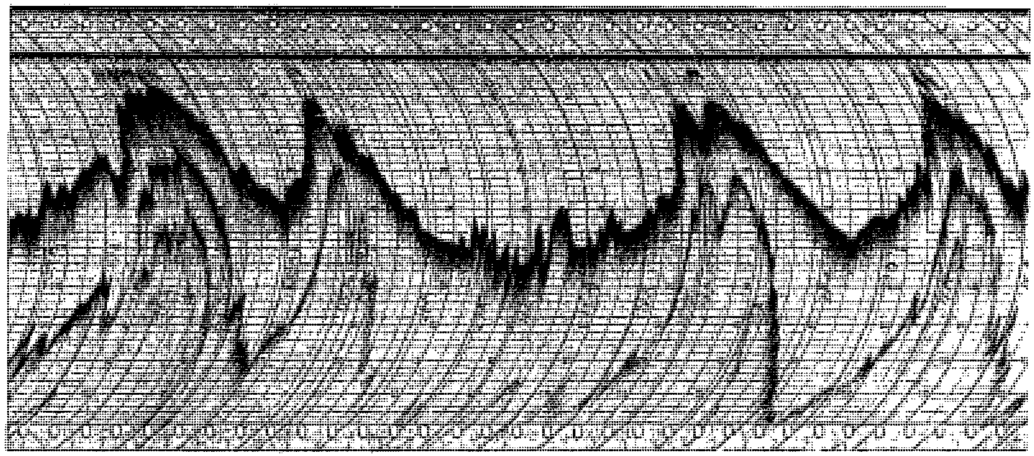

FIGURE 70.—Profile of the sea bottom obtained with a graphic-recording type of echo sounder. Graphic recorders trace electronically a continuous profile of the sea bottom over which the survey vessel is traversing and provide a permanent record (called a fathogram) on specially treated paper for later study. The shoalest depth shown in the figure is slightly over 7 fathoms near the left-hand edge.

for shoal water, and the wire-sounding machine for deep water—have given way to echo sounding (*see* fig. 70),[17] and electronic methods have superseded all previous less accurate methods of positioning the sounding vessel. The latter has undergone more radical changes during the span of the modern nautical chart than perhaps any other technique.[18]

The electronic era in hydrographic surveying began with World War II when Shoran, a form of radar, was developed for strategic aerial bombing. This technique was adapted by the Bureau to the accurate location of a survey ship's position. Being a line-of-sight system, it is limited, under practical operating conditions, to distances of 50 to 75 miles. To extend these limits, a new

17. Echo sounding is an outgrowth of the experimental work begun in 1912 for detecting the presence and nearness of icebergs, and of the submarine-detection devices developed during World War I. A sound impulse emanating from the survey vessel is reflected from the ocean bottom as an echo. The time elapsed for its receipt on the vessel affords a measure of the depth, if the velocity of sound in sea water is known. The latter is dependent upon the existing physical properties of the water—temperature, salinity, and pressure—and is determined during the progress of the survey. SHALOWITZ, SLOPE CORRECTIONS FOR ECHO SOUNDINGS, SPECIAL PUBLICATION NO. 165, U.S. COAST AND GEODETIC SURVEY (1930).

18. From the beginning of hydrographic surveying in this country, the position of the sounding vessel has been determined by sextant angles on signals ashore or afloat. This system is still used for inshore surveys (*see* 542). For offshore surveys, precise dead reckoning was developed together with refinements in celestial observations. Prior to development of modern electronic systems, a method was developed in the Coast Survey, known as Radio Acoustic Ranging (R.A.R.), which utilized underwater sound transmission and radio to determine the distance of the survey vessel from two or more known stations (*see* fig. 7). This method is no longer used. For a discussion of the principles underlying R.A.R. and some of the problems encountered in its use, *see* Shalowitz, *The Physical Basis of Modern Hydrographic Surveying*, 17 PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES 445 (1931).

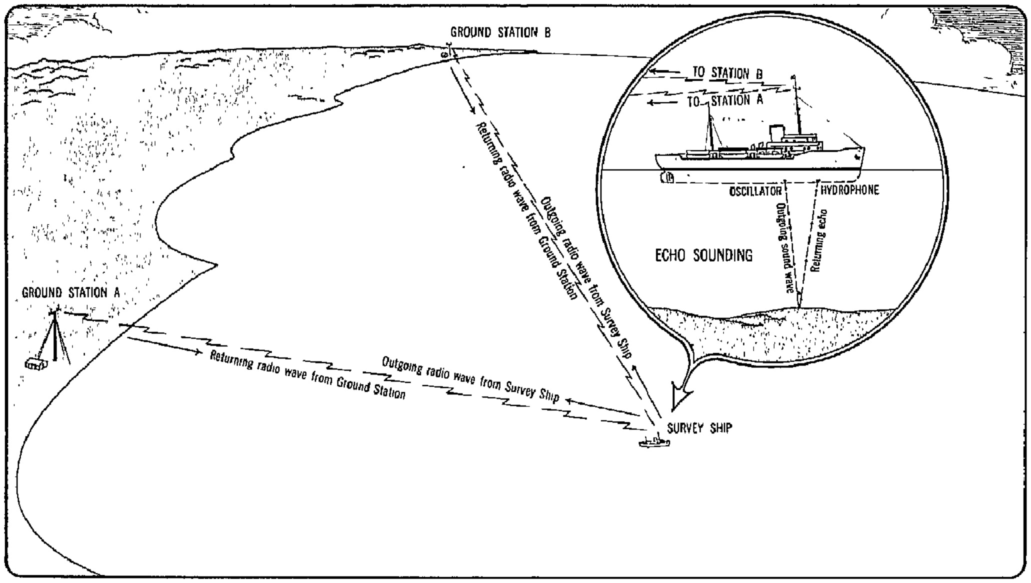


FIGURE 71.—Echo sounding and electronic position determination. While the ship's echo sounder measures the depths by sound, the position of the survey vessel is determined by electronic methods.

electronic device was developed—the Electronic Position Indicator (E.P.I.)—which made possible the precise measurement of distances in excess of 300 miles.[19] More recently, another electronic system—Raydist—using different principles has been utilized by the Coast Survey for determining a survey vessel's position.[20]

The acoustic and electronic methods have steadily pushed seaward the frontiers of accurate hydrographic surveys (*see* fig. 71). They have made feasible the survey of the intricate patterns of our continental shelves and slopes with an accuracy and completeness undreamed of by former methods. The rapidity with which ocean depths can be measured by echo sounding (a matter of seconds compared to the hour or more required by the older methods) has made it possible to take thousands of soundings in areas where formerly only a few scattered ones were economically feasible. Our sum total of geographic knowledge has thus been increased and many heretofore unknown submarine features, of major physiographic proportions, have been brought to light.

19. E.P.I. combined the long-range characteristics of Loran with the distance-measuring features of Shoran. Both Shoran and E.P.I. yield results within the limits of precision required in hydrographic surveying. For references to descriptions and use of these systems, *see* 542 note 30.

20. For references to description and use of this system, *see* 542 note 30.

## 624. Scientific Chart Making

With each accession of new data, resulting from surveying developments, the nautical chart improved in accuracy standards and in coverage. But the chart also developed in its own right, cartographically. Since publication of the early charts by the Coast Survey there has been a progression of improvements both in the character of the chart and in the methods of reproduction—all designed to enhance its value to the navigator and thus add to the safety of life and property at sea.

Chart making is a combination of the work of the cartographer, who compiles the engineering drawing, and of the engraver or lithographic artist, who translates the drawing into a finished product for quantity reproduction. Chart compilation is a process of selection. The usefulness and accuracy of the chart depend not only upon the material entering into its construction, but also upon the critical appraisal of such material and upon the intelligence with which the essentials are portrayed (*see* fig. 72). "Easy reading is hard writing" may well apply to the modern nautical chart. The skilled cartographer must sift from the mass of data before him the important from the unimportant, the strong from the weak, the stable from the changeable. Some data he rejects entirely, some in part, and from the rest he coordinates and selects the information that is to appear on the finished chart.[21]

In addition to these engineering elements, the compiler is ever conscious of the importance of artistry in the chart. Overcrowding of material is avoided lest it confuse the navigator, and the arrangement is orderly so the chart will not appear off balance. It is just as important to make proper and effective use of various forms of graphic presentation in the chart as it is to study the values of different methods of verbal or written presentation.

### 6241. *A New Type of Nautical Chart*

The most significant advance in nautical chart design, since the introduction of colors (*see* 6242), was made in March 1939 when the Coast Survey published the first chart in which special emphasis was given to depth contours.[22] The installation of echo-sounding apparatus on naval and merchant vessels signaled the need for a new type of chart—one that would enable the

21. An amazing amount of material is required to produce a single nautical chart. Figure 73 shows the field survey sheets, sounding and tidal records, volumes of triangulation and magnetic data, and miscellaneous reports used in the making of a single nautical chart of the Coast Survey.

22. This was chart 5101A, San Diego to Santa Rosa Island, Calif. *See* Adams, "*On Soundings,*" 65 United States Naval Institute Proceedings 1121 (1939).

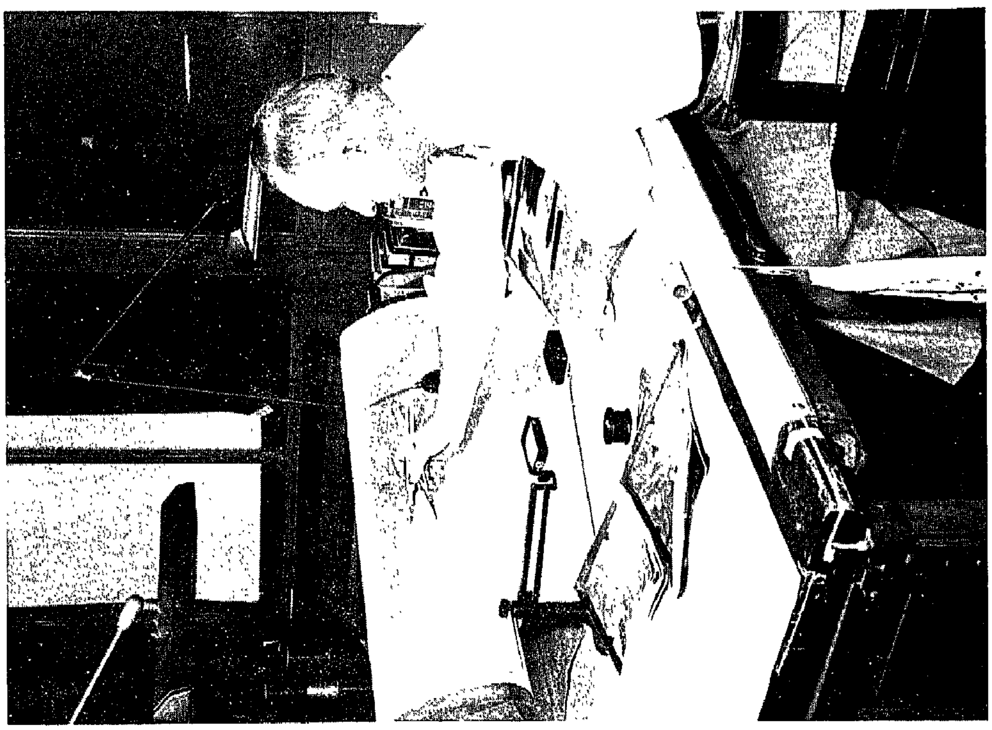

FIGURE 72.—Chart compilation is a process of selection.

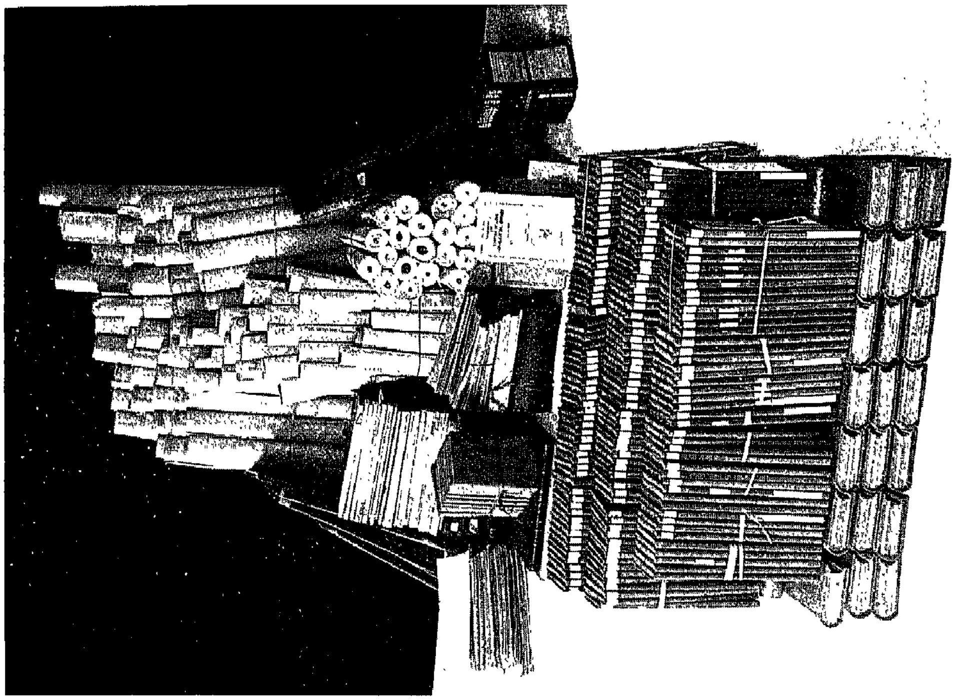

FIGURE 73.—Source material for a single nautical chart.

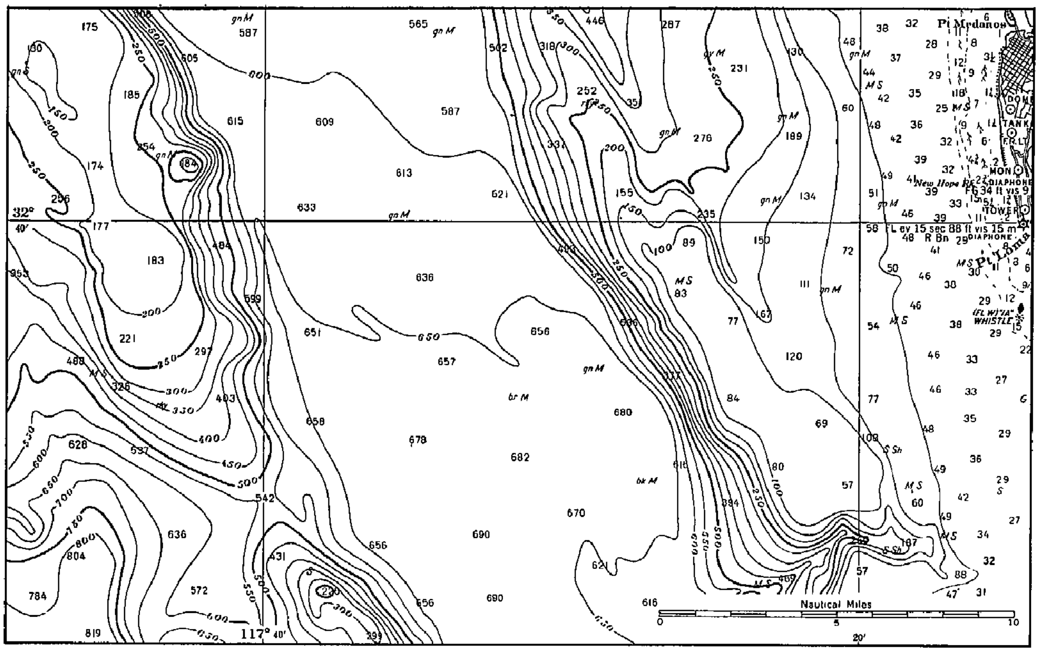


FIGURE 74.—A new type of nautical chart was designed in 1939 which utilized depth contours to emphasize submarine configurations useful to the navigator in locating the position of his vessel. Formerly, charts were characterized by many soundings but few depth contours.

navigator to utilize fully the new sounding technique for fixing his position at sea. It is axiomatic that the more faithfully the chart portrays the submarine relief, the greater will be its usefulness to the navigator. The answer was not found in an increase in the number of soundings charted; this was already a characteristic of the conventional chart. What was called for was a method that portrayed in a simple and usable manner, the wealth of submarine information provided by modern hydrographic surveys. The new chart was the result (*see* fig. 74).

In this chart, depth contours, which are equivalent to land contours on a topographic map, are given special emphasis. In the drawing of the contours, full use is made of all the soundings obtained on the hydrographic survey. Each depth contour, when properly controlled, is the equivalent of an infinite number of soundings of equal depth. Characteristic features of the ocean bottom are brought into prominence. These features are comparable to permanent landmarks and provide the navigator with a simple method for identifying his position by comparing a line of echo soundings with the charted depth contours (*see* 6931(*b*)). Because of the large number of soundings obtained on a modern, echo-sounding survey, the term "depth contour" is appropriate (*see* 563 note 58).[23]

### 6242. *The Reproduction Process*

On the reproduction side, we have indeed traveled far from the early days of copper engraving and plate printing. Charts of this period were entirely engraved by hand—every line, every figure, and every letter. Many were artistic masterpieces. The fineness of detail that was possible by this method of reproduction afforded the chart engraver an opportunity for artistic expression seldom equalled in any other method. These early charts were all black and white reproductions. Many were embellished with elaborate views of harbor entrances and headlands for the guidance of mariners, one of the finest of these being of Anacapa Island, off the southern California coast (*see* fig. 75), engraved by James McNeill Whistler while employed in the Coast Survey.[24]

The introduction of photolithography in chart reproduction has made it possible to use colors for emphasizing important navigational features—for example, the coloring of buoys to correspond to their colors on the ground; the accentuation of lighted aids to navigation by using a color overprint; and the use of tints for the land and the shoal-water areas. The nautical chart of today is a synthesis of the utilitarian and the artistic, and is suitable for meeting present-day demands for quality and quantity production. Today each rotary lithographic press in the Coast Survey is capable of printing 3 to 5 thousand impressions an hour, as compared with the 100-a-day maximum that was possible with the older method of printing directly from engraved copper plates.

The greatest single contribution the Survey has made to the reproduction process has been the development of negative engraving (now commonly referred to as "scribing") around the turn of the century. This technique was first used as a more economical means of revising nautical charts. Revisions were applied directly to the wet-plate glass negatives using the conventional engraving needles then in use. Later, entire nautical charts were reproduced by this method. The compilation manuscript was photographed on glass

23. This type of chart was not possible before the advent of modern hydrographic methods because the contours could not be delineated with sufficient accuracy. As a matter of historical interest, it should be noted that contours were actually used for delineating the floor of the ocean even before their use on land (*see* 563).

24. Whistler's stay in the Survey was brief but hectic. The rules of the Office he soon found too exacting for his artistic temperament, and he became a habitual late-comer. When chided about it in later years, his biographer tells us, he invariably replied: "It was not that I arrived too late in the morning, but the office opened up too early."

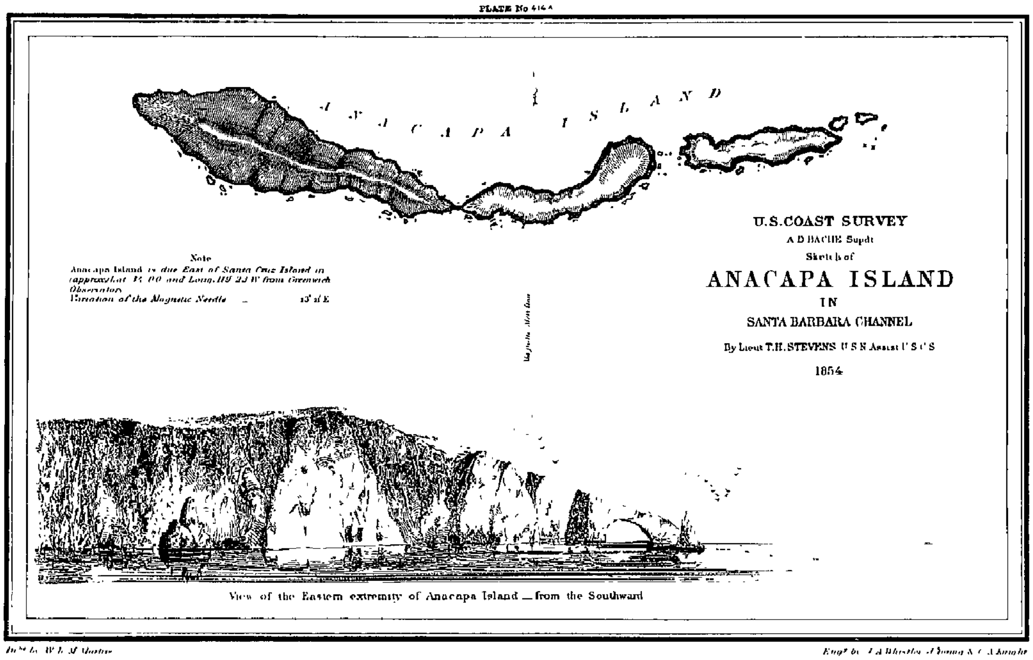


FIGURE 75.—The early charts of the Coast Survey sometimes included sketches of the prominent headlands for the guidance of the mariner. In this sketch of Anacapa Island, Calif., the artistic work of James McNeil Whistler is illustrated.

negatives. These were then coated with an emulsion that was pervious to light and so afforded the engraver with a facsimile of the manuscript. In 1935, the first engraving tool for specific use on glass negatives was designed. A special assignment of reproducing maps for the Tennessee Valley Authority gave impetus to the design of additional tools, and by 1940 all the basic instruments and techniques in universal use today had been perfected in the Bureau. Both glass and plastic are now used for negative engraving. In the Coast Survey, the direction is toward complete conversion from drafting to scribing of final copy, in both the chart production and reproduction stages, so as to realize all of the inherent quality and economy of the technique.[25]

## 625. Classification of Charts

The design of a nautical chart depends upon the needs of navigation in a particular area. A transoceanic liner, sailing between distant ports and re-

25. For a detailed description of the various steps involved in the production and reproduction of nautical charts, *see* Bruder, *Modern Nautical Charts,* MARINE NEWS 16 (Feb. 1957).

stricted to the main channels in entering a port, does not need the same information on a chart that a small pleasure boat needs while cruising in protected waterways, and which may be required to venture into unfamiliar places. The amount of detail, physiographic and geographic, that can be adequately shown on a chart is dependent on its scale (*see* 131). To meet these different needs, a variety of scales is used, ranging from 1:2,500 to about 1:5,000,000. Large-scale charts cover relatively small areas and are used by the mariner for inshore or harbor navigation; small-scale charts covering large areas are used for offshore navigation. For convenience of reference, Coast and Geodetic Survey charts are classified according to scale as follows:

(*a*) *Sailing Charts,* scale 1:600,000 and smaller, are used for planning and for fixing the mariner's position as he approaches the coast from the open ocean, or for sailing between distant coastwise ports. On such charts the shoreline and topography are generalized and only offshore soundings, the principal navigational aids, outer buoys, and landmarks visible at considerable distances are shown. The 1000 series along the Atlantic and Gulf coasts and the 5000 series along the Pacific coast exemplify this type of chart.

(*b*) *General Charts,* scale 1:100,000 to 1:600,000, are for coastwise navigation outside of outlying reefs and shoals. On this type of chart, features are still generalized to a certain degree but not to the extent of the sailing chart. The 1100 series along the Atlantic and Gulf coasts and chart 5202 along the Pacific coast are examples of General charts.

(*c*) *Coast Charts,* scale 1:50,000 to 1:100,000, are for inshore navigation where the course may lie inside outlying reefs and shoals, for entering or leaving bays and harbors of considerable width, and for navigating large inland waterways. The 1200 series along the Atlantic and Gulf coasts, at a scale of 1:80,000, belongs to this class. This is the largest-scale continuous series of charts along these coasts, and although constructed on the Mercator projection (*see* 613), the latitude extent of each chart is sufficiently limited to allow a uniform scale to be used throughout the chart, thus making it useful for a variety of purposes other than navigation. Along the Pacific coast, a continuous series of Coast charts is available for Puget Sound and surrounding area. Chart 5142 of San Pedro Channel is the only chart of this series along the outside coast.

(*d*) *Harbor Charts,* scales larger than 1:50,000, are for navigation in harbors, anchorage areas, and the smaller waterways. The greatest amount of detail consistent with the scale used is shown on these charts. They show channels, soundings, bottom characteristics, shoreline, depth curves, aids to navigation, cable areas, anchorage areas, and other information. There is no continuous series in this classification.

(*e*) *Intracoastal Waterway Charts,* scale 1:40,000, embrace the inside route of New Jersey; the route from Norfolk, Va., to Key West, Fla.; across Florida from St. Lucie Inlet to Fort Myers, Charlotte Harbor, Tampa Bay, and Tarpon Springs; and from Carabelle, Fla., to Port of Brownsville, Tex. They are special-type charts in both format and content, designed especially for small-boat operators and yachtsmen. In February 1962, a new format was adopted for this series. The charts are accordion folded in a handy folio jacket and are especially suited for plotting in close quarters. As these charts are converted to the new format, they will be included in the Small-Craft series with the letters "SC" added to the numbers (*see* (*f*), below).

(*f*) *Small-Craft Charts,* generally at scales 1:40,000 and 1:80,000, are another of the special series, designed for maximum usefulness to the yachtsman and the small-boat operator. They are issued in folio form or as a single sheet printed on both sides in a suitable folder and contain information in tabular and pictorial form not included on the standard charts of the Bureau. This class of charts was begun in 1959 and thus far (Aug. 1963) is available for Long Island Sound, the Potomac River, the Florida Keys, San Francisco Bay, and Puget Sound. Eventually, such charts will be published covering most of the active coastal boating areas. In some areas, the conventional charts are also being published in folded format with an overprint of small-craft information. These are then designated as Small-Craft charts and the letters "SC" added to the number. (*See* 1271 B.)

## 63. CHART ACCURACY AND RELIABILITY

The most important criteria by which the value of a nautical chart may be measured are its accuracy, adequacy, and clarity. The accuracy of a chart depends on the quality of the field surveys; its adequacy is a combined responsibility of the hydrographic and the cartographic engineers; and its clarity results entirely from the good taste and judgment which the cartographic engineer injects into the compilation.

Inasmuch as a chart is a compilation of one or more surveys, it is axiomatic that its accuracy must be dependent upon the accuracy and thoroughness of the surveys on which it is based; it cannot be more accurate, no matter how painstaking the process of compiling has been or how artistic the final product is. And, in turn, the date of a survey is, in general, a good indication of its thoroughness, and possible accuracy. A century ago there were such vast unsurveyed areas that the hydrographer was sometimes obliged to subordinate completeness to speed, for even an inadequate chart was better than no chart. Since that time, decade by decade, standards have become stricter, new methods and instrumental equipment have been devised, and new concepts of adequacy have been adopted—all of which have added immensely to the accuracy and reliability of the chart.

The scales of most hydrographic surveys are at least twice, and often several times, as large as the scales of the charts on which the information appears. The effect of this reduction in scale is to reduce the errors of plotting to an amount which, for all practical purposes, is not measurable at the chart scale. On the other hand, a line or dot of 0.01 inch thickness on a 1:80,000 scale chart would represent a distance on the ground of 66 feet, whereas on the scale of the original survey (1:10,000 or 1:20,000) the same line or dot would represent a distance of 8 feet or 16 feet, respectively. It is obvious, therefore, that, if it can be avoided, the chart should not be used for a quantitative determination of shoreline changes, or for the establishment of an early tidal shoreline on the ground, where the original surveys would afford a better criterion.

In evaluating the adequacy or reliability of a chart, one criterion that may be used is the fullness or scantiness of the soundings. Each sounding represents an actual measure of depth and location, but it represents that depth over only a small area. And each line of soundings represents only a narrow width. Consequently, in coral regions, or where rocks and boulders exist, it is always possible that soundings, however detailed, may have failed to find every small obstruction unless the survey has been supplemented by the wire drag and it is so indicated on the chart (*see* 666(*c*)). Large or irregular blank areas among soundings, or absence of depth curves, generally mean that no soundings were obtained in these areas. When the nearby soundings are deep, it may generally be assumed that the water in the blank areas is also deep; when the surrounding water is shallow, or if the chart shows that reefs or banks are present in the vicinity, the possibility is strong that similar conditions exist in the blank areas.

Cognizance must also be taken of the fact that where the bottom is composed principally of mud and sand and strong currents or heavy surf exist, changes in the shore or in the bottom may be relatively rapid and may have taken place since the last survey was made. This is especially true around the entrances to some bar harbors, bays, and rivers. In localities where the bottom is known to change rapidly, notes are usually printed on the chart calling attention to this fact.

The publication of a chart, therefore, by no means completes the problem of the chart maker. Change, not stability, is the order of nature. This finds significant expression along the seacoast and the littoral. Breakwaters and jetties are built, channels and harbors are dredged, and new paths of commerce are opened. Rivers empty vast quantities of sediment near their mouths and thus build out the coastline and change the underwater configurations. Charts must be kept alive if they are to serve their purpose properly. They must be revised frequently to give an accurate and up-to-date picture of existing conditions.

This responsibility for maintaining high accuracy standards and for keeping the navigator fully informed of vital changes in the chart has always been recognized by the Bureau. In recent years, an added element has appeared that has made the Bureau even more conscious of the need for maintaining the highest accuracy standards in its nautical charts. This has resulted from passage by Congress of the Federal Tort Claims Act and the liberality (in favor of claimants) with which the Supreme Court has interpreted it. Because of its implications for federal charting agencies, and because of its importance to administrative officers of the Bureau upon whom rests the responsibility for disseminating navigational information to the seafaring public, the essentials of the act will be discussed together with the interpretations placed on it by the courts in various maritime situations.[26]

## 631. The Federal Tort Claims Act

The general principle of law involved in suits against the Government is that they cannot be instituted without the Government's consent. This stems from the English common-law doctrine that the King can do no wrong. This doctrine was repudiated in America at quite an early date, but in its place there grew up a legal doctrine that the Crown was immune from suits to which it had not consented. After the American Revolution, the doctrine of consent was invoked on behalf of the Republic and was vigorously applied by the courts. As the activities of the central government broadened, the number of remediless wrongs multiplied—wrongs which would have been actionable if inflicted by an individual or a corporation, but remediless because committed by an agency of Government.

The Federal Tort Claims Act is essentially a waiver-of-immunity statute and marks the culmination of nearly 30 years of effort to mitigate unjust consequences of sovereign immunity from suit.[27] The act waives sovereign immunity of the United States from suits in tort and permits claims for injury "caused by the negligent or wrongful act or omission of any employee of the Government while acting within the scope of his office or employment, under circumstances where the United States, if a private person, would be liable to the claimant for such damage, loss, injury, or death in accordance with the law of the place where the act or omission occurred." [28]

### 6311. *Limitation of Liability*

The act does not apply to all cases of negligence. The waiver of immunity is circumscribed by 13 exceptions, the most important being the so-called "discretionary function exception," which provides that the act shall not apply to "any claim based upon . . . the exercise or performance or the failure to

26. For a fuller treatment of the act in relation to a particular maritime situation, *see* Shalowitz, *Federal Liability for Failure of Navigational Aids*, 7 Journal, Coast and Geodetic Survey 98 (1957).

27. The act was passed in 1946 as Title IV of the omnibus Legislative Reorganization Act (60 Stat. 842).

28. 60 Stat. 844 (1946). Prior to the passage of the act, the only remedy that an aggrieved claimant had for damages resulting from the negligent act of a federal employee was to have a private bill passed compensating him for the loss sustained. The alleviation of this costly and burdensome procedure of private relief bills was the other facet of the purpose of the Tort Claims Act.

exercise or perform a discretionary function or duty on the part of a Federal agency or an employee of the Government, whether or not the discretion involved be abused." 60 Stat. 845 (1946). It is around this exception that many of the cases revolve.

The act furnishes no yardstick for ascertaining what a discretionary function is, and courts have struggled with this exception ever since the first case arose. In the early cases, the lower Federal courts, lacking Supreme Court interpretation, had applied the exception in the light of the circumstances involved and in an effort to balance the general purpose of the act against the practical necessity of leaving the Government free from crippling interferences. It was natural that such judicial construction would not be uniform, and no satisfactory answer was produced for determining exactly where the delicate line of immunity from liability was to be drawn in the complex scale of governmental operations.[29]

### 6312. *The Discretionary Function Exception in the Supreme Court*

In the first case to come before the Supreme Court involving an application of the discretionary function exception, the Court sharply divided on the interpretation of the exception with respect to a particular factual situation. The case was one of imposing magnitude resulting from the Texas City disaster in 1947, in which 560 persons died and 3,000 were injured. Out of the holocaust arose 273 claims for wrongful death, personal injuries, and property damage, aggregating some $200,000,000.[30] Faced with a complex factual situation, reflected by an enormous record, the Court—resting on the legislative history of the act, which assured protection for the Government against liability for errors in administration or in the exercise of discretionary functions—held in a 4 to 3 decision that the acts or omissions complained of fell within the discretionary function exception on the basis that the exception includes not only determinations by executives and administrators in establishing plans, specifica-

29. In a number of cases, the rule was adopted that even if the decision is discretionary, once made the Government must thereafter proceed with due care. In other cases, the courts have examined the statute, regulation, or order under which the agency or the employee was operating at the time, and if words expressly providing for the use of discretion, such as "may," were present they were made the basis for the decision. And *contra,* where the statutory language leaves the agency or employee with no choice but to perform an act, courts have held the act to be non-discretionary and must be performed with due care.

30. *Dalehite* v. *United States,* 346 U.S. 15 (1953). The disaster resulted from the spontaneous combustion of ammonium nitrate fertilizer which was being loaded onto ships, under Government auspices, as part of a foreign aid program. The negligence alleged was in the manufacture, packaging, and transportation of the explosive material without warning of the possibility of explosion, and the negligence of the Coast Guard in failing to supervise its storage and in fighting the fire after it started.

tions, or schedules of operations, but also *the acts of subordinates in accordance with official directions.* "Where there is room for policy judgment and decision," the Court said, "there is discretion." (The Court also noted the traditional immunity of public bodies for injuries due to firefighting.)

While the Court made no attempt to define the scope of the exception, but rather chose to apply it in an *ad hoc* manner to the facts in hand, the effect of the decision was to extend the area of discretionary function further down the scale toward the operational level. Nevertheless, it did not close the door to recovery for all subsequent actions arising from a discretionary function.[31]

Two years later, in *Indian Towing Co.* v. *United States, infra,* the Supreme Court came to closer grips, albeit obliquely, with the application of the discretionary function clause, in one of the first maritime tort cases to come before it under the Tort Claims Act. The case concerned the grounding of the tug *Navajo* on Chandeleur Island, La., and the severe damage sustained by its cargo, it being alleged that the grounding was due solely to the failure of the light on the island, which in turn was caused by negligence of the Coast Guard in not keeping the light in repair or give warning that the light was not operating.

The case was dismissed by the District Court for Louisiana on the ground that the Government had not consented to be sued, and this was affirmed by the Court of Appeals for the Fifth Circuit. On appeal to the Supreme Court a hearing was granted because the case presented an important aspect of the still undetermined extent of the Government's liability under the Tort Claims Act. On rehearing, the judgment of the lower court was reversed and the case remanded to the district court for further proceedings.[32]

It was contended by the Government that the section of the act which imposes liability in the same manner and to the same extent as a private individual under like circumstances must be read as excluding liability in the performance of activities which private persons do not perform.[33] But the Court denied that immunity attached to uniquely governmental activities, since all governmental activity is inescapably "uniquely governmental" in that it is

31. Without defining precisely where discretion ends, there is clear implication in the majority opinion that a distinction exists between injuries flowing from decisions made at a planning level and those arising on the operational level.

32. *Indian Towing Co.* v. *United States,* 350 U.S. 61 (1955). At the first hearing before the Supreme Court, the judgment of the Court of Appeals was affirmed by an equally divided Court (4 to 4). On petition for rehearing, the earlier judgment was vacated and the case reargued before the full bench. The Court then voted for reversal by a 5 to 4 decision.

33. This contention followed the holding in *Feres* v. *United States,* 340 U.S. 135 (1950), which denied liability for injury sustained by a member of the Armed Forces, *while on active duty,* through the negligence of others in the Armed Forces, on the ground that no private individual has power to conscript or mobilize a private army, and that the purpose of the act "was not to visit the Government with novel and unprecedented liabilities." The *Dalehite* case, *supra* note 30, followed the same reasoning with respect to firefighting.

performed by the Government. It said that the statute imposing liability on the United States "as a private individual under like circumstances" does not depend upon the presence or absence of identical private activity, and that "it is hornbook tort law that one who undertakes to warn the public of danger and thereby induces reliance must perform his 'good Samaritan' task in a careful manner."

On the matter of the discretionary function exception, the crux of the opinion is contained in the following significant passage:

> The Coast Guard need not undertake the lighthouse service. But once it exercised its discretion to operate a light on Chandeleur island and engendered reliance on the guidance afforded by the light, it was obligated to use due care to make certain that the light was kept in good working order; and, if the light did become extinguished, then the Coast Guard was further obligated to use due care to discover this fact and to repair the light *or give warning that it was not functioning.* (Emphasis added.) [34]

The Court's interpretation of "like circumstances" in the statute as not meaning "identical circumstances" broadens its scope and opens the door to many situations that would otherwise be barred under previous rulings of the Court.[35]

### 6313. *Maritime Tort Cases in the Lower Federal Courts*

Several cases in the "maritime tort" class have been decided in the lower Federal courts, but all were prior to the Supreme Court decision in *Indian Towing,* and therefore exhibit conflicting interpretations of the act. For example, in *Somerset Seafood Co.* v. *United States,* 193 F. 2d 631 (1951), the Government was held liable for the negligent marking of a wreck on the basis that under the Wreck Acts (30 Stat. 1152 (1899)), the duty to mark and remove the wreck was mandatory. But the court went even further and stated, by way of dictum, that even if the decision to mark or remove the wreck be regarded

34. *Indian Towing Co.* v. *United States, supra* note 32, at 69. On remand (*see* text at note 32 *supra*), the district court found in favor of the United States (on the basis of the evidence) and dismissed the suit on the ground that the "casualty complained of was not caused or contributed to by any act or neglect of governmental personnel but was occasioned solely by negligence, fault, carelessness and incompetence in the maintenance and operation of the *Navajo* and her tow." Of particular interest was the court's finding, as a matter of law, that the *Navajo* was unseaworthy because, among other things, "she did not have tide and current tables, which were necessary navigational information." *Indian Towing Co.* v. *United States,* 182 F. Supp. 264, 270 (1959). This was affirmed by the United States Court of Appeals for the Fifth Circuit in 276 F. 2d 300 (1960), and *certiorari* denied by the Supreme Court in 364 U.S. 821 (1960).

35. *See,* for example, the *Feres* and *Dalehite* cases, *supra* note 33. *See also Sigmon* v. *United States,* 110 F. Supp. 906 (1953), which barred recovery for injuries to federal prisoners, and *National Mfg. Co.* v. *United States,* 210 F. 2d 263 (1954), which barred recovery for injuries arising from an erroneous flood forecast, on the ground that private persons do not operate prisons or disseminate flood information. *But see* text following note 39 *infra* for recent Supreme Court holding with respect to suits by federal prisoners.

as discretionary, there is liability for negligence in marking after the discretion has been exercised and the decision to mark has been made. "There is certainly no discretion," the court said, "to mark a wreck in such way as to constitute a trap for the ignorant or unwary rather than a warning of danger." *Id.* at 635. (This dictum is in keeping with the Supreme Court's holding in *Indian Towing*.)

In *Kline* v. *United States,* 113 F. Supp. 298 (1953), the court refused to go along with the dictum in the *Somerset Seafood* case, and held the Government not liable for failure to rebuild a range light because the Coast Guard had discretion under the statute as to whether, when, and how lights should be restored.[36] The court also held that considering the difficulties and delays that Government departments sometimes experience in getting appropriations even for emergencies, and in drawing specifications, advertising for bids, letting contracts, and getting a job done, even after appropriations have been made, a delay of 3 months in restoring the range light would not constitute negligence.

In *Bray* v. *United States,* 1954 A.M.C. 308 (1953), the complaint charged that the failure of a lighted buoy, maintained by the Coast Guard, to be lighted, or properly lighted, was the cause of damage. In denying recovery, the district court did not rely on the permissive wording of the statute under which the Coast Guard was authorized to establish and maintain aids to navigation, but rather on the ground that it is a provision for fostering shipping and does not declare a duty actionable at law, in equity, or in admiralty. Under the doctrine of the *Dalehite* case, the court held that the discretionary function exception of the Tort Claims Act precluded jurisdiction of the case because the Coast Guard was performing a governmental function.

The case of *Thompson* v. *United States,* 111 F. Supp. 719 (1953), involved damage to a yacht as a result of the mast striking an overhead cable. The cable and height were properly shown on the Coast Survey charts, but no information was given that it was a high-voltage cable. The court found for the United States on the ground that the plaintiff had knowledge of its high-voltage character, and hence the omission of such information from the chart would have no causal connection to the accident. Although the court intimated that the proper place for a warning as to the high-voltage nature of the cable would have been on the nautical chart, it did not pass on the question whether failure to include such information would or would not fall within the purview of the discretionary function exception of the Tort Claims Act.

36. This case appears to be in direct conflict with *Indian Towing,* except for the court's finding that the record failed to show that the Coast Guard did not take adequate steps to warn the seafaring public that the range light was not in operation. The court also distinguished the *Somerset Seafood* case on the basis of the mandatory provision of the Wreck Acts.

*Everitt* v. *United States,* 204 F. Supp. 20 (1962), is one of the more recent cases involving a maritime tort. This arose as a result of damage to a boat in Aransas Bay, Tex., allegedly caused by the negligence of the Corps of Engineers in not removing broken-off piling which had been submerged for over 6 months. The piling was part of a reference line, consisting of a series of creosote logs, 6 inches in diameter and 20 feet high, placed at intervals of 1,000 feet, which the engineers used for surveying the channel once a year. The Government had contended that the decision to make annual surveys and replacements of reference-line pilings was the exercise of a discretionary function and fell within the exceptions in the act and for which the Government could not be held liable, even if abused. But under authority of the *Indian Towing* case, *supra* note 32, the court held that once the Corps of Engineers exercised its discretion to place reference-line pilings, it was obligated to use due care to make certain that the pilings, when not visible, were not so submerged as to come in collision with the boats using the bay.

### 6314. *The Recent Supreme Court Decisions*

While the decisions in the lower and higher Federal courts point up the great difficulty of drawing the line where federal immunity ends and liability begins under the Tort Claims Act—witness the closely divided Supreme Court in the *Dalehite* and *Indian Towing* cases—*Indian Towing* marked a definite trend toward a liberal construction (in favor of claimants) of the act generally and the discretionary function exception specifically.[37] This has now been buttressed by three other cases, each of which broadened the base of recovery under the act.

In *United States* v. *Union Trust Co.,* 350 U.S. 907 (1955), the Supreme Court, upon authority of *Indian Towing,* affirmed, in a *per curiam* opinion, the holding of the two lower courts that the United States was liable for the negligence of its control tower operators in regulating air traffic at a public airport, thus clarifying the meaning of the word "discretion" in the act (*see* 6311) as not applying to discretion exercised on the operational level. This narrows federal immunity from suit to those claims for negligence that arise from decisions made on a policymaking or planning level. But it still leaves open the question as to where the operational level begins at which Government liability attaches.

In *Rayonier Inc.* v. *United States,* 352 U.S. 315 (1957), which involved the question of federal immunity from liability for the negligence of the Forest Service in fighting a

37. This was the view taken by the Court of Appeals for the Fifth Circuit in *Fair* v. *United States,* 234 F. 2d 288 (1956), which involved the death of three persons shot by an Air Force officer who had been released from a government hospital following a discretionary decision by the medical staff. The court held that "the Government is liable for the actions of its employees dealing directly with the public in the application of established policies even if such employees are vested with a measure of discretion." *Id.* at 294. To the same effect is *Jemison* v. *The Duplex,* 163 F. Supp. 947 (1958).

forest fire, the Court, by a decided majority (7 to 2), vacated the judgments of both lower courts and held the intent of Congress to be that losses caused by the negligence of such employees be "charged against the public treasury." *Id.* at 320.[38] In holding that fire-fighting is not immune and that liability can attach to "uniquely governmental" activities, the Supreme Court to this extent overruled the *Dalehite* case. A significant facet of the *Rayonier* case was the Court's holding that "the very purpose of the Tort Claims Act was to waive the Government's traditional all-encompassing immunity from tort actions and to establish *novel and unprecedented* governmental liability." (Emphasis added.) *Id.* at 319.[39] The liberal trend in favor of claimants, evidenced in *Indian Towing* by a narrow margin (*see* note 32 *supra*), was given positive and unmistakable direction in *Rayonier.*

*United States* v. *Muniz and Winston,* 374 U.S. 150 (1963), is the most recent pronouncement by the Supreme Court on the scope and construction of the act. By a unanimous decion (one justice did not participate) the Court refused to read into the act an implied exception which would have barred federal prisoners from recovery for the negligent conduct of prison employees. It cited and endorsed the *Rayonier* case, by stating: "There is no justification for this Court to read exceptions into the Act beyond those provided by Congress. If the Act is to be altered, that is a function for the same body that adopted it." *Id.* at 166. The Court thus affirmed the finding of the Court of Appeals. It emphasized, however, that the Government is not without defenses since the act relieves it from liability if the claim is based upon *"the exercise or performance* or the failure to exercise or perform *a discretionary function or duty* on the part of a federal agency or an employee of the Government, whether or not the discretion involved be abused." *Id.* at 163. (The question involved was on the right to sue and not on the merits of the case.)

## 6315. *Implications for Federal Charting Agencies*

The recent Supreme Court cases hold important implications for all service agencies of Government, particularly those that deal with the safeguard and control of marine and air commerce. The present temper of the Court appears to be to hold these agencies to a stricter accountability for acts of negligence that result in injury to the public, and therefore pose new responsibilities for them, both in the matter of an exercise of greater care on the operational level and in the matter of duly warning the public of potential dangers. But neither is the navigator absolved from taking all necessary precautions to avoid disaster, for, in the final analysis, monetary recovery will depend upon the causal connection between the alleged negligence of the Government and the accident, and such matters as the claimant's failure to use the latest nautical charts, *Coast Pilots,* and *Notices to Mariners,* or to have *Tide Tables* and *Tidal Current Tables* aboard, or his failure to listen to daily broadcasts concerning aids and dangers to navigation, will directly affect the outcome. (*See,* for example, the *Indian*

38. The lower courts had dismissed the complaint on authority of the *Dalehite* case (*see* text at note 31 *supra*). This was prior to the *Indian Towing* case.

39. This statement is in conflict with the Court's statement in *Feres* v. *United States* (*see* note 33 *supra*). Since *Rayonier* did not overrule *Feres,* the latter must now be taken as limited exclusively to members of the Armed Forces on active duty.

*Towing* case on remand (note 34 *supra*) and the *Kline* case (text at note 36 *supra*), where, in denying Government liability, these criteria of prudent care were raised by the trial court.)

For the federal charting agencies, the decisions raise some interesting questions. In the gamut of operations involved in the publication of nautical charts and related data—from the inception of the field survey to the final printing—there are many levels of responsibility, below the overall policy or planning level, where matters of judgment and discretion arise. It is doubtful whether the doctrine of the *Indian Towing* case, limiting federal immunity to the exercise of the initial discretion, would be applicable in such situations. Since this case has not overruled the *Dalehite* case with respect to the level at which liability attaches, perhaps the true interpretation of the Tort Claims Act lies in the direction of both doctrines, and in considering each case on an *ad hoc* basis—in the light of the particular facts involved—keeping in mind the overall purpose of the act as expressed by Justice Frankfurter, namely: "The broad and just purpose which the statute was designed to effect was to compensate the victims of negligence in the conduct of governmental activities in circumstances like unto those in which a private person would be liable and not to leave just treatment to the caprice and legislative burden of individual private laws." [40]

As a result of actions brought under the Tort Claims Act involving Coast and Geodetic Survey charts, two practices have been adopted by the Bureau for safeguarding navigation—the addition of a "power" cable note on the charts (*see* chart 572 at Bush River), which grew out of *Thompson* v. *United States* (*see* 6313); and the addition of a warning note ("Danger Unexploded Bombs and Shells") and a special warning symbol marking the *San Marcos* wreck in Chesapeake Bay (*see* chart 1223).[41]

The Coast and Geodetic Survey has been responsive to the implications of the Federal Tort Claims Act in another area. In the early part of March 1962, the Bureau was faced with a critical charting situation growing out of one of the most turbulent, wind-driven tidal storms ever to strike the Atlantic coast from North Carolina to Long Island. The storm was equally devastating to the nautical charts of the Bureau which were made obsolete by the radical

40. *Indian Towing Co.* v. *United States, supra* note 32, at 68. For a recent treatment of various aspects of the Tort Claims Act, *see* Hunt, *The Federal Tort Claims Act: Sovereign Liability Today,* MILITARY LAW REVIEW 1 (Department of the Army Pamphlet No. 27–100–8, Apr. 1960).

41. This resulted from *Thomson* v. *United States,* 266 F. 2d 852 (1959), in which the court found the *San Marcos* wreck (the wreck of the old U.S.S. *Texas*) to be improperly marked but found the captain of the *Moby Dick* also negligent and therefore applied the admiralty rule of divided damages. On recommendation of the Justice Department to the Coast Survey, following the decision, the danger note and symbol were added to the chart.

changes in the shoreline and the underwater features. Recognizing the need for immediate action to safeguard the navigation of sealanes along the coast, the Survey mobilized a special land, sea, and air task force of about 300 men to resurvey the coastline. Photography was begun on March 13, less than a week after the storm had subsided, and on the following day emergency charting was begun. On March 28, the first 9 chartlets were issued and covered areas of significant change and importance to the mariner, commercial fisherman, and pleasure boatman. By April 13, or one month after the first aerial photographic film was available, 27 such chartlets were distributed for use as overlays on the existing nautical charts (*see* text following note 36 *supra*).[42]

Under Department Order No. 70 (Amended Oct. 26, 1959), the Director of the Survey, subject to approval of the Secretary of Commerce, may settle any claims against it arising out of the Federal Tort Claims Act, where the total amount of the claim does not exceed $2,500. *Regulations,* Coast and Geodetic Survey, at 02502D(1). Department Order No. 70 (Revised May 24, 1963) continues this limitation of amount of claim and sets out the procedures for making such claims.

## 64. PROJECTIONS FOR NAUTICAL CHARTS

The base or framework for any chart is the projection, that is, the systems of lines that represent the parallels of latitude and the meridians of longitude on the surface of the earth. Without this framework, the chart would lack the property that enables the navigator to plot his position readily and to lay down the ship's course with accuracy and ease. Since it is physically impossible to flatten the surface of a sphere without tearing, it is obvious that a strictly accurate representation of a portion of the earth's surface is not possible on a flat sheet of paper. Some distortion is inevitable, but the smaller the area embraced, the less appreciable will be the errors of representation. The underlying problem in map or chart projection is how to represent a portion of the spherical or spheroidal earth on a flat surface with the least amount of distortion (*see* 31, 32). This is resolved by preserving certain properties inherent in a spherical surface, but at the expense of others. The question of which properties to retain and which to sacrifice depends upon the purpose the map or chart is to serve.

42. For a fuller account of this emergency charting project and some results of the storm, *see Emergency Charting of Storm-damaged Atlantic Coast,* and *New Atlantic Seaboard Chartlets,* 54 THE MILITARY ENGINEER 276, 372 (1962).

## 641. The Mercator Projection

It was previously noted that the Mercator projection belongs to the conformal class where correct shape is preserved rather than correct size (*see* 613). Some of its characteristics and limitations were there noted. Although often referred to as a cylindrical projection with the cylinder tangent at the equator, it is best to consider it as derived by mathematical analysis, the spacing of the parallels bearing an exact relationship to the spreading of the meridians along a corresponding parallel. This expansion of the latitude and longitude scales approximates the secant of the latitude. The contrast between a perspective projection upon a tangent cylinder and a Mercator projection is shown in figures 76 and 77.[43]

From the standpoint of the user, the Mercator projection has a number of advantages, among which are simplicity of construction, the existence of a general table applicable to any part of the globe, convenience in plotting and scaling positions by latitudes and longitudes from the border divisions of the chart, and the fact that on it a course can be laid off from any meridian or compass rose within its borders. Its principal advantage (*see* 613), however, and the one responsible for its worldwide use for nautical charts, is that a straight line drawn on it in any direction is a rhumb line, or loxodromic curve. The track of a ship on a constant course is a straight line on the projection and will, at least theoretically, pass all features along that line exactly as charted. This is of great value in coastal navigation because the straight line representing a constant course to be made good will indicate at once the distance abeam that dangers will be passed.

Disadvantages of the Mercator projection are that it exaggerates areas appreciably—seriously when large differences of latitude are involved—and that the scale is constantly changing with latitude, so that a graphic scale cannot be used on the smaller-scale charts, and for measuring distances recourse must be had to the border scale for the latitude in which the distance lies (*see* 692). These disadvantages are in addition to that discussed previously regarding the plotting of radio bearings (*see* note 9 *supra* and accompanying text).

43. The only similarity that a Mercator projection has to a cylindrical projection is that meridians may be conceived as formed by passing planes through the earth's meridians, the intersections of the planes and the cylinder tangent at the equator forming straight, vertical lines. If the cylinder is now cut vertically and spread out, the projected lines will form the meridians on the Mercator projection. The dissimilarity between the two types of projections is emphasized in Special Publication No. 68 as follows: "It is thus misleading to speak of the tangent cylinder in connection with the Mercator projection, and it is better to discard all mention of its relation to a cylinder and to view it entirely as a conformal projection upon a plane . . . . The distances of the various parallels depend upon an integral, and the required values are not obtained by any simple formula." Deetz and Adams (1944), *op. cit. supra* note 11, at 111.

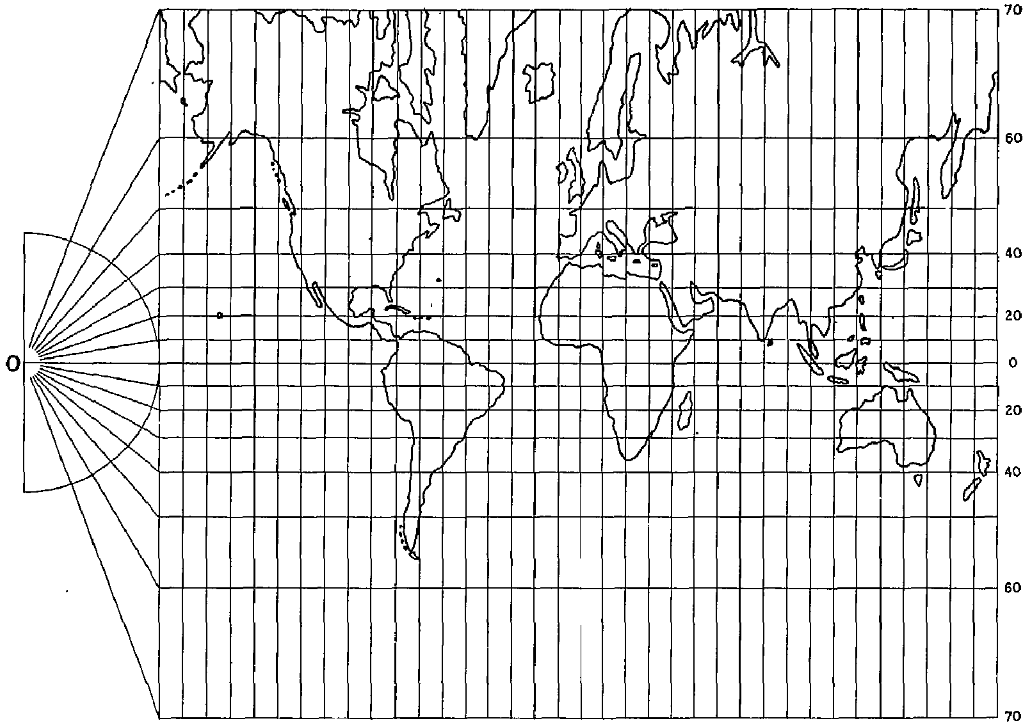


FIGURE 76.—Perspective projection upon a tangent cylinder. The contrast with a Mercator projection is shown in figure 77.

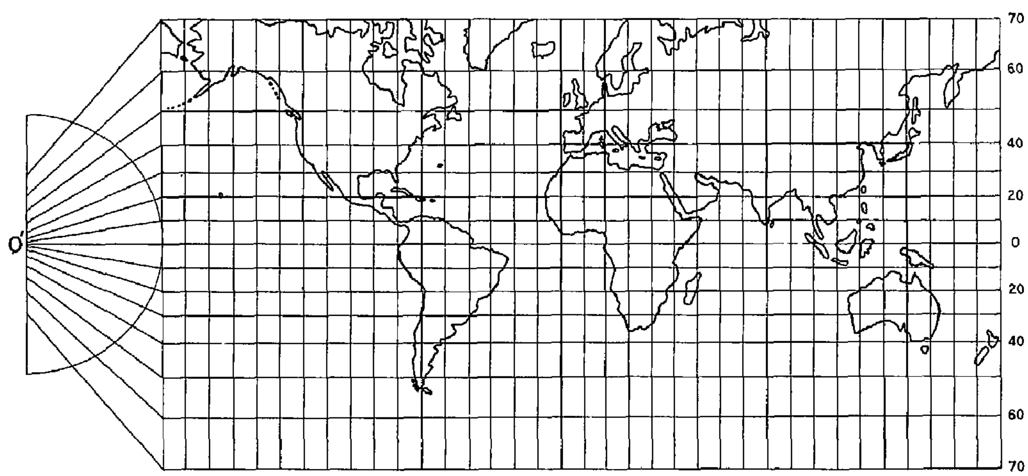


FIGURE 77.—Mercator projection—a comparison.

### 6411. *Adoption by the Coast Survey*

All nautical charts now published by the Coast and Geodetic Survey are constructed on the Mercator projection. But this was not always the case. The early charts were based on the polyconic projection and some perhaps on the Bonne (*see* 342). The exact identification of a projection on the larger-scale charts is not a simple matter. It was not the practice in the early days to indicate the type of projection on the chart proper. This was a later development and was at first shown only when the projection was other than the Mercator.[44] On small-scale charts, it was relatively simple to identify a polyconic projection by the fact that the parallels are curved and the meridians converge, both characteristics being sensible on charts of scale 1:100,000 and smaller.

As near as can be determined at the present time, chart 52, Montauk Point to New York and Long Island Sound (scale 1:200,000), issued October 1889, was the first to be constructed on the Mercator projection.[45] This was evidently an experimental chart and did not at this time represent a definite conversion to the Mercator projection. Charts continued to be published on the polyconic projection. By 1899, only a few charts had been published on the new projection.[46]

The real impetus to general conversion to the Mercator projection was provided by Superintendent Tittmann on March 10, 1910, when he named a chart board to study "in the most comprehensive manner the subject of the Coast Survey Charts" and to submit, among other things, a general scheme for

44. The placement of the name on the chart, when given, varied between the upper right-hand corner and the title. On chart 188, Mobile Bay and Entrance (1894 ed.), the name of the projection (polyconic) was given in the title. The definite change to the title was approved Oct. 5, 1954, and this is the present practice. *New Format for Nautical Charts,* 6 JOURNAL, COAST AND GEODETIC SURVEY 151 (1955).

45. This is based on the following research: Apparently, beginning with about 1880, and perhaps a few years prior thereto, a study was undertaken relative to adopting the Mercator projection. In a report by Charles A. Schott (dated Sept. 15, 1875), in the Annual Report for 1880 (page 290), it is stated: "Mercator's projection is generally employed for the purposes of navigation." And at page 296, the report states: "In conclusion, it is believed that, with respect to projection, the above investigation tends to commend the harbor, coast and sailing charts of the Coast Survey to the fullest confidence of the geographer as well as of the mariner." This would seem to indicate that as of this date no change was contemplated. The Annual Reports for 1888 and 1889 are silent on the matter of using a new projection, as is the Annual Report for 1890 which lists chart 52 as a new chart issued, but without further comment. However, *Notice to Mariners* 121, of Oct. 31, 1889, lists this chart as being on the Mercator projection.

46. There is some evidence that in 1900, the sailing charts were published on both projections. The basis for this is the statement promulgated in 1900 that "The sailing charts are on a small scale, their limits generally extending to a distance over 400 miles from the coast line and covering an area where the position of the ship would be fixed by astronomical sights. For these limits the navigator is given his choice of either the Mercator or polyconic projection, the Survey publishing both." NOTES RELATIVE TO THE USE OF CHARTS 20, SPECIAL PUBLICATION NO. 6, U.S. COAST AND GEODETIC SURVEY (1900). It is doubtful whether charts of the same area and the same scale were published on both projections. The chart catalog of 1900 states at page 13 that "some of the first two classes of charts [sailing and general] are on the polyconic projection and others on the Mercator projection." This seems more likely what was done.

"the kind of projection to be used on the respective scales."[47] The board submitted two reports pertaining to the projection to be used. The first (dated Apr. 27, 1910) dealt with charts on a scale smaller than 1:100,000. It recommended that all such charts constructed in the future should be on the Mercator projection, and all existing charts in that category should be converted to this projection. The second report (dated June 13, 1910) dealt with charts of scale 1:100,000 and larger. New charts in this category were to be based on Mercator and existing charts were in general to be converted only when new drawings or engravings were made or when a large part of the chart was revised.[48] This program has been implemented over the years and today (Aug. 1963) very few unconverted charts remain.

## 6412. *The Scale of a Mercator Chart*

The scale of a chart is the ratio of a given distance on the chart to the actual distance which it represents on the earth (*see* 131). On a Mercator chart, the scale, by construction, varies with the latitude, increasing progressively from the lower to the higher latitudes. This basic principle of the Mercator projection is fundamental in the measurement of distances on the smaller-scale charts (*see* 692). The standard scale of a Mercator chart generally applies to the scale at its middle latitude because that would be the mean scale of the chart, the scale becoming larger north of this latitude and correspondingly smaller south of this latitude.

There are two methods of designing a Mercator chart or series of charts with respect to scale: (1) to maintain a uniform construction scale at a selected latitude for each chart, and (2) to hold the adopted scale correct for a selected latitude of a series of charts. In the first, the mean scale will be the same for all the charts of the series, but the charts will not join accurately, the scale at the northern limit of each chart being greater than the scale at the southern limit of the adjoining chart. In the second method, the charts will all join accurately and the scale of adjacent charts will be the same in the overlapping

47. Letter of Mar. 10, 1910, from Superintendent Tittmann to G. R. Putnam, Chief of D. & E. Division. In this letter, it is stated: "In about 1899 it was decided that all charts on a smaller scale than 1:200,000 should be published on the Mercator projection." Prior to the naming of the board, the Secretary of the Navy had urged the adoption by the Coast Survey of the Mercator projection without regard to scale, as is indicated by his Letter of Feb. 26, 1910, in which it is stated that the 13 navigators of the battleships of the Atlantic fleet urge that "a strong appeal should be made . . . to have all Coast and Geodetic charts that are intended for the use of mariners plotted by Mercator projection." In his reply of Mar. 4, 1910, the Acting Secretary of Commerce and Labor stated that "the Coast and Geodetic Survey has for some time past published the general sailing charts and some others on the Mercator projection, and is extending it to others of larger scale as rapidly as facilities permit."

48. The recommendations of the chart board were approved by Superintendent Tittmann on July 15, 1910.

area. This results in greater convenience in navigating on adjacent charts. But the actual scale of each chart will vary from the standard scale adopted for the series. In the Coast Survey both methods are used in the following arrangement:

The 1200-series charts of the Atlantic and Gulf coasts, scales 1:80,000, are constructed at the scale of the middle latitude of each chart. The use of these charts in series is less important than their individual local use, and the slight break in scale between adjoining charts causes less inconvenience than would the variation in scale of the series, if constructed to the scale of the middle latitude of the series.[49]

The 1100-series General charts of the Atlantic and Gulf coasts are based on the scale of 1:400,000 at latitude 40° (charts 1107 and 1108). The different charts of the series therefore vary in scale but the charts join exactly. This also applies to the following three groups:

General charts of the Pacific coast, San Diego to Strait of Juan de Fuca, are constructed to the scale of 1:200,000 at latitude 41° (chart 5602).

General charts of the Alaska coast, Dixon Entrance to Unalaska Island, are constructed to the scale of 1:200,000 at latitude 60° (charts 8551 and 8552).

Sailing charts of the Pacific coast, San Diego to the western limit of the Aleutian Islands, are constructed to the scale of 1:1,200,000 at latitude 49° (chart 5052).

The 1000-series Sailing charts of the Atlantic coast are constructed to the scale of 1:1,200,000 at a selected latitude of each chart. This gives a nearly uniform scale for the series with no marked discontinuity at the junctions.[50]

The scale shown on the chart and in the nautical chart catalog is generally not a construction scale but a computed scale that approximates the mean scale of the chart. It is the natural scale at about the middle latitude of the chart. For example, the scale given on chart 1110 and in the catalog is 1:432,720, but the construction scale is 1:400,000 at latitude 40°.

The general subject of the scale of a survey or chart, including the method of determining scale, has been previously considered (*see* 131) and need not be repeated here. On a Mercator chart, the scale may be expressed by giving the natural or fractional scale, by a numerical scale, or by means of a graphic or linear scale. In addition, the east and west border subdivisions of the chart form

49. The Atlantic and Gulf coasts of the United States cover a latitude range of 20 degrees, extending from latitude 25° to latitude 45°. If the coast charts were constructed on a scale of 1:80,000 in latitude 35°, the actual scale would be 1:69,000 at the north end of the series and 1:88,000 at the south end. The chart board of 1910 (*see* text at note 47 *supra*) therefore recommended that the 1:80,000 series of Coast charts, and "in general for other series of charts of scale 1:100,000 and larger," be constructed with the scale true on its own middle latitude. This is the practice today.

50. Where a chart covers so large an expanse that for general navigational use a vessel would be within the limits of the chart on a single cruise and the need for junctions with other charts to be on the same scale is not so important, the charts are based on a uniform construction scale at a selected latitude for each chart. Thus, charts 1000, 1001, and 1002 are at scales 1:1,200,000 at latitudes 40°, 31°34′, and 25°11′, respectively. Chart 1007, which covers the entire Gulf of Mexico, is not constructed in series with overlapping charts 1001 and 1002, but is based on a scale of 1:2,000,000 at latitude 33°46′.

a scale for measuring distances on small-scale charts and these are termed latitude scales.

(*a*) *Natural Scale.*—The natural scale of a chart may be expressed as a simple ratio (1:80,000) or as a fraction $\left(\frac{1}{80{,}000}\right)$, which means that one unit of distance on the chart—for example, an inch—represents an actual distance of 80,000 of the same unit on the surface of the earth. This is also referred to as a "fractional scale" and the fraction is termed the "representative fraction" or the "R.F." of the chart (*see* 1311).[51]

(*b*) *Numerical Scale.*—This form of scale is in reality merely a statement of the distance on the earth represented by one unit on the chart—for example, "1 inch equals 20 miles," "3 inches to the mile," etc. On Mercator charts, a numerical scale can also take the form of "1° of longitude equals 2.50 inches." From the nature of the Mercator projection, irrespective of scale, the distance between meridians is the one constant value on this type of chart.[52]

(*c*) *Graphic Scale.*—In this type of scale, a line or bar is subdivided into nautical miles, yards, etc. A graphic scale is used on Mercator charts only when the chart is of such scale, or limited north-south extent, that there is practically a uniform scale throughout the chart. In the Coast Survey, a graphic scale is used on nearly all nautical charts of scale 1: 80,000 or larger (*see* fig. 26), in addition to the natural or fractional scale.[53]

(*d*) *Latitude Scale.*—On Mercator charts of scales 1: 100,000 or smaller, the east and west borders are subdivided in degrees and minutes to indicate a latitude scale. It is in a sense a variant of the graphic scale, since a minute of latitude is very nearly equal to a nautical mile. Inasmuch as the scale of a

51. On the nautical charts of the Bureau, the ratio form is used. This is also the form used throughout this publication.

52. The numerical scale of a chart may be readily converted to a natural scale and vice versa. Thus, if the numerical scale is 1 inch=20 nautical miles, and a nautical mile (international) equals 6,076.115 feet, or 72,913.38 inches (*see* note 148 *infra*), then the natural scale would be 1: (20 x 72,913.38), or 1: 1,458,268. Similarly, if the natural scale of a chart is 1: 80,000, one inch of the chart represents 80,000 inches on the earth. The numerical scale would then be $\frac{80{,}000}{72{,}913.38}$, or 1.097 nautical miles (international) to an inch. Stated differently, the scale would be $\frac{72{,}913.38}{80{,}000}$, or 0.911 inch to a nautical mile (international).

53. Graphic scales have been shown on the nautical charts of the Bureau from the earliest time. When the polyconic projection was used there was no limitation on the use of such scale, since one of the properties of this projection is that one scale may be used for any part of the chart. Graphic scales showing nautical miles, statute miles, yards, and kilometers have been used at different times. The nautical mile scale was always shown. The kilometer scale was shown on charts from about 1877 to 1917. The present practice is to show at least two graphic scales—one in nautical miles and one in yards. Other graphic scales, in statute miles and in feet are sometimes shown. EDMONSTON, NAUTICAL CHART MANUAL 9, U.S. COAST AND GEODETIC SURVEY (1956). On Intracoastal Waterway charts, a scale of statute miles is also used.

Mercator chart varies with the latitude, it is important to keep this in mind when using the latitude scale for measuring distances on the chart (*see* 692).

### 642. State Plane Coordinate Grids

In areas where the Corps of Engineers use the State Coordinate Systems (*see* Part 1, 2113 B) for control, dashed tick marks at 5,000- or 10,000-foot intervals are added in the borders of large-scale charts (*see* chart 6151). Intermediate tick marks are used in the center of the chart in the land areas where the chart has a considerable extent in an east-west direction, in order to take into account curvature. A note on the chart indicates the name of the grid and the interval of the tick marks.[54]

## 65. SIGNIFICANT FEATURES ON NAUTICAL CHARTS

A nautical chart consists of many features, both topographic and hydrographic. Over the years, certain practices have been developed for their representation, but some of the early ones are still in use; others have been modified; and still others have been discontinued, or superseded by new practices. A proper interpretation of these features is essential for an understanding of their significance and use by the navigator or by the investigator.

### 651. The Soundings

The soundings, or depths, are without doubt the most significant single feature that appears on a chart, for it is these depths that determine where a vessel can and cannot safely navigate. Vertical numerals have always been used, designed in size to permit a representative selection being made.

There are two important aspects of a depth that must be kept in mind when reading a chart—(*a*) the unit in which the depths are expressed, and (*b*) the sounding datum or plane to which they are referred. Associated with the depth is another aspect (*c*) the character of the bottom.

(*a*) *Depth Unit.*—Coast Survey charts have always carried a note giving the depth unit or units used. But the units used have differed during different periods and on the different coasts. There were of course exceptions even after a change in policy was adopted. These were due in some cases to the par-

54. *Id.* at 67. By connecting the tick marks with straight lines, they can be used for control of Corps of Engineers surveys. If the chart were on the same projection as the State Coordinate System in use for the area, then the plane coordinate grid would be truly rectangular.

ticular needs of an area, and in other cases it was a matter of a chart being reissued after a change in policy, but not reconstructed.

The early practice—prior to about 1852—was to chart the depths in feet. The practice of using "feet" to depths of 18 feet, and "fathoms" beyond was then inaugurated.[55] The use of the double unit continued into the 1900's. In 1911, the sailing charts on the Pacific coast changed to using fathoms only. The policy of using only feet on some charts was established in 1915, and the use of two depth units on one chart eliminated.[56]

Before 1920, the depths to which fractions were used were not uniform. Some charts used ¼ fathoms to 20 fathoms, while others used it to 10, and ½ fathoms to 20. In 1920, the general policy was to use ¼ fathoms to 7 fathoms, ½ fathoms to 8, and whole fathoms beyond, except adjacent to the 10-fathom curve where, in flat bottom, ½ fathoms were used to avoid displacement of the curve. No fractions were used on charts expressed in feet.[57]

The present practice is to use one depth unit only—feet or fathoms, or the combined form of fathoms and feet to 11 fathoms—throughout a single chart. General and Sailing charts along all coasts, and Coast charts along the Pacific coast use fathoms as the depth unit. On all other charts on the Atlantic and Gulf coasts the depth unit is feet, as is the case with most of the harbor charts on the Pacific coast. Charts of Alaska and the Hawaiian Islands are generally in fathoms. When the combined form of fathoms and feet is used, the foot part of the sounding is shown as a subscript. Thus, 6 fathoms 1 foot would be charted as $6_1$.

*(b) Sounding Datum.*—The sounding datum, or the chart datum as it is sometimes called, is the plane of reference for the charted soundings and is based on tidal definition. It follows the plane of reference used on the hydrographic surveys on which the chart is based (*see* 564). The planes differ on the different coasts because the characteristics of the tide differ.[58]

Along the Atlantic and Gulf coasts, the early practice was to use a sounding datum referenced to low water spring tides. It was designated as "lowest spring tides observed" (New York Harbor chart of 1845) or as "mean low water, spring tides" (Long Island Sound chart of 1855). When such a plane

55. The New York Bay and Harbor chart of 1866 used the double unit except in some rivers, where only feet were used. The Potomac River charts used only feet in 1864.

56. Annual Report, U.S. Coast and Geodetic Survey 141 (1915).

57. FLOWER, RULES AND PRACTICES RELATING TO THE CONSTRUCTION OF NAUTICAL CHARTS 22, SPECIAL PUBLICATION NO. 66, U.S. COAST AND GEODETIC SURVEY (1920).

58. Along the Atlantic coast there is the semidiurnal type of tide with two tides a day of approximately equal range; in the Gulf of Mexico, the diurnal type is the predominant tide with but one high and one low water in a tidal day; and along the Pacific coast, the mixed type of tide prevails, with two high waters and two low waters each tidal day and an inequality in successive high-water heights, in successive low-water heights, or in both.

was used, the tide note on the chart gave information for determining the plane of mean low water. Other early charts used mean low water as the sounding datum. The present practice is to use the plane of mean low water. This also applies to Puerto Rico.[59]

Along the Pacific coast, the early practice was to use a sounding datum of mean low water. Beginning in about 1853, the datum of mean lower low water, or something equivalent thereto, was used (*see* 5642). The exception was the Puget Sound area where sounding datums varied from mean low water, to mean of selected lowest low waters, to harmonic or Indian tide plane, to 2 feet below mean lower low water, to mean lower low water in 1921 (*see* 5643).

In Alaska, the early practice (1867–1897) was to use mean lower low water and the mean of a few selected lowest lows, depending on the locality. Then the harmonic tide plane was used, with some exceptions. This was later replaced by a plane 2 feet below the mean of the lower low waters. Finally, in 1908, the datum was changed back to mean lower low water except in Wrangell Narrows where it was 3 feet below mean lower low water. This exception was eliminated in 1929. (*See* 5644.)

The present practice for charts along the Pacific coast, Alaska, and the Hawaiian Islands is to use the datum of mean lower low water throughout.[60]

Both the depth unit and the sounding datum on all present-day charts are prominently displayed in the title.

(*c*) *Bottom Characteristics.*—A feature associated with the soundings on a chart is the character of the bottom. The reasons for obtaining and charting bottom characteristics have been discussed in 567. Their value to the navigator under certain conditions has been recognized from the beginning of the Coast Survey. A feature of the early charts was the large number of detailed bottom characteristics included. Abbreviations were generally used for color but the type of bottom was often written out. The early charts also contained tables of abbreviations for bottoms.[61]

The present practice is to show a reasonable number of characteristics over the chart. Generally, two words, or their abbreviations, are used. In harbors, inland waters, and along the coast, where the navigator might be interested

59. This is derived by averaging all the low waters during the required cyclical period, but where tides are predominantly diurnal, with days when two low waters are recorded, as in the Gulf of Mexico and along the south coast of Puerto Rico, the plane of mean low water is derived by using only the lower of the two low waters on those days when the tide becomes semidiurnal (*see* Volume One, Part 2, 1613).

60. This is derived by averaging all the lower low waters during the required cyclical period. For the Columbia River this datum is determined during lowest river stages and is known as the Columbia River Datum (*see* 5645).

61. The value of bottom characteristics to the navigator in the early days is indicated by the complete descriptions of their use with characteristic soundings given in the *Coast Pilots* of 1878 and 1880 for navigating Nantucket Shoals during foggy weather.

in the holding quality of the bottom, the type or character is given, while in deep water the type and color are given as a possible aid in position determination.

### 652. Depth Contours

Depth contours, or curves of equal depth, are an important feature on a nautical chart. They bring order out of what may otherwise appear to be chaos. If clearly shown, they represent a great aid in interpreting the soundings and in emphasizing the submerged dangers and the safe channels (*see* 563). Depth curves have been used on nautical charts from a very early period, but in recent years they have come into greater prominence and wider use with the advent of echo sounding. This has also resulted in a changed symbolization.

(*a*) *Early Symbolization.*—Depth curves on sketches and preliminary charts (*see* 123) were shown by dotted lines. The dots were arranged in groups to indicate the depths in fathoms—single dots for the 1-fathom curve, two dots for 2 fathoms, and three dots for 3 fathoms. On finished charts, sanding was used to show depths of 3 fathoms or less (*see* 663). Additional curves were sometimes shown and in such cases were labeled on the chart. As surveys were extended farther offshore more depth curves were added, symbolized by a combination of dots and short dashes to indicate multiples of 10 fathoms. Under 10 fathoms, dashed lines were used but they did not always represent the same depth on contemporary charts and had to be either labeled on the curve or shown in a note on the chart.

(*b*) *Present Practice.*—The year 1939 marked a definite change in charting procedure insofar as depth curves were concerned. In that year, an experimental chart was published which was designed to utilize to the fullest extent the wealth of submarine information furnished by echo-sounding surveys (*see* 6241). The *many soundings and few depth curves* design of the then conventional chart was replaced by the *many depth curves and fewer soundings* design of the new chart.[62] The first such chart showed the 3-, 10-, and 20-fathom curves in black using the conventional dot and dot-dashed lines, and each 50-fathom contour thereafter in a solid blue line, with a blue tint from the shoreline to the 50-fathom depth contour. As echo-sounding surveys became available in various areas and the charts were revised, more depth contours were added but with this modification: continuous, black contours were used

62. Since each depth contour represents an infinite number of equal depths along that contour, there are in reality more "soundings" on the new chart than on the old. The term "depth contour" is appropriate where the depth curves are based on modern echo-sounding surveys (*see* 563 note 58).

in the tinted area and for contours of greater depth when not extensive; when extensive, blue was used.[63] Regardless of color, the depth contours are continuous when based on modern, adequate surveys, and dashed in areas of inadequate surveys.[64]

The practice in 1963 is to use continuous, solid contours in black, where formerly they would have been charted in blue. However, there is no present program for any systematic conversion from blue to black, and there will be charts with blue depth contours for many years to come.

Depth contours are labeled in the same unit as the soundings, and include within their limits all soundings of the same depth as the contour.

## 653. Aids to Navigation

Aids to navigation, as the name implies, are shown on charts to assist the mariner in navigating his vessel from one place to another. Charted aids fall into two general classes—fixed aids, and floating aids. Among the first are lights, daybeacons, and radiobeacons; among the second are lightships and buoys. Brief notes usually accompany the various aids regarding their characteristics, such as shape of buoys, period of flashing of lights, and the elevation and visibility of the larger lights. The number of aids shown and the amount of information concerning them varies with the scale of the chart. This discussion will be limited to buoys only.

### 6531. *Buoyage System in the United States*

Of the various types of aids to navigation shown on nautical charts, buoys occupy a most important place because they provide an economical and flexible system in which modifications can be readily made to accommodate the system to changes in underwater configurations. They can be moored close to the track of vessels to mark shortest routes and by their use constricted natural channels are sometimes made available to navigation that otherwise would

63. Edmonston (1956), *op. cit. supra* note 53, at 48. The term "extensive" was used to denote the closeness of the selected contours for a given area. If the contours were so close as to detract from the soundings, blue was used; otherwise they were shown in black. For example, chart 322 (1958 ed.) of the approaches to Penobscot Bay has 4 black contours within the tinted area and 4 blue contours outside; chart 1114 (1952 ed.) of the Gulf of Mexico has 12 black contours; and chart 1107 (1945 ed.) of the Cape Cod area has 15 blue contours.

64. *See* chart 322 (1950 ed.). When charts contain areas covered by modern surveys and areas with only reconnaissance or very early surveys, the depth contours are drawn only to the limits of the former (*see* chart 1106 (1955 ed.)).

be unusable. The present system of marking and numbering United States buoys dates back to September 28, 1850, when Congress passed "An Act making Appropriations for Lighthouses, Light Boats, Buoys, etc." [65] Conformity as to shape resulted from the recommendations of the International Marine Conference of 1889.[66]

The waters of the United States are marked by the *lateral system* of buoyage. The positions of marks in this system are determined by the general direction taken by the mariner when approaching a harbor, river, estuary, or other waterway from seaward. The principal buoyage in United States waters consists of *red* buoys and *black* buoys, and follow a simple rule as to color, shape, and numbering:

> On entering a harbor from seaward, the right or starboard side of the channel is marked by conical shaped buoys (termed nun buoys) painted red with even numbers, while the left or portside is marked by cylindrical shaped buoys (termed can buoys) painted black with odd numbers, the numbers for each side increasing from seaward. *Red-Right-In* is an easily remembered aid.[67]

Other types of buoys used for special markings are: *Red and black horizontally banded* buoys to mark junctions or bifurcations of channels, or an obstruction that can be passed on either side; *black and white vertically striped* buoys to mark the center of a channel that can be passed close aboard; and special purpose buoys which may be white, yellow, orange, green, or a combination of colors.

## 6532. *Symbolization of Aids on Charts*

It was noted previously that the early charts of the Survey were engraved on copper and printed directly from the copper plates (*see* 6242). These charts

65. 9 Stat. 500. Section 6 of the act provided: *"And be it further enacted,* That hereafter all buoys along the coast, or in bays, harbors, sounds, or channels, shall be colored and numbered, so that passing up the coast or sound, or entering the bay, harbor, or channel, red buoys with even numbers shall be passed on the starboard hand, black buoys with uneven numbers on the port hand, and buoys with red and black stripes on either hand. Buoys in channel ways to be colored with alternate white and black perpendicular stripes." *Id.* at 504. The use of distinctive colors for buoys was first proposed in 1838, but was not adopted until 1847 and then only in a portion of Long Island Sound. Annual Report, U.S. Coast Survey 64, 67 (1847).

66. Bowditch, American Practical Navigator 29, H.O. Pub. No. 9, U.S. Navy Hydrographic Office (1958).

67. As all channels do not lead from seaward, arbitrary assumptions are at times made in order that the system may be consistently applied. Buoys along the coast and used in coastwise navigation have characteristics based on the assumption that proceeding "from seaward" constitutes a southerly direction along the Atlantic coast, a northerly and westerly direction along the Gulf coast, and a northerly direction along the Pacific coast. On the Intracoastal Waterway, proceeding in a generally southerly direction along the Atlantic coast and in a generally westerly direction along the Gulf coast is considered as proceeding "from seaward." *Id.* at 977.

were all black and white reproductions. It was therefore not practical to have the buoys correspond in color to their actual colors in the water. The practice was to chart a black buoy or the black part of a buoy in black and merely show the outline for any other color, a note near the buoy giving the color.

The advent of lithography in chart reproduction just after the turn of the century brought with it a significant change in the symbolization of buoys and lighted aids to navigation. Buoys were now colored to correspond to their actual colors in the water, and lighted aids were accentuated by using a color overprint.

Except for the very early period, buoys, other than mooring, were shown by a diamond-shaped symbol and a small dot at the base of the symbol, the dot marking its position. This is the practice today. All buoys other than black ones carry abbreviations indicating their colors, regardless of the color shown on the chart. Modern charts use a magenta overprint for unlighted red buoys, and a small magenta disc centered on the dot at the base of the buoy symbol for lighted buoys.

In charting aids to navigation, it is the practice to omit them on small-scale charts when they are completely shown on overlapping large-scale charts.

## 654. Planes of Reference

Besides the sounding datum (*see* 651(*b*)) two other planes of reference are used on nautical charts—(*a*) for elevations, and (*b*) for the shoreline.

(*a*) *Elevations.*—The plane of reference for elevations is mean high water. This applies to the elevations of rocks, bridges, landmarks, and lights. Contour and summit elevation values are given in feet and refer to mean sea level, if the source for such information is referenced to this plane.[68]

Associated with the elevations of alongshore rocks is their symbolization on the nautical chart. This follows the criteria used for the hydrographic surveys (*see* 5655) and is discussed in 666.

(*b*) *Shoreline.*—The plane of reference for the shoreline on nautical charts is mean high water and corresponds to the plane used on the topographic surveys of the Bureau. The shoreline is the mean high-water line as nearly as it can be determined by the topographer without actually running a line of levels (*see* 441). The basis for the use of mean high water is that it is the dividing line between the land and the sea (*see* 4411).

68. The former practice was to underline the elevations of inland mountain peaks referred to mean sea level. Adams (1942), *op. cit. supra* note 2, at 69.

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## 655. Geographic Datum

The geographic datum of a nautical chart is the adopted position in latitude and longitude of a single point to which the charted features of a vast region are referred. The development of geographic datums in the United States and Alaska, from independent datums to the present North American 1927 Datum, is fully discussed in 22 and 23.

The early charts along the Atlantic and Gulf coasts occasionally used a local origin for longitudes. The projection on the chart was referred to the local origin with the Greenwich longitudes shown by tick marks in the borders. In all cases, however, the positions of lighthouses were given in tabular form with their longitudes referred to Greenwich.[69] Pacific coast charts were always referred to the Greenwich meridian.

As new values for longitude became available (*see* 352 and 37), changes were made in the charts. The change was first shown on Atlantic and Gulf coast charts by unlabeled tick marks to the east of the meridians. A standard note describing the change was later added which read as follows: "The lines marked in the border on the right of the Meridians indicate the latest or corrected Longitudes; and are so placed for reference on the charts on which the Meridians are not in accordance with the new Longitudes." The tick marks and note were removed from the charts in the 1890's, and the values of the meridians and parallels corrected and shown to seconds of arc to take into account the new values.

After the adoption of the United States Standard Datum (same as North American Datum) in 1901 (*see* 223), charts were based on that datum. This continued until the adoption of the North American 1927 Datum when charts were based on that datum (*see* 225). The early charts of the Bureau did not indicate by note or otherwise the datum of the chart. Beginning in the late 1930's, after the geodetic network in the eastern half of the country was adjusted to the 1927 datum, the geographic datum was inserted on the chart in the upper right-hand corner of the border, the form of note used being "N.A. 1927."[70] This continued until 1956 when the datum note was no longer used inasmuch as, with few exceptions, all charts of conterminous United States and Alaska were on this datum.[71]

69. The Boston charts used the State House (*see* chart 337, Boston Harbor, 1857 ed.), the New York charts used the City Hall (*see* chart 120, New York Bay and Harbor, 1845 ed.), and the charts of Mobile Bay used Fort Morgan (*see* chart 188, Mobile Bay, 1851 ed.).

70. Prior to this, the note "N.A. Datum" was used. This was so even after the adoption of the N.A. 1927 Datum, since the change was not made until a particular chart was reconstructed.

71. Edmonston (1956), *op. cit. supra* note 53, at 7. The Hawaiian charts are based on the Old Hawaiian Datum (*see* 242), and in the Caribbean area, charts are on the Puerto Rico Datum (*see* 243). *Ibid.*

The geographic datum of a chart becomes important when comparisons are made of charts widely separated in point of time. Such charts must first be brought to the same datum before accurate comparisons can be made, in the same manner as hydrographic or topographic surveys of different dates are compared (*see* 37).

## 656. Geographic Names

It has been well said that "A geographic name is a term in common use for a feature of the earth's surface whose identity it serves to establish. It is one of the essentials of map expression and incites an interest beyond the importance of the name itself, its suitability, and distinctiveness." [72] The importance of geographic names, insofar as they related to our surveys and charts, was recognized at a very early period in the history of the Survey. In the Annual Report for 1855, Superintendent Bache stated: "It was of the first importance, then, to trace the history of discovery on that coast [the western coast]; to ascertain the original names and the successive ones; to restore those which were corrupted, and to fix those uncorrupted beyond the power of change; to go back to the earlier names, when the later had not become so permanently attached to the localities as to make it too difficult; and, in short, to make the Coast Survey maps and charts the standard for names and their spelling, as for the geography of the country." [73]

Apart from their general geographic value, geographic names are essential for the intelligent use of nautical charts and *Coast Pilots*. It is distinctly annoying and conducive to error to have to use latitudes and longitudes, or long descriptive phrases, to refer to geographic features. And it is important that names be accurate since carelessness in this respect may cast doubt on the vital portions of the chart relating to navigation.

### 6561. *Early Studies*

Under the impetus of Superintendent Bache and the superintendents who followed him, considerable emphasis was placed by the Bureau on geographic names. A number of special studies were undertaken, among which were the

72. Deetz, *The Genesis of Geographic Names,* 23 The Military Engineer 371 (July–Aug. 1931).

73. Annual Report, U.S. Coast Survey 10 (1855). To this end, Bache engaged the noted ethnographer, Dr. J. G. Kohl. Bache's instructions to Kohl were "To trace the succession of discoveries and explorations from Cortez to those of Wilkes and De Mofras, giving their dates and localities . . . . To give the best authorities for the names of localities, showing how the names have been given, and thus to establish their orthography as a basis for the geography and hydrography of the western coast of the United States. To furnish a catalogue of the names of headlands, capes, sounds, bays, and harbors, with the authorities." *Id.* at 11. For a statement on Kohl's study, *see* 6561A.

work on names of the Pacific coast by George Davidson and embodied in his monumental Coast Pilot of 1889; [74] "Notes on the Coast of the United States," in 1861; [75] a memoir on "Geographical Names on the Coast of Maine"; [76] "Hawaiian Geographic Names"; [77] and a "Geographic Dictionary of Alaska," this still being the "bible" of Alaskan names existing prior to 1905.[78]

### A. THE KOHL COLLECTION OF MAPS AND NAMES

It was noted above that the Kohl study of the western coast of the United States was the earliest of its kind made under the auspices of the Coast Survey. Over the years, many inquiries have been received regarding this study, particularly the geographic names which Kohl collected. Because of its historical interest and to avoid future research into this subject a résumé is included here of what Kohl prepared and, as near as it is now possible to determine, the disposition that was made of the material he assembled.

(*a*) *Historic Description of Western Coast.*—On March 1, 1855, Dr. Kohl, in a letter to Superintendent Bache, announced the completion of the historical portion of the work, the collection of historical maps, and the catalog of printed and manuscript books and maps relating to the western coast.[79] The historical portion consists of 284 sheets and describes each recorded voyage and exploration

74. DAVIDSON, PACIFIC COAST PILOT, U.S. COAST AND GEODETIC SURVEY (1889). This was the most complete record of the coast ever to be published for the use of the mariner. While the publication was issued more as a coast pilot than as a gazetteer, it contains many references to the authorities who named the features.

75. A series of manuscript books in eight volumes, prepared by Superintendent Bache, for the coast from Delaware Entrance to Mississippi Sound. Features such as shoals, inlets, sounds, bays, islands, harbors, and roadsteads are named and identified. Many of these features are shown and named on accompanying charts, but others are not.

76. Prepared under the direction of Superintendent Peirce by E. Ballard of the Maine Historical Society and published in the annual report of the Bureau. Annual Report (Appendix 14), U.S. Coast Survey (1868).

77. Annual Report (Appendix 7), U.S. Coast and Geodetic Survey (1902). This is a 54-page memoir compiled by W. D. Alexander, an assistant in the Survey, and formerly surveyor-general of the Hawaiian Islands. In 1943, a "Gazetteer [of the] Hawaiian Islands" was published by the Navy Hydrographic Office, based on the work of the Coast and Geodetic Survey. The gazetteer contains a glossary of words frequently found in Hawaiian geographic names, and an alphabetical list of names with their designations and latitudes and longitudes.

78. BAKER, GEOGRAPHIC DICTIONARY OF ALASKA (2d ed.), BULLETIN No. 299, U.S. GEOLOGICAL SURVEY (1906). This work was begun by Wm. H. Dall and Marcus Baker of the Coast Survey around 1873, and, after some interruption, was completed by Baker in 1901 while associated with the U.S. Geological Survey. It was adopted by the Board on Geographic Names and reissued as a second edition in 1906. The first edition contained about 6,300 names and 2,800 cross references; the second edition contains about 9,300 names and 3,300 cross references.

79. Annual Report (Appendix 64), U.S. Coast Survey 374 (1855). There is indication that the maps and other data were sent to the Library of Congress on Mar. 8, 1912 (*see* Memorandum of May 22, 1885, for the Assistant in Charge of the Office, under library classification G83/K79).

party on the west coast from Balboa in 1513 to and including Coast Survey operations in 1854. It is titled "History of the Discovery and Exploration of the Western Coast of the United States."[80] This part of Dr. Kohl's work, exclusive of the Coast Survey operations, was later edited and published in the Annual Report for 1884.[81]

In his letter of March 1, 1855 (*see* text at note 79 *supra*), Kohl also referred to a list of nearly 300 geographical names of bays, capes, harbors, etc., "with critical and historical remarks, settling the orthography of the names." This list could not be traced.[82]

(*b*) *Historic Description of Gulf Coast.*—On April 17, 1856, Dr. Kohl submitted his material on the history of the Gulf coast of the United States.[83] This included a historic portion containing an account of the coast from 1492, a hydrographic portion containing a list or review of all the principal points and names, and a bibliographic portion comprising chronological and critical lists of maps and books relating to the Mexican Gulf coast.[84]

(*c*) *Historic Description of Atlantic Coast.*—On November 1, 1856, Dr. Kohl completed his study of the history of the Atlantic coast, following the same

80. The work is divided into eight major subdivisions, as follows: (I) From the beginning of the discovery of America to Cortes, 1492–1532; (II) From Cortes to Drake, 1532–1579; (III) From Drake to the Jesuits, 1579–1697; (IV) From the Jesuits to the Franciscan missionaries; (V) From the expeditions of the Franciscans to Vancouver, 1769–1792; (VI) Vancouver, his associates and contemporary navigators, 1792–1796; (VII) From Vancouver's time to the beginning of the U.S. Coast Survey's operations, or from the end of the 18th century to 1849; and (VIII) The operations of the U.S. Coast Survey on the west coast of the Union, 1849–1854. Two manuscript copies of this work are filed in the Coast Survey library under the classification G83/K79/:94/1855. One copy is heavily corrected in colored inks and appears to be the original; the other incorporates the first corrections but is further corrected in pencil. The latter copy comprises 534 pages.

81. Annual Report (Appendix 19), U.S. Coast and Geodetic Survey 546 (1884). An abstract of the contents and a list of the charts used were added for this printing.

82. In 1958, an exhaustive search was made in connection with an inquiry relative to the origin of the name "Earthquake Bay" along the southern California coast (*see* note 89 *infra*). Various works on geographic names and other sources in the Coast Survey library were examined, and consultation had with the Library of Congress and other possible source centers. All yielded negative results. *See* Letter of of Mar. 14, 1958, from the Director, Coast and Geodetic Survey, to Walter W. Jenkins. The library records show that the maps used by Kohl and referred to in his letter were available in the Bureau in 1908 and that some of the material of the collection was transferred to the Library of Congress in 1912 (*see* note 79 *supra*).

83. Annual Report (Appendix 66), U.S. Coast Survey 322 (1856).

84. The historical portion is available in the Coast Survey library under the classification G83/K79/871/(1856). This was later edited and, with an abstract of the contents and a list of charts added to it, was published in the Annual Report of 1884 (Appendix 19) at page 513. A separate cahier entitled "Calendar Kohl Mss. (G83/K79)" indicates that the historic and hydrographic portions, except for the description of the south coast of Florida, were available in the Coast Survey on Mar. 17, 1908. The calendar also indicates that the notes on the charts used and a portfolio of charts were transferred to the Library of Congress in 1912 (*see* note 79 *supra*).

general procedure as for his other studies.[85] This included a historic portion, a list of names, copies of maps and notes, and a catalog of maps.[86]

(*d*) *Hydrographic Description of Western Coast.*—On November 10, 1857, Dr. Kohl, in a letter to Superintendent Bache, announced the completion of a comprehensive hydrographic description of the western coast.[87] The original manuscript is in 283 sheets. The coast is described as the early explorers saw it with special reference to the names they applied to the different features.[88] There are 695 names in this work, among which is the name "Bahia de los Temblores" (Earthquake Bay) on sheets 21 and 22.[89]

(*e*) *Collection of Early Maps.*—Besides the maps referred to in previous paragraphs which Dr. Kohl used in the various studies undertaken for the Coast Survey, mention should be made of another collection of maps which he brought with him to this country in 1854. This was contained in a series of portfolios and consisted of hand-copies which he had made of maps relating to the progress of discovery in America.[90] When Kohl returned to Europe about 1858, the State Department became the custodian of the collection. Because of the

85. Annual Report (Appendix 65), U.S. Coast Survey 319 (1856).

86. The original manuscript of the historic portion was available in the Bureau on Mar. 17, 1908, but could not be found in Feb. 1963. However, it was published (in probably edited form) in the Annual Report of 1884 (Appendix 19) at page 495. The list of names is available except for the section covering the coast of New Jersey which was lost in 1903 (*see* library classification G83/K79/:815). The maps and notes and the catalog were transferred to the Library of Congress in 1912 (*see* note 79 *supra*).

87. Annual Report (Appendix 52), U.S. Coast Survey 414 (1857).

88. The description of San Francisco Bay from this work was published in the *National Intelligencer* on Sept. 22 and 24, 1857; and the introductory remarks on the physical features of the western coast was published in the same newspaper on Oct. 8 and 20, 1857 (*see* library classification G83/K79/:94).

89. Because of the interest exhibited in recent years as to the origin of this name (*see* note 82 *supra*), the following extracts from Kohl's manuscript are given: "Between Point Loma in the South and Point Fermin in the North the coast of California trends in the following manner: At first East of Point Fermin, which projects very far into the Sea and towards the West, the coast runs for some time directly East, then it runs for a long distance Southeast, and in about 33°10′ N.L. it changes directly to the South to Point Loma, which projects again more to the West and into the Ocean, than any of the other headlands between it and Point Fermin. In this manner the coast describes here *a kind of semicircle* of however a very large radius, and forms a kind of bay of not a great depth . . . . The long-stretched bay on the coast is still more marked as a particular division or section of the Ocean by the two great islands Santa Catalina and San Clemente to the West of it, which shut it up to a certain degree, and separate it still more from the rest. This division of the Ocean has however no particular name on our maps. The Spaniards called it *'la Bahia de los Temblores'* (the Bay of the Earthquakes). We find this name on the greater part of the old Spanish maps, and the bay is still to-day called so on many Spanish, French and other charts. The name appears only to have disappeared on the English and American charts. The name was at first introduced on the land expedition of Portala and the Franciscan friars from S. Diego to Monterey, as the name of a river which they called *'Rio de los Temblores'* because they experienced there an earthquake . . . . The name is very characteristic because this whole coast is subject to frequent earthquake shocks . . . . The name *'Bay of Los Temblores'* is very appropriate, because it alludes to one of the most characteristic geographical features of the region, and it seems worth the while to revive and restore it again."

90. These were taken from old geographical and other printed treatises and from manuscripts in European archives and libraries. WINSOR, THE KOHL COLLECTION OF MAPS RELATING TO AMERICA, LIBRARY OF HARVARD UNIVERSITY (1886). This publication also included references to maps not mentioned by Kohl. There are 998 items listed, of which 474 are from Kohl. This was reprinted, with the addition of an author list and a dictionary index of all subjects and authors mentioned, as a Library of Congress publication in 1904.

importance of the maps to scholars and the desirability of having a key to them, the collection was transferred to the Harvard University library and the catalog prepared by the librarian (*see* note 90 *supra*). On July 17, 1903, the collection was transferred from the State Department to the Library of Congress.[91]

### 6562. *Later Studies*

Among the later studies of geographic names by the Coast Survey may be mentioned those of the Virgin Islands;[92] a publication on "Geographic Names in the Coastal Areas of Alaska," in 1943;[93] a publication on "Geographic Names in the Coastal Areas of California, Oregon, and Washington" (undated, but subsequent to 1940);[94] and a "Gazeteer of the Philippine Islands," in 1945.[95]

### 6563. *Procedure for Names Study*

Intensified names work in the Coast Survey began in the early 1930's when all investigations of names were concentrated in one office in the then Division of Charts, thus providing a centralized and specialized control that was available to all in the Survey who made use of names.[96]

Investigation of geographic names in the Bureau follows a systematic and inclusive procedure. It provides that a written record be kept of the sources consulted, conflicting usage, and decisions adopted. In this way, the history of a name is always available for future consultation. There are two aspects of the

91. Dr. Kohl also wrote a memoir on the early cartography of the northwest coast of North America which was deposited with the American Antiquarian Society at Worcester, Mass. (*Proceedings*, Oct. 1867, Apr. 1869, and Apr. 1872). Another significant contribution of Dr. Kohl was his "A History of the Discovery of Maine," prepared at the invitation of the Historical Society of Maine and published in 1869. This treatise on the region known as the Gulf of Maine was referred to by Winsor (*see* note 90 *supra*) as "the most important single contribution to the history of the discovery and cartography of our Eastern Coast."

92. McGuire, Geographic Dictionary of the Virgin Islands of the United States, Special Publication No. 103, U.S. Coast and Geodetic Survey (1925). This was prepared following the first survey of the islands by the Coast Survey. The publication is based upon the field reports and other literature. All conflicts in names were submitted to the United States Geographic Board for decision. The features are described and the origins of the names are given when available.

93. This publication of 9,847 names includes the names of all the features in the coastal areas which were shown on the Coast Survey nautical charts of 1940 and those named on other federal and private maps.

94. The publication follows the procedure used in the Alaska publication (*see* note 93 *supra*). A total of 6,807 names is included.

95. This contains 47,355 original entries and cross references. Fourteen sources were used in the compilation. All variant names were included, no attempt being made to determine the most likely name of any feature.

96. This was established by Memorandum of Sept. 5, 1934, from the Assistant Chief, Division of Charts. The present organizational set-up for this function (in 1963) is the Geographic Names Section in the Administrative and Technical Services Division.

investigation—the field and the office. The field examination is made in connection with the topographic and hydrographic surveys which form the principal sources of the charted geographic names. The field investigator has the duty of checking with residents of an area, or by consulting local libraries and archives, every name for its correctness and form, and to resolve, as far as local authority is concerned, all cases of conflict. In addition, he obtains all previously unpublished names which he finds to be well established in local usage. The investigator submits a special report on his findings with recommendations for cases where local usage differs from that shown on the published charts of the Bureau.

The office investigation of geographic names is sometimes made preliminary to the field investigation, and such information is furnished the field investigator; at other times it is made after the field report has been received. In either case, all available sources in the Washington Office are consulted and these may include the various charts, maps, and *Coast Pilots* published by the Bureau, and all other maps and publications by other federal agencies, such as topographic quadrangles, soil maps, post route maps, forest and reservation maps, postal guides, light lists, state and county highway maps, railway guides, state guides, atlases, etc.

From this combined investigation a decision is made as to the name to adopt or to be submitted to the Board on Geographic Names for disposition (*see* 6564). It is not necessary that all names be submitted to the board for a decision. Names known not to be in conflict with the principles adopted by the board need not be submitted—for example, names in undisputed local usage; names provisionally approved by the board; and official names of post offices appearing in the United States Postal Guide.[97]

## 6564. *United States Board on Geographic Names*

The United States Board on Geographic Names was constituted by President Benjamin Harrison on September 4, 1890, as the Board on Geographic Names. Its purpose was to decide "unsettled questions concerning geographic names," and to obtain "uniform usage in regard to geographic nomenclature and orthography . . . throughout the Executive Departments of the Government, and particularly upon the maps and charts issued by the various departments and bureaus."[98] Through several Executive orders the duties and

97. Such use does not mean that the board approves them, and they may be called up for formal decision at any future time, if it is found that they are causing confusion.

98. Sixth Report of the United States Geographic Board, 1890–1932, V (1933).

authority of the board have been changed (including its name), and for a period of time was actually abolished as a formal board, but essentially its duties today are as originally defined.[99]

The board exercises jurisdiction over geographic names jointly with the Secretary of the Interior. It is interdepartmental in composition and is made up of members from the Departments of State, Army, Navy, Air Force, Interior, Commerce, Post Office, Agriculture, and from the Library of Congress, the Central Intelligence Agency, and the Government Printing Office. The Coast and Geodetic Survey represents the Department of Commerce on the board.

The jurisdiction of the board extends to all unsettled questions concerning geographic names which arise in the departments; all cases of disputed nomenclature; and to the approval before publication of all names hereafter suggested for any place by any officer or employee of the Government. It also includes the duty of determining, changing, and fixing place names within the United States and the insular possessions. The decisions of the board relative to geographic names are final so far as the Federal Government is concerned and are accepted as the standard authority.

The board follows certain guiding principles, local usage carrying the greatest weight. Some of the other principles adhered to are the following:

Euphonious and suitable names of foreign or Indian origin are retained.

Excessive duplication of extremely common names, especially within one state, are avoided.

Newly assigned names in honor of living persons are not approved.

Long and clumsily constructed names and names composed of two or more words are avoided. If a two-word name is essential, consideration is given to combining the two words into one.

Only one name should be applied to a stream throughout its entire length, and the name should generally follow up its longest branch.

Where practicable, independent names are given to the branches of a river, unless there is thoroughly established usage to the contrary.

The spelling which is in undisputed local usage is generally adopted.

The possessive form is avoided when it can be done without destroying the euphony of the name or changing its meaning. When the possessive "s" is retained the apostrophe is almost always omitted.

99. The first change occurred on Jan. 23, 1906, when President Theodore Roosevelt, by Executive order, vested the board with the additional duty of "determining, changing, and fixing place names within the United States and insular possessions." *Ibid.* On Aug. 10, 1906, the President again enlarged the duties of the board to include advisory powers concerning the unification of the symbols and conventions used on maps. *Id.* at VI. As a result the name of the board was changed to United States Geographic Board. This was abolished on Apr. 17, 1934, by President Franklin D. Roosevelt, and its functions transferred to the Department of the Interior, where it was constituted as a Division of Geographic Names with representation from other departments. *See* Memorandum of Sept. 5, 1934, *supra* note 96. Subsequent thereto, but prior to May 16, 1936, it was re-established as the United States Board on Geographical Names. Its present designation is United States Board on Geographic Names.

Where two or more names for the same feature appear to be equally established in local use, that which is most appropriate, euphonious, and older is adopted.[100]

The following classes of names are required to be submitted to the board for a decision: all new names recommended for previously unnamed features; new names for previously named features and old names that are to be applied to features differing from the original ones; names for which there is an existing decision of the board which appears to be incorrect or inadequate from latest information; names whose usages differ in federal or other publications, or whose local usage differs from published usage; and names of places (cities, towns, villages, and settlements) which are duplicated within the same state.[101]

### A. DECISIONS OF THE BOARD

Although all names are subject to review by the board at its option, and to approval or disapproval by the Secretary of the Interior, in practice the board's Domestic Names Committee takes final action on most names within its purview. Decisions are printed quarterly, and at long intervals all of the decisions of the board since its establishment are published complete in one consecutive alphabetical list. The Sixth Report published in 1933 is the latest complete report (*see* note 98 *supra*).[102]

The earlier decisions of the board usually indicated only the spelling of the name on which a decision was made, followed by information sufficient for identification of the place or feature to which the name applied. Because the range of problems presented to the board has increased in recent years, the published decisions have been amplified to include the following: spelling, thing named, location, pronunciation and hyphenation (when not self-evident), rejected names and forms of names, and history and derivation of the name.[103]

100. ADAMS (1942), *op. cit. supra* note 2, at 52. It should be noted that the restriction against naming features in honor of living persons is applicable only to *newly assigned* names to previously unnamed features, and even where names of living persons have become established as geographic names the board does not view with favor their perpetuation. A notable exception has, however, been made in the case of names in Antarctica

101. *Id.* at 53. Although not obligatory, the following types of cases are generally also submitted: names of natural features which are likely to cause confusion through duplication; names for which there are existing decisions of the board concerning which important new evidence is available or which it is believed might be revised if reconsidered; and names for which there are existing decisions, or names in undisputed use that are not spelled in accordance with their derivation or that are objectionable because they are awkward, misleading, or difficult to spell or pronounce. *Ibid.*

102. In the Geographic Names Section in the Coast Survey, a complete card file of the board's decisions is maintained.

103. Formerly, only the proper names were considered by the board, but current decisions include generic terms as well. For a more detailed treatment of the subject of geographic names—particularly in relation to the Board on Geographic Names—including terminology used for submarine relief, *see* ADAMS (1942), *op. cit. supra* note 2, at 46–56. *See also* JEFFERS, HYDROGRAPHIC MANUAL 245–249, PUBLICATION 20–2, U.S. COAST AND GEODETIC SURVEY (1960).

### 6565. *Charting Geographic Names*

The principal sources of charted geographic names are the topographic and hydrographic surveys of the Bureau. The topographic surveys—both planetable and photogrammetric—are the authority for most geographic names of all land features inshore from the high-water line; and in addition the names of lakes, small streams, rivers, and sloughs which are not sounded during the hydrographic survey. The hydrographic surveys are the authority for names seaward from the high-water line, including the names of all water features such as rivers, channels, sloughs, and inlets; the reefs, rocks, banks, and shoals therein; and all small islands and the names of geographic features thereon.

On the very early charts, lettering of names of features followed a system in which capitals, lower case, and italics (in the order noted) indicated the importance of the respective features to navigation (*see* New York Bay and Harbor chart of 1845). Beginning in 1860, a system was inaugurated of using vertical lettering for the names of land features which extended above the plane of mean high water, and slanting lettering for all names relating to water areas and features below the plane of mean high water (*see* same chart of 1861).[104] This is also the present practice with the addition that the former also applies to fixed aids above high water and the latter to floating aids.[105]

The placement of geographic names on nautical charts (this also applies to the topographic and hydrographic surveys) follows well-established cartographic principles. Thus, in the case of a point of land, the name is placed as near to the feature as practicable. But the name of a feature which covers a considerable area, such as an island or bay, is placed in the approximate center of the area, where possible, and is curved to follow the general configuration of the feature.[106]

A geographic name is applied to a particular feature which has identity. If the feature ceases to exist, the name becomes meaningless and is removed from the charts. Thus, where an inlet through a barrier beach has been closed permanently and another similar inlet breaks through, the practice is to remove the name and not to apply it to the new inlet. But where a named inlet or point of land has migrated from its original position, the name is retained but in the new position.

104. This practice originated with the "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey," promulgated in 1860 (*see* 462).

105. EDMONSTON (1956), *op. cit. supra* note 53, at 70.

106. *Id.* at 71. Names of rivers and features of unusual length are not spread out, but are spaced for easy reading and repeated if necessary. *Ibid.*

### 6566. *Some Legal Aspects of Charted Geographic Names*

There are various legal aspects of charted geographic names that may arise in connection with the interpretation of a historical or legal document, or with a statute in which a particular name appears. If the name can be identified on a survey or chart made around the date of the document, it would be strong indication of what was understood at the time by the parties to the document.

A case in point is the use of the name "bay of New York," or New York Bay, in the Compact of 1834, between New York and New Jersey, which invested the State of New York with an extraterritorial jurisdiction over all the waters of such bay. The specific question was the geographic extent of New York Bay, that is, whether it was confined to the area above The Narrows or whether it continued south of The Narrows to the New Jersey shoreline (*see* chart 369). It was stated by the Supreme Court of New Jersey that what started as a "routine enforcement of the gambling laws develops into one of major importance," the question for decision being "whether New Jersey ceded any portion of its otherwise exclusive jurisdiction to New York under the Compact of 1834 over the waters lying off Monmouth County and westerly of Sandy Hook, all of which lie within the New Jersey territorial boundary as established by that Compact." [107]

The State of New Jersey requested assistance from the Survey in ascertaining the geographic extent of "New York Bay" based, if possible, on maps dated around 1834.

Based on a comprehensive research and analysis of available maps, charts, and other material in the Coast Survey and in the Library of Congress (21 sources were consulted), we were able to state in summary that "none of the published charts of the Coast Survey have ever designated the area of 'Lower Bay' as 'New York Bay' or 'Bay of New York,' although there are references in the Annual Report of the Coast Survey for the year 1857 that New York Bay could have been thought of as also encompassing the lower bay; that in the early charts, the name is confined to the area north of The Narrows, and in the later charts the terminology 'Upper Bay' and 'Lower Bay' is used without the appendage 'New York'; and that there is no uniformity of treatment on non-

107. *New Jersey* v. *Carlajtes et al.*, 132 A. 2d 515, 516 (1957). The case arose under an indictment for violation of a New Jersey gambling statute on board a ship moving in the waters of Sandy Hook Bay south of the territorial boundary between New York and New Jersey about one-half mile off the New Jersey shoreline, seaward of low-water mark. The lower court dismissed the indictment for want of jurisdiction on the ground that the Compact of 1834 gave New York exclusive jurisdiction over the waters where the arrests took place. The State of New Jersey appealed the decision.

Coast Survey maps and publications, the majority indicating the name 'New York Bay' to be applied to the area north of The Narrows." [108]

The court said that if the intent of the parties is to be interpreted in the historical setting of 1834, attention must be directed to maps and writing of that period. The court then concluded that "these earlier writers and cartographers . . . confined New York Bay to the area above The Narrows and described The Narrows as the connecting link between the Bay and the Atlantic Ocean, although later works spoke in terms of an 'Upper Bay' and a 'Lower Bay.' " [109]

## 657. Dates on Charts

This subject has been dealt with at length in a former chapter (*see* 1272) and will not be repeated here other than to emphasize again that dates on charts represent the dates of publication and bear no relationship necessarily to the date when a particular area was surveyed or when certain information was obtained. Two adjacent soundings on a chart may sometimes be from surveys years apart. If the precise date of origin is required, recourse must be had to the original data from which the chart was compiled (*see* 1275).

## 658. Tide Notes

Tide notes are included on nautical charts in order that the navigator may have readily available information on the mean range or the diurnal range of the tide at key places on the chart. Since the early charts published by the Bureau, these notes have undergone considerable change in both form and content. Prior to 1853—the date of publication of the first tide tables in the annual reports of the Bureau (*see* Part 1, 2322)—the purpose of the tide note was also to furnish information for prediction purposes so that the time and height of the tide could be determined when used in conjunction with the Nautical Almanac.[110] The key to this was the information on the "Corrected

108. The Supreme Court of New Jersey quoted this Coast Survey summary, as well as many of the sources furnished the State of New Jersey which it in turn embodied in its brief to the court. *Id.* at 520–521.

109. *Id.* at 521–522. The judgment of the lower court was therefore reversed and the indictment reinstated. For other facets of the legal implications of charted geographic names, *see* Volume One, Part 1, 4541.

110. Finnegan, *Historical Note on Tide Predictions,* 5 Journal, Coast and Geodetic Survey 100 (1953).

Establishment of the Port" or the time interval between the moon's meridian passage (upper or lower) and the following high water. This is known as the "high-water lunitidal interval." The interval between the moon's passage and the following low water is the "low-water lunitidal interval." The early notes also gave values for the spring and neap tides, as well as other tidal information (*see* chart of Hell Gate, N.Y., 1851 ed.).

Tide notes for prediction purposes, in varied forms, were continued on charts for many years after the advent of the *Tide Tables,* and as late as 1898 they contained 11 elements for each place (*see* chart 109, Boston Bay and Approaches, 1898 ed.). Gradually they fell into disuse.[111]

The present practice (since 1955) for the Atlantic and Gulf coasts is to give the following four values, all referred to the datum of soundings (MLW): mean high water, mean tide level, mean low water, and extreme low water (*see* fig. 78). For Pacific coast charts, the values are given for mean higher high water, mean tide level, mean lower low water, and extreme low water, all referred to the datum of soundings (MLLW) (*see* fig. 79).[112] The values given are based on actual observations at the station named, and may vary from a few days to many years. However, short-series observations are reduced to mean values before publication, except the entry for "extreme low water" (*see* 6581).

The date of the tide note is the month and year which the latest information was applied, and is shown by a numeral in the lower left corner of the note, thus: "(463)"—meaning April 1963. The note is reviewed about every 3 years for new values.

111. The early charts of the Gulf coast stated that the range of the tide was small, irregular, and much influenced by the wind. Average values for the rise and fall were given for all tides, for tides when the moon's declination was greatest, and when it was least. The prevailing wind for each month was also given (*see* chart 188, Mobile Bay, 1858 ed.). The term "grand tides" was introduced on the charts in the 1890's and was defined as those tides occurring when the moon was at its farthest declination (*see* chart 188, Mobile Bay and Entrance, 1894 ed.). This was later changed to "tropic tides," in contradistinction to "equatorial tides" when the moon is on the equator.

112. Between 1940 and 1955, the standard tide note for charts of scale larger than 1:200,000 gave the values for mean high water, mean sea level, and lowest tide to be expected (*see* chart 246, Boston Harbor, 1946 ed.). In 1955, for uniformity, the Coast and Geodetic Survey and the Navy Hydrographic Office changed their tide notes to the form shown in figures 78 and 79. *Nautical Chart Tide Note,* 7 JOURNAL, COAST AND GEODETIC SURVEY 119 (1957). The value for "mean tide level" (half-tide level), was substituted for "mean sea level" because mean tide level is a plane that is exactly halfway between the planes of mean high water and mean low water and therefore can be readily determined from the high- and low-water tabulations. To derive the plane of mean sea level, all the hourly heights must be averaged. Since the two planes usually lie close to each other, it is sufficient to use mean tide level for most purposes. MARMER, TIDAL DATUM PLANES 69, SPECIAL PUBLICATION NO. 135, U.S. COAST AND GEODETIC SURVEY (1951).

TIDAL INFORMATION

| Place | Height referred to datum of soundings (MLW) | | | |
|---|---|---|---|---|
| | Mean High Water | Mean Tide Level | Mean Low Water | Extreme Low Water |
| | feet | feet | feet | feet |
| Egmont Key | 1.3 | 0.6 | 0.0 | −3.0 |
| Bradenton | 1.5 | 0.7 | 0.0 | −3.0 |
| St. Petersburg | 1.4 | 0.7 | 0.0 | −3.0 |
| Gulfport | 1.5 | 0.8 | 0.0 | −3.0 |

(858)

FIGURE 78.—Tide note for Atlantic and Gulf coasts charts.

TIDAL INFORMATION

| Place | Height referred to datum of soundings (MLLW) | | | |
|---|---|---|---|---|
| | Mean Higher High Water | Mean Tide Level | Mean Lower Low Water | Extreme Low Water |
| | feet | feet | feet | feet |
| Alcatraz Island | 5.8 | 3.1 | 0.0 | −2.5 |
| Rincon Point | 6.1 | 3.3 | 0.0 | −2.5 |
| Oakland Pier | 6.0 | 3.2 | 0.0 | −2.5 |
| Point Avisadero | 6.6 | 3.5 | 0.0 | −2.5 |

(1061)

FIGURE 79.—Tide note for Pacific coast charts.

## 6581. *Extreme Low Water*

Predictions for the height of tide as given in the *Tide Tables* reflect the normal astronomic tide to be expected. They do not take into account the effect that unusual meteorological conditions might have on the rise or fall of the tide at any particular time. Since the most dangerous situation for the navigator would arise if meteorological effects caused the water level to be lower than predicted—especially near the time of low water—the Bureau, as a precautionary measure, publishes in its tide note the value of the lowest water level observed or estimated for the limits of the chart. This is now designated as "extreme low water." Its value may be based on the lowest water level observed at a tide station over a short period or a long period, or it may be an estimated value based on the best available reports and information.[113] The important point to keep

113. On chart 346, Edgartown Harbor, Mass. (1943 ed.), where no long series of observations was available, the value for "extreme low water" was derived by examining the lowest water levels observed at Newport, R.I., and Woods Hole, Mass., where observations were available for about 30 years. From these the most probable value for the lowest water level at Edgartown was inferred as 2.5 feet below the plane of mean low water.

in mind is that the term "extreme low water" as used in the tide note is not a recognized tidal plane, as is the term mean low water or mean high water, and should not be confused with the lowest tide resulting primarily from astronomic causes which would reflect spring, perigean, and tropic tide effects.[114] Unless the term "extreme low water" is defined in relation to the astronomic tide by a fixed decrement, such as 2 feet or 3 feet below mean low water (a plane of definite ascertainment), it would be too uncertain a value to be used in the determination of tidal boundaries.

The term has been used (without definition) in some state decisions. Thus, in a case involving an application of an early Massachusetts ordinance, the court said: "The petitioner owned the fee to the flats adjacent to her land and her ownership, by virtue of the colony ordinance of 1641–47, extended to extreme low water or to one hundred rods from the ordinary high water mark, if the low water mark lies beyond that distance." [115]

(*a*) *Monthly Lowest Low Water.*—The datum of monthly lowest low water has been used when it was desired to have the datum so low that most low waters would be above it. As its name implies, it is the plane determined by the average height of the lowest low waters of each month over a considerable period of time. Although sometimes referred to as extreme low water or storm low water, it would be best not to confuse it with either of these designations. Extreme low water could exceed the monthly lowest low and the latter is frequently not due to storms. The term monthly lowest low water is self-explanatory and definitely refers to the low water which, during the month in question, falls to the lowest level.[116]

114. For Edgartown Harbor, Mass., the spring, perigean, and tropic tide effect is about one-half foot below mean low water as compared with the value of 2.5 feet derived for extreme low water (*see* note 113 *supra*).

115. *Iris* v. *Town of Hingham*, 22 N.E. 2d 13, 15 (1939). The actual wording of the ordinance was that "in all creeks, coves and other places, about and upon salt water, where the sea ebbs and flows, the proprietor of the land adjoining, shall have propriety to the low water mark, where the sea doth not ebb above a hundred rods, and not more wheresoever it ebbs further." As authority for its statement, the court cited the early case of *Commonwealth* v. *Alger*, 61 Mass. 53, 67 (1853), where the colony ordinance was comprehensively considered. But nowhere in the decision is the term "extreme low water" mentioned. All the references are either to "the land between high and low water mark," to "low water mark," or to "the shore between the high and low water mark," the last reference being to the property of the sovereign at common law. In *East Boston Co.* v. *Commonwealth*, 89 N.E. 236 (1909), the court held the word "ordinary," when applied to a high- or low-water mark in a grant made in 1640, to be used in the sense of average, by the courts of this country and of England, rather than "extreme low water." But the court distinguished a grant under the ordinance of 1641–1647, which "for reasons stated in decisions," the court said, "means the line of extreme low water shown at an ebb of the tide, resulting from usual causes and conditions" (citing *Wonson* v. *Wonson*, 96 Mass. 71, 82 (1867)). *Id.* at 237. This statement also leaves in doubt the line to be used for demarcating the boundary. However, it can be stated definitely that, whatever line the court had in mind, it could not be the line referred to in the tide note on the charts as "extreme low water," for the reason that the latter may result from storms and would not fall within the description "resulting from usual causes and conditions," as used by the court.

116. MARMER (1951), *op. cit. supra* note 112, at 127. For a discussion of other tidal datum planes sometimes used besides the principal datum planes, *see id.* at 128–130.

### 659. Loran Lines of Position

Loran is an electronic system, developed during World War II, for fixing a vessel's position regardless of the weather or the state of the sea. To make the system practicable for the navigator, it was necessary to chart the lines of position for the different Loran transmitters. These lines consist of two or more families of hyperbolic curves, each family being shown in a distinctive color.

The first Coast Survey chart to show such lines was published in 1946. The method of presentation was to print the Loran lines in register on the back of a standard navigational chart. When the navigator located his position by Loran, he transferred the position to the face of the chart by a prick point. This method, after some modification, gave way to the present method—adopted late in 1950—of showing the Loran data on the face of the chart. The lines of position are reduced in weight so as not to detract from the hydrographic information. Loran was first shown on the Sailing charts, but the system has gradually expanded to take in many of the General and Coast charts. For further discussion of the Loran principle and the method of determining position, *see* 6931(*c*).

## 66. SYMBOLIZATION

The complete symbolization used on nautical charts is given in Appendix F. In this section, emphasis will be placed on those features that have been the subject of inquiry from time to time or that may have a legal connotation. Where of importance, references will also be made to former practices. It should be noted, in this respect, that the earliest reference to symbolization for charts is contained in the pamphlet designated as "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey," published in 1860 (*see* 462). Included in these rules were guides for the drawing of every detail of the finished chart, from the symbols and dimensions for the topographic and hydrographic features to the style and gage of the lettering.

### 661. High-Water Line

The high-water line, which is the dividing line between land and sea, was always prominently displayed on the nautical chart as the heaviest, continuous, black line inside the neat line. It is the mean high-water line as nearly as it

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can be determined by the topographer without running levels (*see* 442). The modern practice is to decrease the weight of the line up streams and rivers. In areas where the fast land is fringed by vegetation, such as marsh or mangrove, the outer edge of the vegetation is used as the dividing line and is symbolized by a continuous, black line about half the thickness of the normal high-water line. The inshore limits of vegetation, which is generally the edge of the fast land, is represented by a black, broken line slightly lighter than the outer edge of the vegetation. Where the high-water line is unsurveyed, a heavy, black dashed line is used.

### 662. Low-Water Line

The low-water line on a chart represents the line of zero soundings, or the sounding datum (*see* 651(*b*)). On the Atlantic and Gulf coasts it is mean low water, and on the Pacific coast it is mean lower low water. The charted low-water line is taken from the hydrographic survey when it is defined by soundings; when not so defined, it is an adjusted line between the hydrographic and topographic surveys in case of a conflict (*see* 4461). The low-water area (high-water line to low-water line) was formerly symbolized by the heaviest sanding on the chart, the outer edge of the sanding following in detail the low-water line. In the low-water area, the type of material was sometimes indicated by either symbols or bottom abbreviations (*see* chart 637, Koos Bay, 1865 ed.). The modern practice is to eliminate sanding from the chart (*see* 663), hence the low-water line is symbolized by a single row of black dots and the low-water area by a yellow-green tint, the same as is used for marsh areas (*see* 664(*b*)). When known, the character of the area—sand, mud, grass, etc.—is given in several places.

### 663. Sanded Areas

A common practice on finished charts in the early years was to sand the area from the high-water line to a particular depth curve by means of gradations in the sanding so as to form adjacent bands, the band farthest offshore being the most open, and the low-water area being the most dense. For the most part three bands, besides the low-water area, were used to indicate the 6-, 12-, and 18-foot depth curves (*see* chart 671, San Pablo Bay, 1863 ed.).[117] This practice continued as long as charts were printed in black and white and two depth units were used on the same chart (*see* 651(*a*)). With the adoption of

117. It is important to note that when sanding was used, whether for the low-water area or for the deeper depths, it did not necessarily indicate the nature of the bottom material. It could be sand or grass or any other material, unless indicated on the chart.

one depth unit for a chart, the sanding below the low-water line was replaced by dotted lines (*see* chart 560, Potomac River, 1906 ed.). When lithography was introduced in nautical charting after the turn of the century, a blue tint was used on an experimental basis to replace the sanding. A buff tint was then added to accentuate the land areas of the chart.

### 664. Tinted Areas

Since the early 1940's, the blue tint has to an increasing extent replaced sanding. In 1952, the Nautical Chart Manual provided for the use of the blue tint in water areas to the curve which is considered the danger curve for that particular chart. In general, this is the 6-foot curve for Intracoastal Waterway and Small-Craft charts, the 12- or 18-foot curve for Harbor charts, and the 30-foot curve for Coast and General charts.[118]

(*a*) *Wire-Dragged Areas.*—Areas in Alaska which have been covered to a safe depth with the wire drag, but which have not been adequately sounded, are shown on the charts with a bright green tint. This treatment has also been used on other charts of important areas covered by the wire drag.

(*b*) *Marsh Areas.*—Another significant chart feature to which tinting is now applied is marsh area. The former practice was to use the regular marsh symbol corresponding to salt marsh or fresh marsh (*see* fig. 52). These were quite extensive in the San Francisco Bay and Delaware Bay areas. To avoid the use of an additional color plate the tint used is a combination of the blue plate for the water area and the buff plate for the land area, the resultant being a yellow-green shade.

### 665. Improved Channels

The improvement of rivers and harbors and the Intracoastal Waterways for navigation is under the authority of the Corps of Engineers. Copies of their surveys are furnished the Bureau for application to the nautical charts. The manner of showing a dredged channel has always been by black, dashed lines to represent the side limits, with the controlling depth and date of ascertainment given adjacent to or inside the channel. In the middle 1930's an elaborate caution note was added regarding the possibility of shoaling at the sides. This

118. The 1956 edition of the manual carries an identical provision. Edmonston (1956), *op. cit. supra* note 53, at 50. Chart 5101A, San Diego to Santa Rosa Island, Calif., the new chart designed in 1939 for echo-sounding navigation (*see* 6241), showed a blue tinted area from the high-water line to the 50-fathom depth contour. This was later changed to two shades of blue—a deeper blue to the 10-fathom contour and a lighter shade to 50 fathoms. This is the treatment used on the present chart.

**OAKLAND OUTER AND INNER HARBORS**

Tabulated from surveys by the Corp of Engineers - surveys to Sept. 1961

| Controlling depths in channels entering from seaward in feet at Mean Lower Low Water | | | | | | Project Dimensions | | |
|---|---|---|---|---|---|---|---|---|
| Name of Channel | Left outside quarter | Left inside quarter | Right inside quarter | Right outside quarter | Date of Survey | Width (feet) | Length (naut. miles) | Depth M.L.L.W. (feet) |
| Bar Channel | 29.8 | 35.3 | 36.7 | 34.0 | 9-61 | 800 | 0.45 | 35 |
| Outer Harbor Entrance Channel | b23.0 | 35.3 | 35.5 | c22.0 | 9-61 | 650-600 | 0.87 | 35 |
| Outer Harbor | 30.0 | 35.4 | 35.0 | d20.3 | 9-61 | 600-1350 | 1.40 | 35 |
| Inner Harbor | | | | | | | | |
| Entrance Channel | 20.0 | 29.9 | 31.5 | e14.6 | 2,9-61 | 800-500 | 1.00 | 30 |
| Inner Harbor Reach | f20.0 | 30.3 | 30.0 | g10.4 | 2-61 | 500-600 | 2.27 | 30 |
| Grove St. Pier to Brooklyn Basin | h22.0 | 29.3 | 29.2 | i19.4 | 2-61 | 600 | 1.30 | 30 |
| Brooklyn Basin South Channel | j17.2 | 28.7 | 30.0 | k12.0 | 2-61 | 600-500 | 0.90 | 30 |
| Brooklyn Basin North Channel | 18.0 | 12.0 | 12.0 | 9.0 | 8-50 | 300 | 0.93 | 25 |
| Park St. Bridge Reach | l15.9 | 20.2 | 21.9 | 15.6 | 2-61 | 500-275 | 0.42 | 30 |
| Tidal Canal | | | | | | | | |
| Fruitvale Avenue Bridge Reach | 17.1 | 17.8 | 17.0 | 12.0 | 9-57 | 275 | 0.35 | a 25 |
| Fruitvale Avenue to San Leandro Bay | 12.0 | 16.2 | 16.0 | 9.0 | 8-50 4-57 | 275 | 0.73 | a 25 |

a. Project depth is 25 feet but channel is dredged and maintained to 18 feet.
b. The channel has shoaled along the edge; a depth of 33 feet was available in the inside half of the quarter.
c. The channel has shoaled along the edge; a depth of 26.7 feet was available in the inside half of the quarter.
d. The channel has shoaled along the edge from Richmond Outer Harbor Buoy 4 to 850 yards easterly; a depth of 29 feet was available in the inside half of the quarter opposite the shoal.
e. The channel has shoaled along the edge from the junction with Inner Harbor Reach to about 335 yards northwest; a depth of 25.3 feet was available in the remainder of the quarter.
f. The channel has shoaled along the edge; a depth of 28.8 feet was available in the inside half of the quarter.
g. The depth was 27.6 feet except for shoaling to 10.4 feet in the outside 50 feet of the quarter.
h. The channel has shoaled along the edge; a depth of 26.0 feet was available in the inside half of the quarter.
i. The channel has shoaled along the edge; a depth of 29.3 feet was available in the inside half of the quarter.
j. Shoal depth is located on the channel edge; a depth of 25 feet was available in the inside half of the quarter.
k. The depth was 20.1 feet except for shoaling to 12.0 feet in the outside 50 feet of the quarter.
l. The depth was 19.2 feet except for shoaling along the channel edge from the Park Street Bridge to 250 yards northwest.

Note.-The Corps of Engineers should be consulted for changing conditions subsequent to the above.

FIGURE 80.—Form of tabulation used on nautical charts for showing controlling depths and other information in important dredged channels.

note was simplified in February 1946 to read: "Improved channels shown by broken lines are subject to shoaling, particularly at the edges."

In the late 1940's it became apparent that more detailed information was required regarding depths in the important dredged channels for adequately safeguarding navigation. The result was the incorporation on the chart of a tabulation giving the project width of the channel, the minimum depth in each quarter width of channel, and the date of the survey on which the depths are based (*see* fig. 80). This applies to channels 400 feet wide and greater. There are variants of this treatment depending on the width of channel and the information available.[119]

### 666. Dangers to Navigation

The principal dangers to navigation shown on nautical charts are rocks (bare, awash, and sunken), reefs, and wrecks.

(*a*) *Rocks.*—The symbolization of rocks on the nautical chart follows the criteria used for the hydrographic surveys (*see* 565) and may be summarized as follows: Along the Atlantic and Gulf coasts, rocks whose elevations are 2 feet or more above mean high water are shown with the bare rock symbol and the height above the plane shown adjacent thereto in slanting numerals enclosed in parentheses; rocks whose peaks are in the zone between 1 foot above mean high water and 1 foot above mean low water are shown by the rock awash symbol (3 lines crossing) with the height above mean low water shown adjacent to the symbol in vertical numerals underlined and in parentheses;[120] and rocks whose peaks are covered more than 1 foot at mean low water are shown with the sunken rock symbol (a simple cross) if depth is unknown, or as a sounding with notation "Rk" adjacent, if the depth is known. For rocks along the Pacific coast, the same principles are followed for elevations and symbolization except that in each case the dividing line is increased by 1 foot and the sounding datum is mean lower low water instead of mean low water.[121]

(*b*) *Reefs and Ledges.*—The nature of reefs and ledges and their progressive symbolization have been described in connection with hydrographic surveys

119. Edmonston (1956), *op. cit. supra* note 53, at 50–51. Channels 100 feet to 400 feet wide are treated similarly except that the controlling depth is given for the middle half and for each outside quarter. This is the practice in 1963.

120. Where a rock is actually awash at the sounding datum, that is, where the summit is between 1 foot below and less than 1 foot above mean low water on the Atlantic and Gulf coasts and between 2 feet below and less than 2 feet above mean lower low water on the Pacific coast, a special symbol is used on the nautical charts—a simple cross with a dot in each quadrant, but no elevation given. This symbol is not used on hydrographic surveys. *Id.* at 53–55.

121. *Ibid.* These rules are not inflexible and in their application consideration is given to the character of the area, whether exposed or protected; the proximity to shore; the range of the tide; and the probable visibility of the rock at some stage of the tide. Special care is used in charting isolated and dangerous rocks by encircling the symbol with a black, dotted line. *Ibid.* Questions have occasionally arisen as to the interpretation of the notations "awash ¼ tide," "awash ⅔ tide," etc., appended to the rock awash symbol on hydrographic surveys and on nautical charts (*see* Register No. H–4865 (1928), and chart 5895, St. George Reef and Crescent City Harbor, 1949 ed.). Are they reckoned from the low stage of the tide or from the high stage? A study of the sounding records revealed unmistakably that such notations refer to the low stage of the tide. Because of the possible ambiguity, such notations are not used in charting and preference is given to the actual height of the rock at the chart datum. Edmonston (1956), *op. cit. supra* note 53, at 54.

(*see* 566). A rocky reef is always detached from shore, whereas a ledge is a rocky formation connected with and fringing the shore. On the nautical charts, coral and rocky reefs and ledges are indicated by the same symbol (a jagged formation simulating bedrock). The area between the high-water line and the outer edge of the reef or ledge is tinted yellow-green, the same as the low-water area (*see* 662), and the type of reef or ledge—rock or coral—is named when known.[122]

(*c*) *Wrecks.*—Charted wrecks are of two kinds—stranded or sunken. A stranded wreck is one where any portion of the hull is above the chart datum; a sunken wreck is one below the chart datum or where the masts only are visible. Figure 81 shows the treatment of various types of wrecks. When wrecks, rocks, or obstructions have been cleared by the wire drag, the maximum clearance depth is charted with a basket or bracket under it.

## 67. RULES OF THE ROAD BOUNDARY LINES

The "Rules of the Road" were adopted for preventing collisions at sea. This they attempt to do by providing standards of notice such that the master of a vessel can immediately determine what course of action to take in order to prevent his vessel from being placed in a collision situation. They cover requirements for lights, sound signals, steering, and sailing. The rules are set out in a pamphlet published by the U.S. Coast Guard and titled "Rules of the Road, International-Inland" (CG–169).

The rules of the road are in no sense optional, but are for the most part absolutely mandatory and apply with equal force to all vessels—naval, public, and private. Departure from them, other than to avoid immediate danger, must be justified on the ground that it could not possibly have contributed to the collision.[123]

### 671. History of the Rules

The first general set of rules regarding the avoidance of collisions at sea was published by Trinity House, London, in 1840, and was recognized as enforceable by the British Admiralty Court. Many of these rules were made statutory in 1846, but The Merchant Shipping Amendment Act of 1862 was the

122. *Id.* at 52. There is no distinctive symbol for a submerged reef or ledge, and where the limits have been determined they are indicated on the chart by a dashed line enclosing sunken rock symbols or an appropriate legend. *Ibid.*

123. Farwell, The Rules of the Nautical Road 197, 198 (1954).

| | | |
|---|---|---|
| *Visible wreck* | | *Stranded wreck, showing any portion of the hull or superstructure above datum of soundings (not masts and funnels only).*<br>*Note that the bottom line of the symbol, which represents the water surface, must always be parallel to the bottom of the chart.*<br>*Do not apply this symbol in crowded areas, especially when it interferes with topography. (Use dangerous sunken wreck symbol instead.)*<br>*When marked by a fixed red light (on charts with magenta overprint).* |
| *Dangerous sunken wreck* | | *Wreck over which the exact depth is unknown but is considered dangerous to surface navigation and might have less than 10 fathoms over it.* |
| *Nondangerous sunken wreck* | | *Wreck over which the depth is unknown but not considered dangerous to surface navigation or has more than 10 fathoms over it.* |
| *Sunken wreck with only masts visible* | *Masts* | *All of hull or superstructure submerged. Masts showing above datum of soundings.* |
| *Wreck, depth known* | 5 *Wreck* | *Least depth found over wreck.* |
| *Wreck, cleared by wire drag* | 21 *Wreck or Wk* | *Wreck cleared by wire drag to 21 feet. (See instructions listed under wire drag.)* |
| *Wreckage* | *Wreckage* | *Outline of the area of a number of wrecks.* |
| *Wreck, large-scale chart* | *Wreck* | *On large-scale charts, wrecks should be delineated in outline when all or most of the hull or superstructure shows above the sounding datum.* |
| *Wreck, submerged, large-scale chart* | *Wreck* | *On large-scale charts, submerged wrecks should be outlined by a dashed line.* |

FIGURE 81.—Symbolization for various types of wrecks shown on nautical charts.

real impetus to the adoption of rules of the road on an international basis. The Act of 1862 contained a set of "Regulations for preventing collisions at sea" which became the forerunner of the international rules later adopted.[124]

In the United States, the Act of April 29, 1864 (13 Stat. 58) adopted Rules and Regulations for Preventing Collisions on the Water. These were the first rules of the road to be adopted and became effective September 1, 1864. The international rules have been revised several times, the last amendment being in 1948 as a result of the proposal of the International Conference on Safety of Life at Sea held at London. Congress approved this revision on October 11, 1951 (65 Stat. 406) and it became effective on January 1, 1954.[125]

## 672. The Act of February 19, 1895

Prior to 1895, the laws pertaining to collisions at sea provided that certain rules should be followed by vessels on the high seas and in coastwise waters, while within harbors, rivers, and inland waters certain local modifications peculiar to the United States were to be observed. But nowhere was the line of demarcation between coastwise waters and inland waters drawn. This was an obvious defect and resulted in admiralty courts being left in doubt as to whether the international or the local rules should have been followed in a given collision situation in the channels leading from the harbors into the high seas.[126]

To remedy this, Congress passed the Act of February 19, 1895 (28 Stat. 672), entitled: "An Act To adopt special rules for the navigation of harbors, rivers and inland waters of the United States . . . supplementary to the Act of August nineteenth, eighteen hundred and ninety, entitled 'An Act to adopt regulations for preventing collisions at sea.'" Section 2 of the act provided that "The Secretary of the Treasury is hereby authorized, empowered and directed from time to time to designate and define by suitable bearings or ranges with light houses, light vessels, buoys or coast objects, the lines dividing the high seas from rivers, harbors and inland waters," thus determining the scope of application of the two sets of rules.[127]

124. Colombos, The International Law of the Sea (4th ed.) 292 (1959). In less than 10 years after passage of the act, the rules were accepted as obligatory by more than 30 of the maritime States of the world including the United States. *Ibid.*

125. Farwell (1954), *op. cit. supra* note 123, at 200.

126. Report of Commissioner of Navigation to Secretary of the Treasury 77 (1895).

127. The act became effective Mar. 1, 1895. Sec. 4 excludes from the term "inland waters" the Great Lakes and their connecting and tributary waters as far east as Montreal, these being regulated by the Act of Feb. 8, 1895 (28 Stat. 645). The authority which the act conferred upon the Secretary of the Treasury was successively transferred to the Secretary of Commerce and Labor by the Act of Feb. 14, 1903 (32 Stat. 829), later redesignated "Secretary of Commerce" by the Act of Mar. 4, 1913 (37 Stat. 736); to the Com-

Following passage of the act, the Secretary of the Treasury named an advisory board to recommend for his approval what lines should be established.[128]

### 6721. *Application to Coasts of United States*

The first lines to be designated were announced on May 10, 1895, and covered the areas of New York Harbor, Baltimore Harbor and Chesapeake Bay, Galveston Harbor, Boston Harbor, and San Francisco Harbor.[129] Over the years, other lines have been designated or existing lines modified when deemed in the public interest.

Figures 82 to 85 inclusive, show the present lines established by the Coast Guard for the coasts of conterminous United States, and reflect modifications made as of January 18, 1963.[130]

Recent lines established include the Gulf coast area from Pass a Loutre westward to the Rio Grande (*see* fig. 83),[131] and the entrances to a number of harbors along the California coast (*see* fig. 85).[132]

### 673. Designation of Boundary Lines on Charts

When the first rules of the road boundary lines were established (*see* note 129 *supra* and accompanying text), they were indicated by descriptive notes on the large-scale nautical charts (*see* chart 109, Boston Bay and Approaches, 1896 ed.). The title of the note did not always follow a standard form. Thus, the following titles have been used at different times: "Line Dividing the High Seas from Inland Waters" (1896); "Lines Dividing the High Seas from

mandant of the Coast Guard in 1946 (60 Stat. 1097–1098); to the Secretary of the Treasury in 1950, or to the Secretary of the Navy when the Coast Guard is operating in that department (64 Stat. 1280), and delegated by the Secretary of the Treasury to the Commandant of the Coast Guard (15 Fed. Reg. 6521 1950)).

128. The board was composed of the Superintendent of the Coast and Geodetic Survey, as chairman; the Commissioner of Navigation, as secretary; and the naval secretary of the Light-House Board, the Supervising Inspector-General of Steam Vessels, the chief of the Revenue-Cutter Service, as members. Report of Commissioner of Navigation, *supra* note 126, at 77.

129. *Id.* at 240. Later that year, the lines for additional areas along the Atlantic, Gulf, and Pacific coasts were announced.

130. 28 Fed. Reg. 490 (1963). Formerly, such sketches were included in the Coast Guard publication CG–169 (*see* 67). They were discontinued with the issue of Sept. 1953, after the Coast Survey adopted the policy of incorporating such lines on the nautical charts (*see* 673).

131. These became effective on Jan. 1, 1954. 18 Fed. Reg. 7893–7894 (1953). The purpose of establishing them was to remove confusion that had arisen regarding where the lines should be when specific lines are not described. *Ibid.*

132. These lines became effective Apr. 25, 1961. 26 Fed. Reg. 3527 (1961). The harbors not shown are Arcata Bay-Humboldt Bay, Port Hueneme, Marina del Rey, Redondo Harbor, and Newport Bay. In each case, the dividing line is the line connecting the outer ends of the breakwaters.

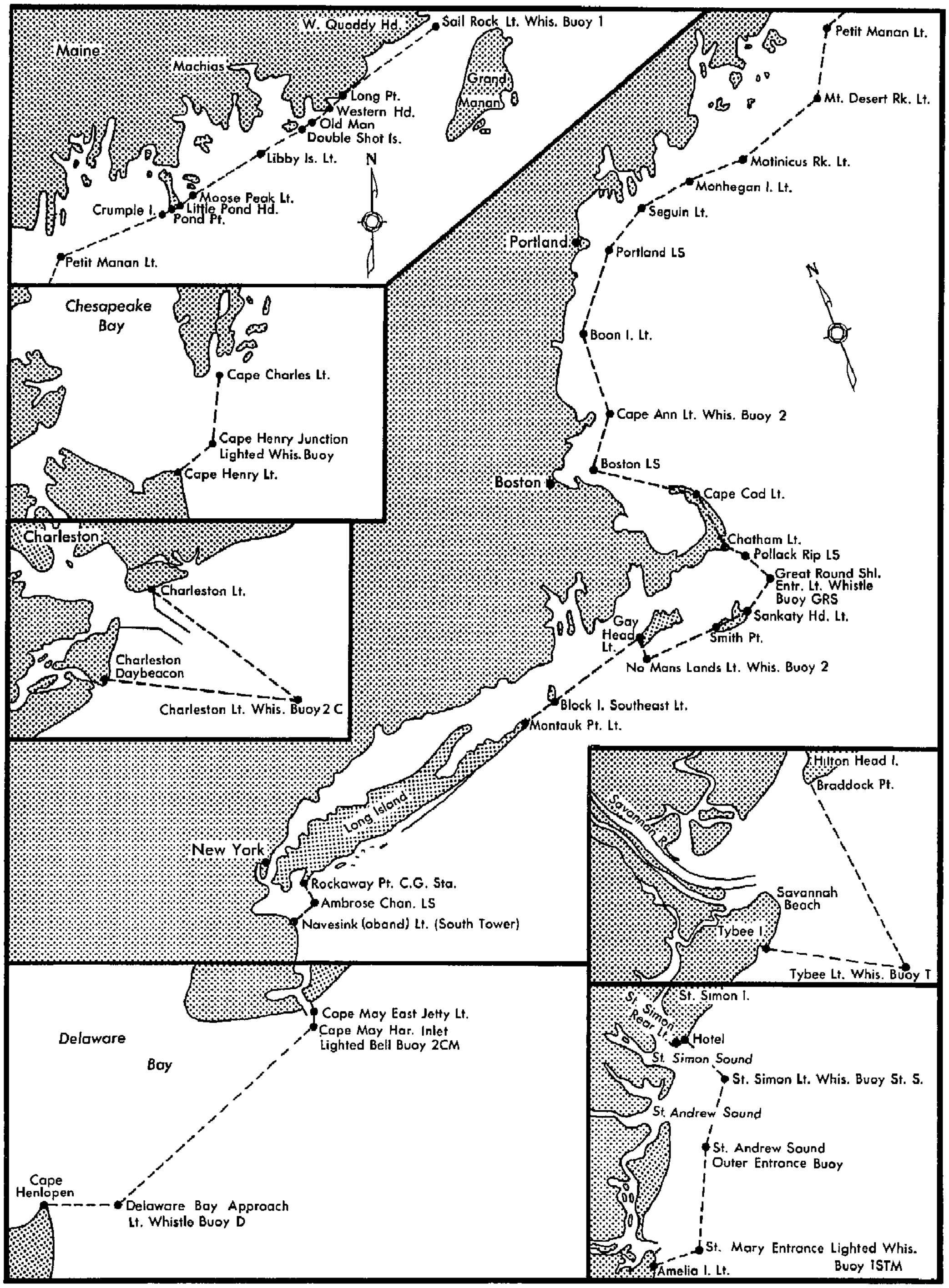


FIGURE 82.—Rules of the Road boundary lines—Atlantic coast.

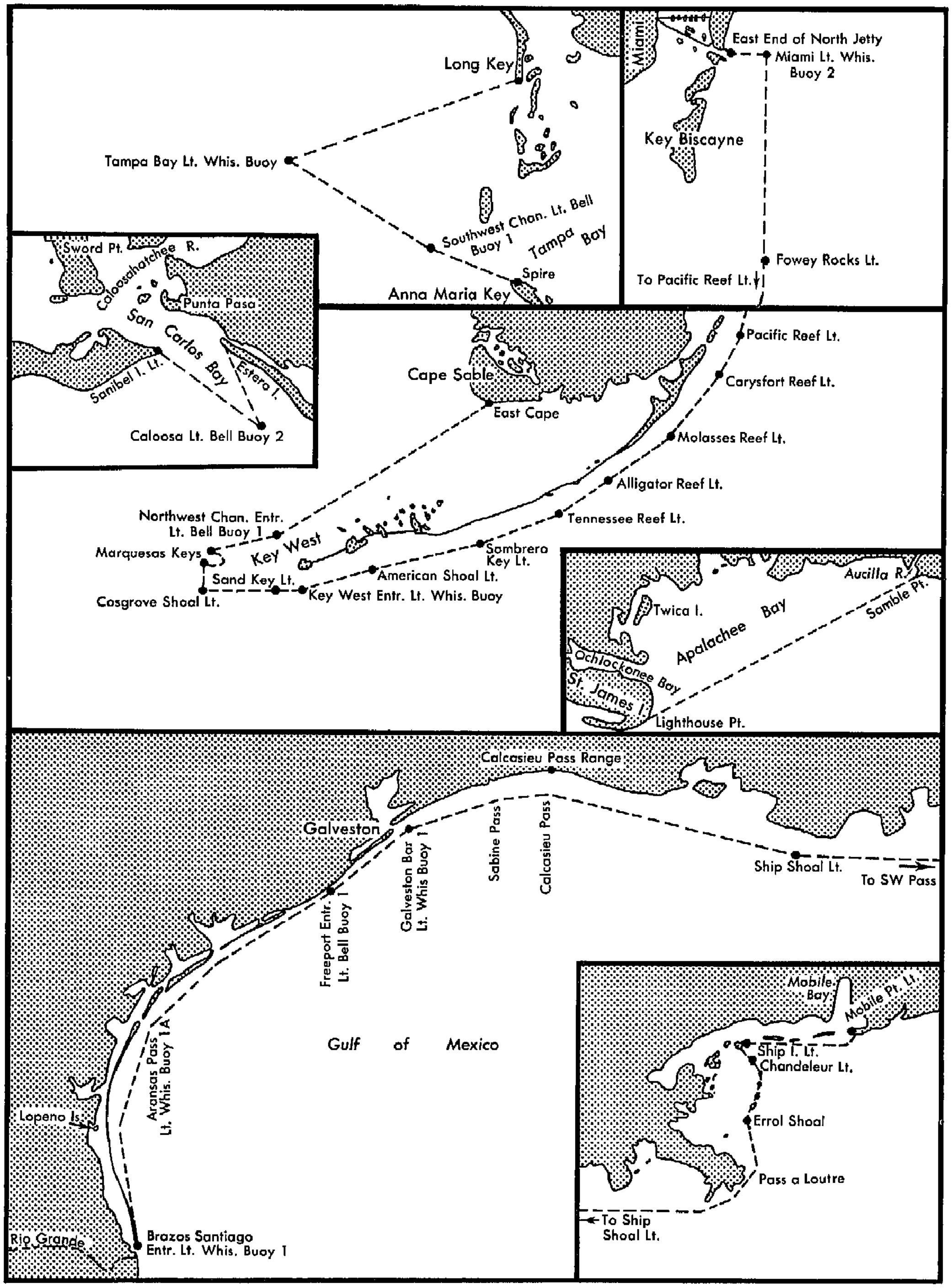


FIGURE 83.—Rules of the Road boundary lines—Gulf coast.

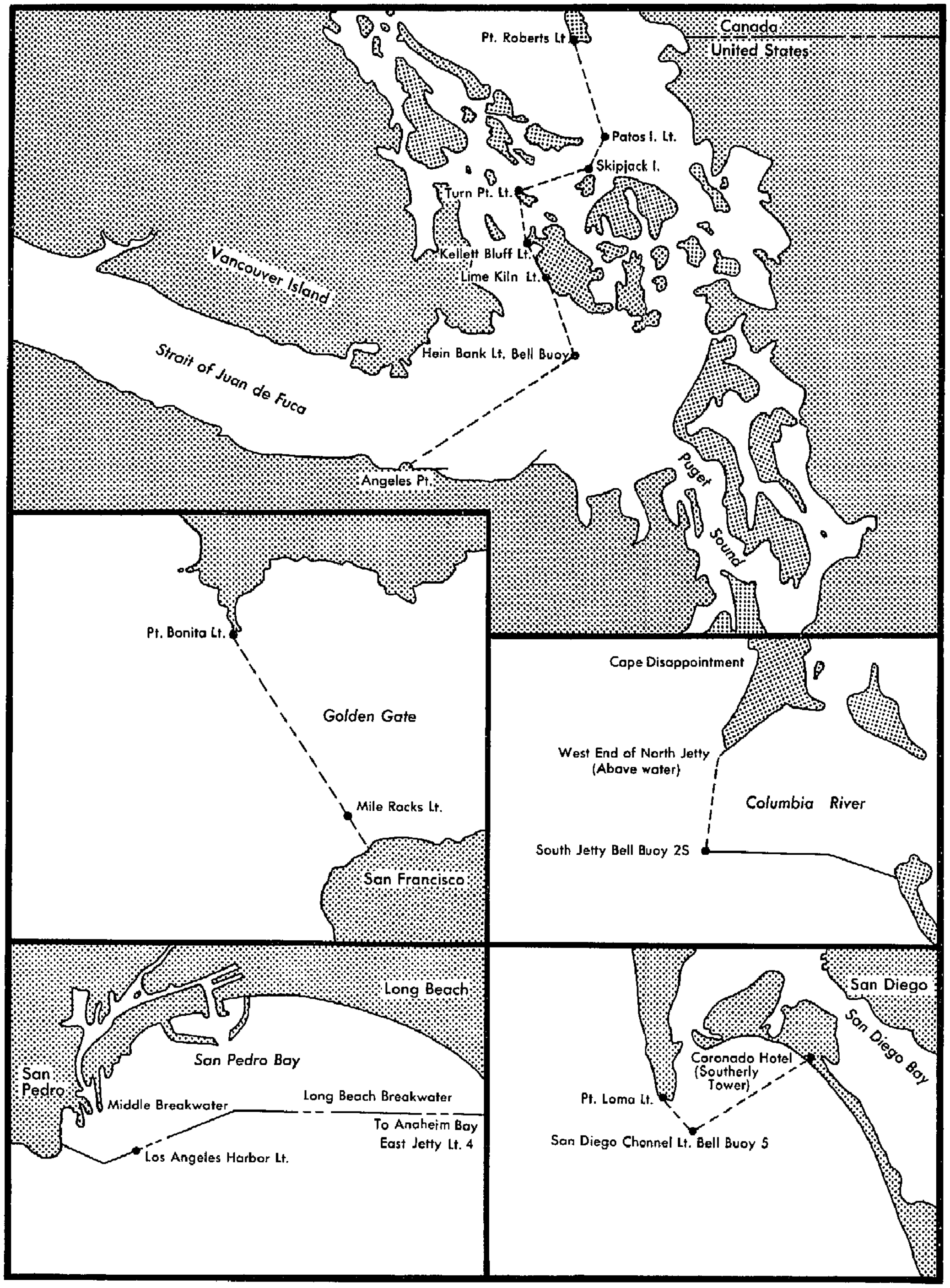


FIGURE 84.—Rules of the Road boundary lines—Pacific coast.

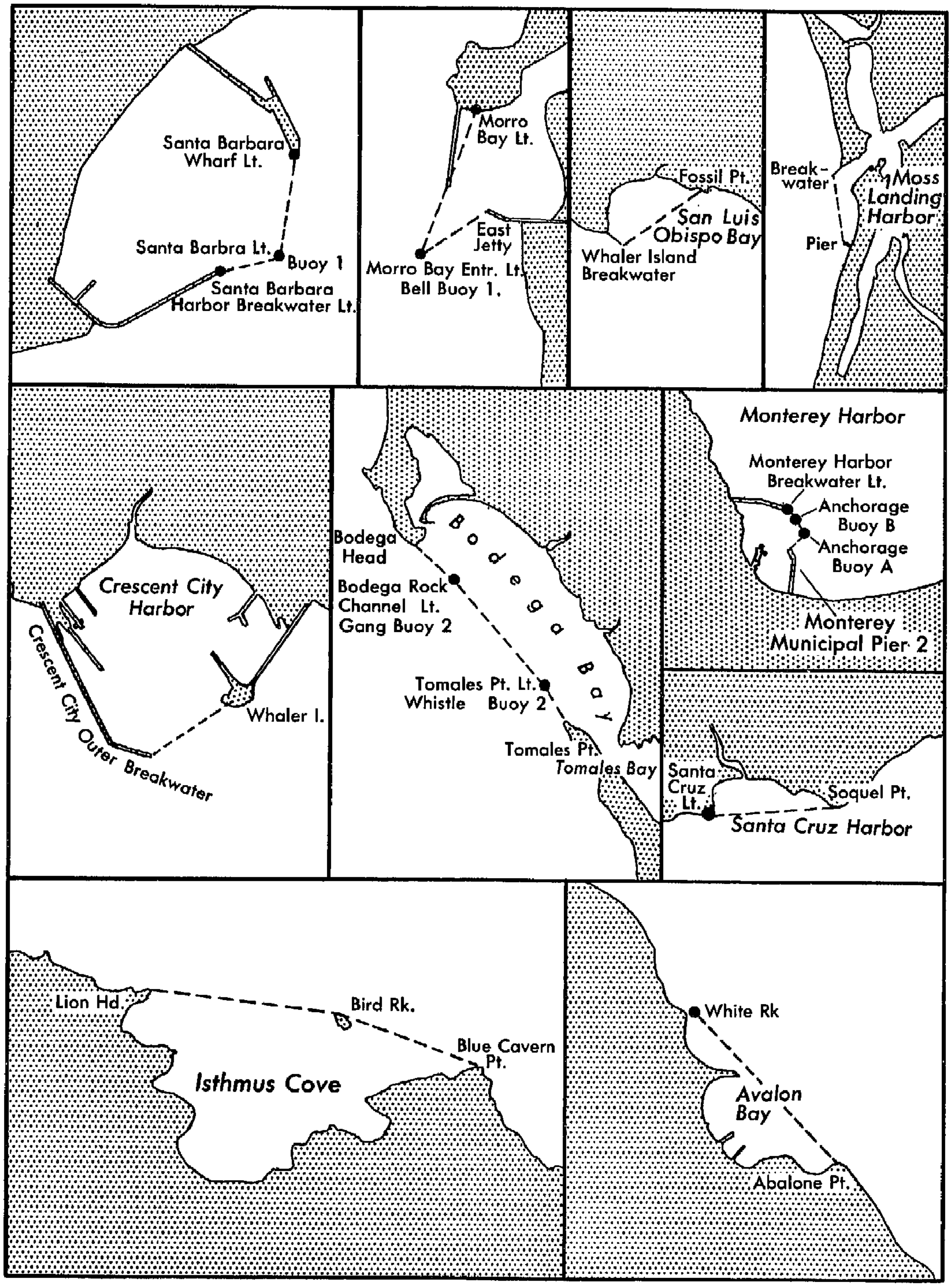


Figure 85.—Rules of the Road boundary lines—Pacific coast.

Inland Waters, relating to Rules of the Road" (1898–1916); and "RULES OF THE ROAD for inland waters must be followed for harbors inshore of a line . . . ." (*see* chart 1215, Approaches to New York, 1914–1947 eds.).

Beginning with 1948, the note described above was removed from the charts and the actual demarcation lines substituted with the label "Use Inland Rules of the Road" placed on the inshore side of the line. This is the practice in 1963. The general policy is to show these lines on charts of 1:80,000 scale and larger. But if it is found impracticable to use the line in any place, a note is added giving the limits within which the Inland Rules of the Road apply.[133]

### 674. INTERPRETATION OF BOUNDARY LINES

Questions frequently arise regarding the exact import of the rules of the road boundary lines under certain factual situations, particularly the question of the status of the water areas inshore of such lines. The few interpretations that have been made of these lines—judicially and administratively—are therefore of significance in the delimitation of sea boundaries.

#### 6741. *Judicial Interpretation*

One of the first cases to come before the Federal courts following passage of the Act of February 19, 1895 (*see* 672), was *United States* v. *Newark Meadows Improvement Co.,* 173 Fed. 426, 428 (1909). This involved an indictment brought in the District Court of New York charging illegal dumping of refuse in the "tidal waters of the lower bay of the New York Harbor and its adjacent waters," at a place 2¼ miles from Sandy Hook, N.J. The court dismissed the indictment on the ground that it should have been brought in the District Court of New Jersey inasmuch as the offense occured within the 3-mile belt along the New Jersey coast. Although the offense occurred within the "harbor of New York," as prescribed by the Secretary of the Treasury under the Act of February 19, 1895, the court said: "This legislation, however, was for the purpose of delimiting the inland waters of the United States, in order to inform navigators where the inland rules of navigation, as distinguished from the inter-

133. EDMONSTON (1956), *op. cit. supra* note 53, at 18. Exceptions have been made in the case of charts 1115, 1116, and 1117 along the Gulf coast and some of the charts in Alaska (*see* chart 8102, for example) which are smaller than 1:80,000 scale but on which the lines are shown.

national rules, become applicable. It does not purport to change the boundaries of any federal district, nor enlarge the jurisdiction of any federal court; and it is obviously beyond the power of Congress directly or indirectly to enlarge or narrow the territorial limits of New Jersey."

This case would seem to be authority for the proposition that the rules of the road boundary lines serve navigational purposes and do not determine territorial boundaries.[134]

### 6742. *Administrative Interpretation*

Administratively, the Department of State, in the conduct of foreign relations, has also had occasion to express the position of the United States as to the effect of the Coast Guard lines on territorial boundaries. In a reply to an inquiry from the Norwegian Minister as to whether the United States had determined the geographic points for drawing up the basic lines for the territorial waters and the fishery boundary,[135] the Assistant Secretary of State replied, in a letter dated July 13, 1929, in part, as follows:

> The geographic points for drawing up the basic lines for the territorial waters and the fishery boundary, with the exception of certain limited areas covered by special treaty or agreement, have not been determined by the United States. Agencies of the Federal Government have made their own determinations for administrative purposes; for example, the Steamboat Inspection Service has made certain decisions regarding lines separating inland waters from the high seas. However, no final determination has been made which would be binding alike upon all agencies of the Federal Government.
>
> No general statute defines the territorial waters of the United States.

The Norwegian Minister was furnished with a copy of "Pilot Rules for Certain Inland Waters of the Atlantic and Pacific Coasts, and of the Coast of the Gulf of Mexico," and his attention called to page 11 where, under the heading "Boundary Lines of the High Seas," the designation is given of the lines dividing

134. The New York harbor lines were also involved in a different context in *Carlson* v. *United New York Sandy Hook Pilots' Assn.*, 93 Fed. 468 (1899). This was an admiralty action brought in the District Court of New York by the administrator for a seaman killed while being transferred from the pilot ship to a steamer. The court found no negligence and the case was decided on that ground. By way of dictum, the court considered the contention that the accident having occurred more than 3 miles from shore was on the high seas and not within any state limits where a state wrongful-death statute would apply. But the court held that the accident was within state boundaries because the lines designated under the 1895 Act seemed to coincide with a line drawn through points 3 miles from Sandy Hook and Rockaway.

135. The Minister also requested copies of "any regulations which might exist regarding the delineation of the political coastline or the drawing up of the limit between internal and territorial waters."

the high seas from rivers, harbors, and inland waters. With regard to these lines (now established by the U.S. Coast Guard), the letter stated:

It should be understood that the foregoing lines do not represent territorial boundaries, but are for navigational purposes, to indicate where inland rules begin and international rules cease to apply.[136]

Perhaps the most potent administrative interpretation of the rules of the road boundary lines is to be found in the Coast Guard's order of December 1, 1953, designating the line between inland waters and the high seas along the Gulf coast from Mobile Bay to the Rio Grande, the greater portion of it for the first time (*see* 6721). In promulgating the lines, the Commandant stated:

The establishment of descriptive lines of demarcation is solely for purposes connected with navigation and shipping. Section 2 of the Act of February 19, 1895, as amended (33 U.S.C. 151), authorizes the establishment of these descriptive lines primarily to indicate where different statutory and regulatory rules for preventing collisions of vessels shall apply and must be followed by public and private vessels. These lines are not for the purpose of defining Federal or State boundaries, nor do they define or describe Federal or State jurisdiction over navigable waters. Upon the waters inshore of the lines described, the Inland Rules and Pilot Rules apply. Upon the waters outside of the lines described, the International Rules apply.[137]

## 68. DEFINITIONS RELATING TO NAUTICAL CHARTS

Certain definitions relating to features on nautical charts have been standardized for international use and for more restricted local use.

### 681. Ocean Bottom Features

The International Committee on the Nomenclature of Ocean Bottom Features, meeting in Monaco on September 22, 1952, adopted the following nomenclature:[138]

*Continental Shelf, Shelf Edge,* and *Borderland.*—The zone around the continent, extending from the low-water line to the depth at which there is a marked increase of slope to greater depth. Where this increase occurs the term *shelf edge* is appropriate. Conventionally its edge is taken at 100 fathoms (or 200 metres) but instances are known where the

136. Excerpts from this letter are given in Hackworth, I Digest of International Law 644–645 (1940).

137. 18 Fed. Reg. 7893 (1953). Prior to issuing the regulation, a public hearing was held and comments invited. "Where practicable," the Commandant stated, "the comments, views, and data relating to safe navigation were accepted and parts of the described lines as proposed were revised accordingly. The comments, data, and views submitted which were based on reasons not directly connected with promoting safe navigation were rejected." *Ibid.*

138. Bulletin, International Union Geodesy and Geophysics 555 (July 1953).

increase of slope occurs at more than 200 or less than 65 fathoms. When the zone below the low-water line is highly irregular, and includes depths well in excess of those typical of continental shelves, the term *continental borderland* is appropriate.

*Continental Slope.*—The declivity from the outer edge of the continental shelf or continental borderland into great depths.

*Borderland Slope.*—The declivity which marks the inner margin of the continental borderland.

*Continental Terrace.*—The zone around the continents, extending from low-water line, to the base of the continental slope.

*Island Shelf.*—The zone around an island or island group, extending from the low-water line to the depths at which there is a marked increase of slope to greater depths. Conventionally its edge is taken at 100 fathoms (or 200 metres).

*Island Slope.*—The declivity from the outer edge of an island shelf into great depths.

*Basin.*—A depression of the deep-sea floor more or less equidimensional in form, but not necessarily large and pronounced.

*Trench.*—A long but narrow depression of the deep-sea floor having relatively steep sides.

*Submarine Canyon* and *Valley.*—An elongated steep-walled cleft running across or partially across the continental shelf, the continental borderland and/or slope, the bottom of which grades continually downwards. When the sides have a more gentle slope the term *submarine valley* is more appropriate.

*Depth.*—A term which may be used for a few of the deepest soundings.

*Deep.*—The well-defined deepest area of a depression of the deep-sea floor conventionally applied where soundings exceed 3,000 fathoms.

*Rise.*—A long and broad elevation of the deep-sea floor which rises gently and smoothly.

*Ridge.*—A long elevation of the deep-sea floor having steeper sides and less regular topography than a rise.

*Seascarp.*—An elevated and comparatively steep slope of the sea floor.

*Gap.*—A steep-sided furrow which cuts transversely across a ridge or rise.

*Sill* and *Sill Depth.*—A submarine ridge or rise separating partially closed basins from one another or from the adjacent ocean. The greatest depth over the sill is commonly known as the *sill depth.*

*Plateau.*—A very extensive but ill-defined elevation of the deep-sea floor, the top of which may be diversified by lesser features of elevation and depression.

*Seahigh.*—An elevation of the deep-sea floor of more than 3,000 feet, the morphology of which is insufficiently well known to be covered by a more precise definition.

*Seamount.*—An isolated or comparatively isolated elevation of the deep-sea floor of more than 3,000 feet.

*Tablemount* (or *Guyot*) and *Oceanic Bank.*—A *seamount* (roughly circular or elliptical in plan) generally deeper than 100 fathoms, the top of which has a comparatively smooth platform. When the platform has a depth less than 100 fathoms the term *oceanic bank* is appropriate.

*Seapeak.*—A *seamount* (roughly circular or ellipitical in plan) with a pointed top.

*Seaknoll.*—A submarine hill or elevation of the deep-sea floor less prominent than a *seamount.* (This term should only be used if the feature has been adequately surveyed, and the terms *seamount, tablemount* or *guyot,* and *seapeak* should be used if the elevation exceeds 3,000 feet above the surrounding floor.)

*Deep-Sea Terrace.*—A benchlike feature bordering an elevation of the deep-sea floor at depths greater than 300 fathoms.

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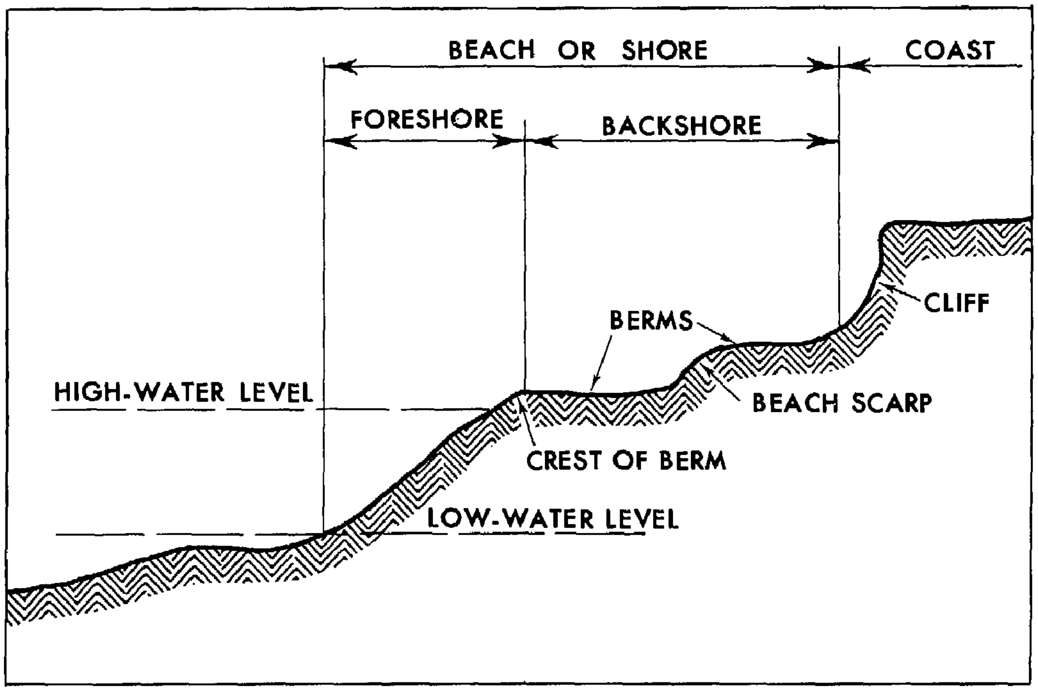


FIGURE 86.—Shore terminology and related terms.

## 682. SHORE TERMINOLOGY

At the margin of the sea there are several recognized shore features, or zones, characterized by the relationship of land to sea during the rise and fall of the tides. These have acquired a terminology which, while subject to some variation depending upon the purpose for which the classification is made, is fairly uniform.

In the field of shore processes and development, four distinct zones are recognized in the area between the low-water line and the coast, namely, *shore, coast, foreshore,* and *backshore* (*see* fig. 86).[139]

*Shore.*—This is the most important of the four zones, and extends from the low-water mark inshore to the base of the cliff (large or small), which usually marks the landward limit of effective wave action. It is the zone over which the line of contact between land and sea migrates.

*Coast.*—The zone of land of indefinite width (perhaps 1 to 3 miles) that extends inland from the shore to the first major change in terrain features.

139. These follow the definitions adopted by the U.S. Beach Erosion Board in Technical Report No. 4 (1954). Comparsion will be made with JOHNSON, SHORE PROCESSES AND SHORELINE DEVELOPMENT (1919); wherever differences exist.

*Foreshore.*—That part of the shore lying between the crest of the seaward berm (or the upper limit of wave wash at high tide) and the ordinary low-water mark.[140]

*Backshore.*—The zone of the shore that lies between the foreshore and the coast and is covered by water during exceptional storms only.[141]

In the field of riparian land ownership and where the common law prevails, the Supreme Court has held the term *shore* to be the "land between ordinary high and low-water mark, the land over which the daily tides ebb and flow." [142] Used in this sense, shore is synonymous with foreshore. The backshore, under this interpretation, would be the zone extending from the high-water line to the coast.

From the standpoint of shore and sea boundaries, the term *shore* has a special significance. Its inshore limit—the high-water line—marks the boundary of private property in most of the states, and its offshore limit—the low-water line—forms the baseline for the measurement of seaward boundaries (*see* Volume One, Part 1, 33).

Additionally, the following terms are associated with the zones defined above:

*Mean High-Water Line.*—The intersection of the tidal plane of mean high water with the shore.

*Mean Low-Water Line.*—The intersection of the tidal plane of mean low water with the shore.

*Coastline.*—The line of contact between land and sea. In the Coast and Geodetic Survey, the term is considered synonymous with shoreline.[143]

*Shoreline.*—The line of contact between the land and a body of water. On Coast and Geodetic Survey nautical charts and surveys the shoreline approximates the mean high-water line. In Coast Survey usage the term is considered synonymous with coastline.[144]

140. In *id.* at 161, *foreshore* is defined as that part of the shore that lies between the ordinary high- and low-water marks and is daily traversed by the oscillating water line as the tides rise and fall. This corresponds to the legal definition of the term *shore* (*see* text at note 142 *infra*).

141. The foreshore and the backshore are the two components into which the shore is divided. This is true according to both authorities (*see* note 139 *supra*), but the dividing line is different (*see* note 140 *supra*).

142. *Borax Consolidated, Ltd.* v. *Los Angeles,* 296 U.S. 10, 22–23 (1935). The civil law concept of shore has been interpreted by the Supreme Court of Texas as extending to the line of mean higher high tide. *Luttes* v. *State,* 324 S.W. 2d 167, 191 (1958).

143. In the field of shore processes and development, coastline has been defined technically as the line that forms the boundary between the coast and the shore and marks the seaward limit of the permanently exposed coast.

144. Designations sometimes used in studies of shore processes are *high-tide shoreline* to indicate the position of the water line at high tide, and *low-tide shoreline* for the position of the water line at low tide. The latter would mark the seaward limit of the intermittently exposed shore. JOHNSON (1919), *op. cit. supra* note 139, at 161.

## 69. USING NAUTICAL CHARTS

In using Mercator charts, the fundamental principles of the projection must constantly be kept in mind. These affect primarily the determination of direction, the measurement of distance, and the plotting of positions. For certain purposes, it may also be necessary to make allowance for any distortion that may have crept into the chart, especially if quantitative measurements are to be made for studying the rates of shore recession or advance (*see* 132).

### 691. The Problem of Direction

From the nature of the Mercator projection (*see* 613), the rhumb line (loxodromic curve), or line which cuts all the meridians at a constant angle, is a straight line (*see* fig. 87). It follows, then, that since the meridians on a Mercator chart are parallel, the direction or bearing of a rhumb line between any two points on the chart can be measured with a protractor from the nearest meridian or from the compass rose at any convenient place on the chart. The projection being conformal, directions and angles are correctly represented.

A great circle (orthodromic curve), which represents the shortest distance between two points on the surface of the earth, appears as a curved line on a Mercator chart concave toward the equator (*see* fig. 87). Exceptions to this are the great circles represented by the meridians and the equator which are straight lines on the projection.

This difference between rhumb lines and great circles is of importance in the determination of position by radio bearings. Such bearings follow the arcs of great circles, and, if plotted on a Mercator chart, would appear as a curved line. To facilitate the plotting, it is the practice to apply a correction to the radio bearing to convert it to a mercatorial bearing which can then be plotted as a straight line. The amount of the correction depends upon the convergency of the meridians, and the sign of the correction is dependent upon whether the bearing is taken from the ship or from the radiobeacon, whether the ship is east or west of the beacon, and whether north or south latitude is involved.[145] A radio bearing is always plotted *from* the position of the radiobeacon or fixed station since its position is known and charted. Hence, if bearings are observed from the ship, 180° must be added after the other correction. For distances less

145. When bearings are taken from the ship and read clockwise, the sign of the correction is *minus* in north latitude where the ship is *east* of the radiobeacon, and *plus* where it is *west*. In south latitude the signs are reversed. The signs are also reversed for bearings observed at the radiobeacon and radioed to the ship.

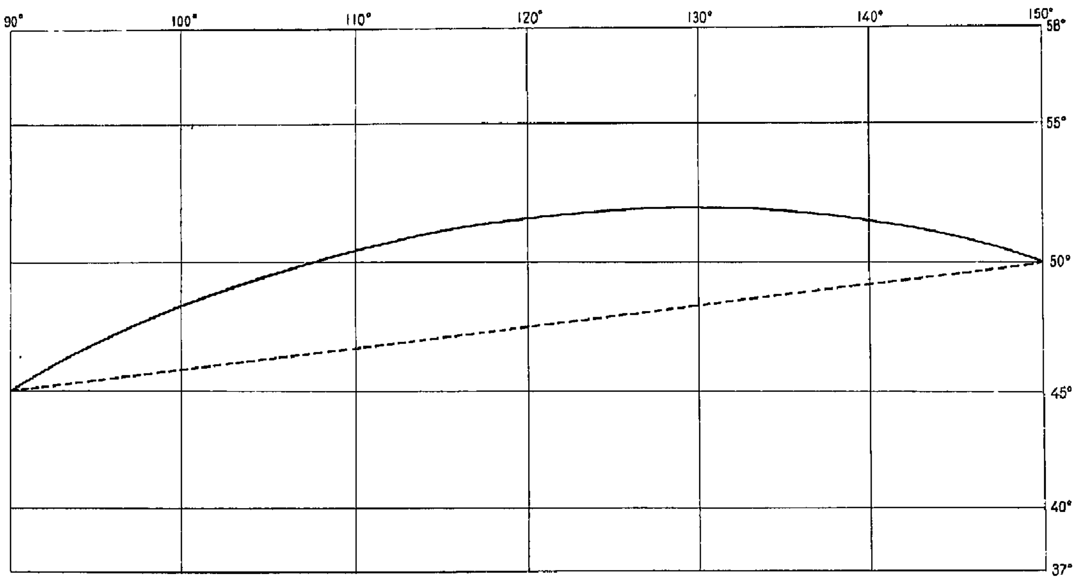


FIGURE 87.—Rhumb line and great circle on a Mercator projection. The dotted line is the rhumb line, which is a straight line on this projection, and the curved line is a great circle which lies on the polar side of the rhumb line.

than 50 miles, the corrections are negligible. A table of corrections is published in all the *Coast Pilots* of the Coast and Geodetic Survey.[146]

### 692. DISTANCE MEASUREMENT

The measurement of distances on a Mercator chart is closely associated with the principles of the projection. It will be recalled that the latitude intervals increase progressively with the distance from the equator, and it is these latitude intervals along the east and west borders of the chart, subdivided with sufficient closeness, that provide distance units for any latitude on the chart. The latitude midway up the border will have a mean value for the whole extent of the chart because there will be as many units longer above the mid-latitude as there are units shorter below the mid-latitude. It is this principle of the mean value that is used in measuring distances on a Mercator chart, no matter what the direction of measurement is.[147] The use of the latitude scale for distance

146. *See also* Table 1 of BOWDITCH (1958), *op. cit. supra* note 66, which contains similar data. For a full discussion of the problem and the derivation of formulas, *see* Shalowitz, *Conversion of Radio Bearings to Mercatorial Bearings,* 5 FIELD ENGINEERS BULLETIN 101, U.S. COAST AND GEODETIC SURVEY (1932).

147. Charts covering a limited range of latitude show no perceptible change in scale (for example, charts 1:40,000 scale and larger, and most charts of 1:80,000 scale (the exceptions being those in the northern latitudes)), and such charts carry a graphic scale, based on the middle latitude, for measuring distances.

measurement is based on the assumption that a minute of latitude is equal to a nautical mile. For practical navigation this is considered sufficiently accurate. Due to the spheroidal shape of the earth, the length of a minute of latitude actually increases from 1,842.8 meters at the equator to 1,861.7 meters at the pole. Strictly speaking, then, a minute of latitude is equal to a nautical mile in latitude 48°15′ only.[148]

If the distance between two points directly north and south of each other is to be measured, the difference between their latitudes expressed in minutes will give the distance in nautical miles. On the other hand, if the points are east and west of each other, the distance can be found by using as a unit of measure a small number of latitude subdivisions to the north and south of the latitude of the line and stepping that off between the two points with a pair of dividers.[149] Distances represented by rhumb lines at an angle to the meridians may be measured by taking between the dividers a small number of subdivisions on the border scale to the north and south of the middle latitude of the line to be measured, and stepping this off on the line. Thus, if it be required to obtain the length of a line running at an angle to the meridians between the parallels of 40° and 45°, a number of subdivisions on the border scale to the north and south of the middle latitude (42°30′) of the line is taken (the number of subdivisions used is a matter of judgment and will depend upon the scale of the chart used and the length of the line) and with the dividers this distance is stepped off on the line, the total number of minutes in the measurement being the length in nautical miles. In thus taking for a unit a mean value at the middle latitude of the line, there will be approximately as many miles shorter than the mean as there are miles longer than the mean. If the line is of

148. This follows from the definition of the U.S. nautical mile (prior to July 1, 1954) as being equal to one-sixtieth of a degree or 1/21,600 of a great circle on a sphere whose surface is equal to the surface of the earth. This value, calculated for the Clarke spheroid of 1866, is 1,853.248 meters (6080.20 feet), which is the length of a minute of arc at latitude 48°15′. MITCHELL, DEFINITIONS OF TERMS USED IN GEODETIC AND OTHER SURVEYS 59, SPECIAL PUBLICATION NO. 242, U.S. COAST AND GEODETIC SURVEY (1948). On July 1, 1954, the international nautical mile of 6,076.10333 U.S. feet, or 1,852.0 meters, was adopted in the United States, following the proposal of the International Hydrographic Bureau in 1929. This value was revised July 1, 1959, to reflect a refinement of the value of the yard, following an agreement among directors of National Standards Laboratories of English-speaking nations to obtain uniformity in precise measurements involving the yard. The new value for the international nautical mile is 1,852.0 meters=6,076.11549 international feet (approximately) and is based upon the new relationship of 1 yard=0.9144 meter, in place of the old relationship of 1 yard=0.91440183 meter. This, however, does not apply to any data expressed in feet derived from and published as a result of geodetic surveys within the United States. These will continue to bear the old relationship until such time as it becomes desirable and expedient to readjust the basic geodetic survey networks, after which the new ratio will apply. 24 Fed. Reg. 5348 (1959). For conversion tables based on the new relationship, *see* UNITS OF WEIGHT AND MEASURE, MISCELLANEOUS PUBLICATION 233, NATIONAL BUREAU OF STANDARDS (1960).

149. The measurement can also be made by taking one-half the line and laying it off along the latitude scale to the north and south of the latitude of the line. The difference between the latitudes expressed in minutes will give the distance in nautical miles.

considerable length it can best be measured by dividing it into parts and measuring each part with a unit of measurement referred to its middle latitude, as in the above example.

On small-scale charts covering a considerable extent of the earth's surface, it may be desirable, in the measurement of very long lines, to first plot the great circle through the end points of the line on a gnomonic chart and then transfer the great circle to the Mercator chart by latitudes and longitudes.[150] The great circle is then divided into segments and each segment measured by means of the latitude scale, as described above. Although the shortest measured distance is derived from the apparently longer of the two lines (the great circle being a curve and the rhumb line a straight line on the Mercator chart), this anomaly is explained by the fact that the distance unit of measurement as obtained from the middle latitude of a great circle is in a higher latitude and therefore longer than the middle latitude unit of the rhumb line (*see* fig. 87). Therefore, the distance along a great circle on a Mercator chart measures the shortest distance between two points.

## 693. Position Determination

Since meridians and parallels on a Mercator chart are straight lines at right angles to each other, it is a comparatively simple matter to plot a position of known latitude and longitude or to determine the latitude and longitude of a plotted position. The only instruments required are a straightedge and a pair of dividers. A position can be plotted by marking on the east and west latitude scales of the chart the latitude of the point and joining these two marks by a straightedge, drawing a short line in the vicinity of the longitude of the point. The longitude of the point is plotted in a similar manner by using the top and bottom longitude subdivisions of the chart. The intersection of the two lines is the position required.

To find the latitude and longitude of a plotted position, one point of the dividers is fixed on the position and the other point spread until it reaches the nearest charted parallel (if none is charted, a handy one is ruled). One point of the dividers is then fixed at the end of the same parallel on the latitude scale, and with the other point the latitude of the position is read. A similar procedure is used to determine the longitude of the position, this value being read off from the longitude scale at the top or bottom of the chart.

150. One of the properties of a gnomonic projection is that a great circle on it is a straight line. The gnomonic chart contains a specialized procedure for measuring distances.

## 6931. *Methods of Position Determination*

The modern nautical chart contains a variety of information by which the navigator may determine his position by any one of a number of methods or combination of methods. Three of these—visual bearings, depth contours, and Loran lines of position—are in common use and will be described. (Position determination by radio bearings is described in 691.) These methods are dependent upon the charted information, in contrast to methods where the nautical chart is merely used as a medium for plotting, for example, when navigating by celestial observations.

(*a*) *By Visual Bearings.*—In position determination by visual bearings on fixed objects the same precautionary measures must be taken as with radio bearings observed at the vessel. A line of sight follows the shortest path on the earth's surface, that is, a great circle. If the distances under consideration are

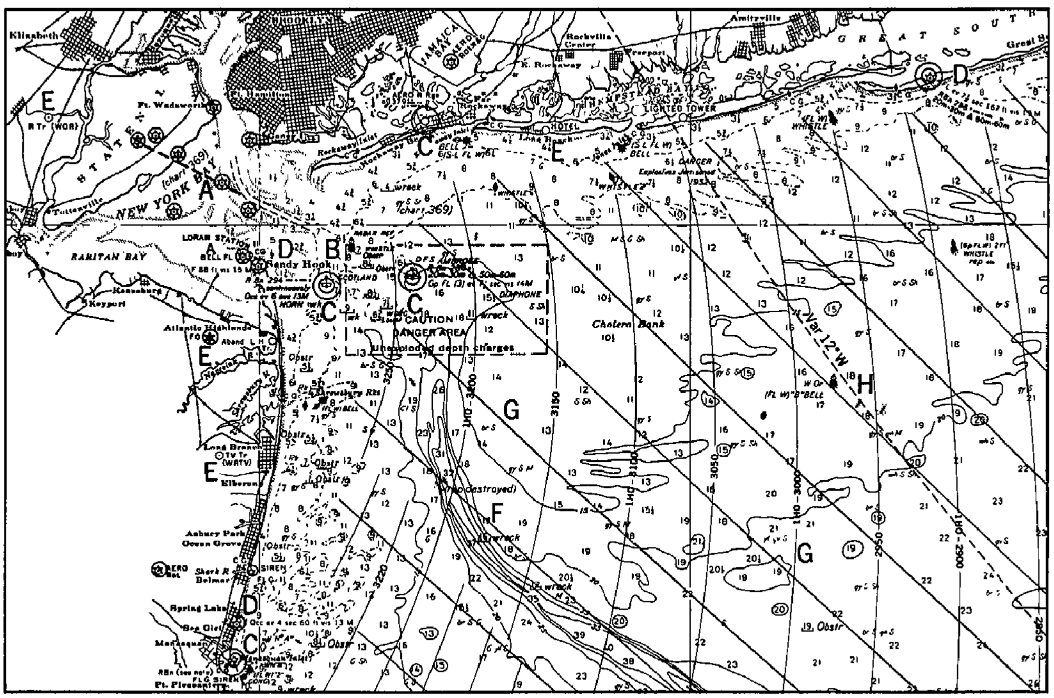


FIGURE 88.—Section of chart 1108 (reduced) showing aids to navigation available to the navigator in approaching or leaving New York Harbor. Tints are used to accentuate the land area and the shoal-water areas.

great enough visual bearings must first be converted to mercatorial bearings before they can be correctly plotted on the chart (*see* 691).[151]

(*b*) *By Depth Contours.*—Many nautical charts now contain sufficient depth contours to adequately delineate characteristic features of the ocean bottom. This provides a vessel, equipped for echo sounding, with a practical method of position determination. Simply stated, this consists merely in fitting a series of observed echo soundings to the depth contours on the chart. This is accomplished by recording with care a number of soundings and simultaneous log distances, and plotting these accurately on a strip of transparent paper at the scale of the chart. The line of soundings on the paper is then fitted to the depth contours on the chart by moving it so that it remains approximately parallel to the true course steered.

Charted submarine valleys are extremely useful in position determination. They usually are narrow, V-shaped in cross section, and have a continuous downward slope along the axis of the trough. The maximum depth obtained when crossing the axis gives a strong position because it occurs in only one place in the valley bed.

Depth contours may also be used as lines of position and may be combined with other information—radio bearings, visual bearings, or lines of position from celestial bodies—to obtain the position of a vessel.

(*c*) *By Loran Lines of Position.*—Loran is a hyperbolic navigation system in which the time difference between the arrival times of a pair of radio pulses transmitted from two widely spaced stations is measured with a high degree of accuracy by the vessel's Loran receiver. Since radio waves travel with the speed of light, the measured time difference represents the actual difference in distance of the position of the receiver from the two transmitters. This time difference establishes a Loran line of position. When time differences are obtained from two pairs of transmitters, the resulting lines of position intersect to form the Loran fix.[152] These hyperbolic lines of position are all precomputed when a chart is constructed and all necessary factors taken into account. The navigator does not have to concern himself with the calculation of the lines. When he measures his time differences he goes directly to the chart and interpo-

151. This precaution must also be followed in determining a vessel's position by the 3-point fix method where the angles are observed on distant mountain peaks.

152. The geometrical principle on which this is based is that the locus of points with a constant difference in distance from two reference points is a hyperbola having the transmitters as focal points.

lates between charted lines of position to determine the exact line corresponding to the measured time difference.[153]

### 6932. *Approaches to New York Harbor*

Figure 88 is a section of Coast and Geodetic Survey chart 1108, Approaches to New York Harbor, on which has been indicated by letters the various aids that can be used by the navigator on approaching or leaving the harbor. The extent of the aids available are indicated in the following summation (tints and colors, to accentuate the land topography, shoal-water areas, lights, etc., provide additional cartographic aids):

At *A,* he has a range for a line of position through Ambrose Channel; at *B,* he has a danger warning and channel marker—buoy with radar reflector by day, and light of fixed characteristics by night; at *C,* he has radio beacons on the lightships and on shore for obtaining bearings by radio compass from the vessel; at *D,* he has the height and visibility of lights for determining position; at *E,* he has landmarks for taking angles and bearings—structures and natural objects by day and lights by night; at *F,* he has depth contours for use with an echo sounder; at *G,* he has Loran lines of position for use with his Loran receiver by day or night; and at *H,* he has isogonic lines (lines of equal magnetic declination) to be applied to his magnetic compass.

### 694. Principal Chart Adjuncts

While the nautical charts themselves contain the essential data for the navigation of the waters covered by them, there is certain collateral information that the navigator must have but which it is not feasible to show on the chart because of its scale or because of the nature of the information involved. To provide for this, separate publications are issued by the Government which may be considered principal chart adjuncts. The more pertinent of these are the following (*see* fig. 89):

(*a*) *Catalog of Nautical Charts.*—The catalog lists nautical charts, auxiliary maps, and related publications of the Coast and Geodetic Survey, and includes references to similar publications of other federal agencies. The format is loose-leaf, and separate pages are available showing diagrams of charts for a designated area. The preliminary pages of the catalog contain certain general information pertaining to chart construction and to the classification and use of nautical charts. Each page of the catalog proper contains the layout of charts

153. Loran lines of position are now shown on certain selected nautical charts of the Coast and Geodetic Survey. They are indicated in the chart catalog by a dagger symbol (†) and an appropriate note. For detailed information on the Loran system of navigation, including certain limitations in its use, *see* Catalog of Loran Charts and Publications, U.S. Navy Hydrographic Office (1955).

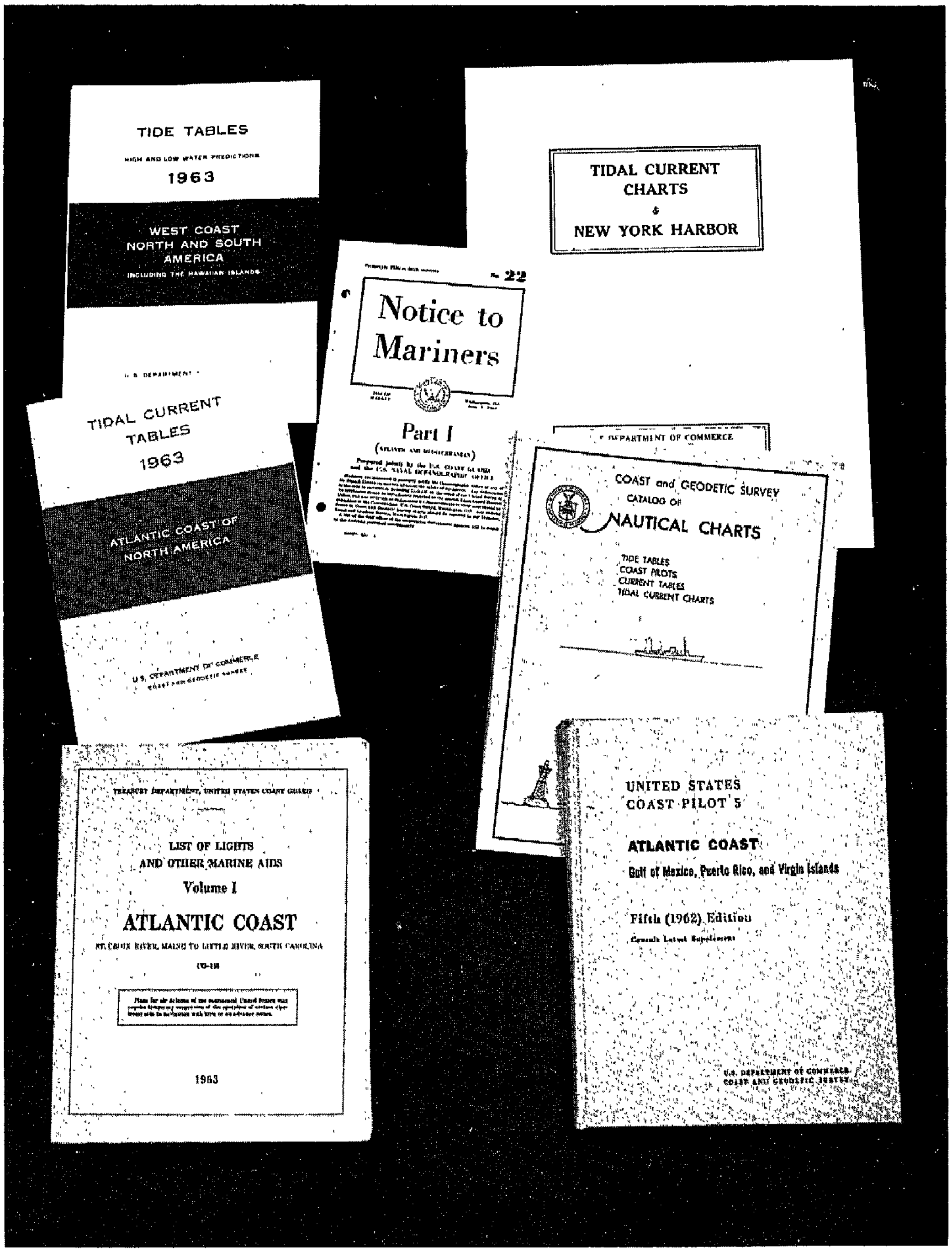


FIGURE 89.—Principal nautical chart adjuncts. Some of the publications issued by the Government for the navigator's use.

for that area. This is backed up by tabular information which gives the chart number, price, title, scale, and paper size, grouped into the various chart classifications (*see* 625). Also included is a list of sales agents for the charts and related publications of the Bureau, and a numerical list of nautical charts giving the price and catalog page.

To help insure that only the latest nautical charts are used, the publication of a revised list of charts titled "Dates of Latest Editions" was begun in March 1963 and will be published each month. By means of symbols, the user's attention is drawn to new charts, new editions, and discontinued charts.

(*b*) *Coast Pilots.*—These are published in eight volumes or parts and cover the coasts of the United States together with Puerto Rico and the Virgin Islands. Each volume furnishes information required by the navigator that cannot be shown conveniently on the nautical chart, such as detailed data relative to the coastline, port information, sailing directions for coasting and entering harbors, and general information as to weather conditions, radio service, etc. New editions are published about every 7 years, but supplements, giving changes and new information, are published annually.[154]

(*c*) *Tide Tables.*—Since all depths on a chart are reduced to the sounding or chart datum, the navigator must know the actual depth of the water during any part of the tidal cycle in order to make the most effective use of the charted information. This is furnished by the *Tide Tables* which give the predicted times and heights of high and low water for every day in the year for a number of reference stations, and differences for obtaining similar predictions for numerous other places. From these values it is possible to interpolate by a simple procedure the height of the tide at any hour of the day (*see* Part 1, 2322 A).[155]

(*d*) *Tidal Current Tables.*—Such tables are issued annually in advance of the year for which they are prepared. They include daily predictions of the times of slack water and the times and velocities of the strength of flood and ebb currents for a number of waterways, together with differences for obtaining predictions at numerous other places. Also included is a method for obtaining the velocity of current at any time.[156]

154. *Coast Pilots* are divided in the following order: *Atlantic Coast*—Pilot 1, Eastport to Cape Cod; Pilot 2, Cape Cod to Sandy Hook; Pilot 3, Sandy Hook to Cape Henry; Pilot 4, Cape Henry to Key West; Pilot 5, Gulf of Mexico, Puerto Rico, and Virgin Islands. *Pacific Coast*—Pilot 7, California, Oregon, Washington, and Hawaii. *Pacific Coast, Alaska*—Pilot 8, Dixon Entrance to Cape Spencer; Pilot 9, Cape Spencer to Arctic Ocean. This form of classification was adopted in May 1953, and superseded the old *sections* and *parts* form. *Title Changes of Coast Pilots,* 6 JOURNAL, COAST AND GEODETIC SURVEY 151 (1955).

155. The coasts of the United States are covered in two volumes: East Coast, North and South America; and West Coast, North and South America.

156. Two volumes cover the coasts of the United States, as follows: Atlantic Coast of North America, and Pacific Coast of North America and Asia.

(*e*) *Tidal Current Charts.*—These publications consist of a set of 12 charts which depict the direction and velocity of the current for each hour of the tidal cycle. The charts present a comprehensive view of the tidal current movement in the respective waterways as a whole and also furnish a means for readily determining for any time the direction and velocity of the current at various localities throughout the water areas covered.[157]

(*f*) *Notices to Mariners.*—A weekly pamphlet prepared jointly by the U.S. Coast Guard and the U.S. Naval Oceanographic Office. These are issued as a safety aid to keep mariners constantly advised of changes so they may keep their nautical charts and *Coast Pilots* up to date. For additional information pertaining to this item, *see* 1272.

(*g*) *List of Lights.*—Lights and other marine aids to navigation, maintained by or under authority of the U.S. Coast Guard, are described in the List of Lights. The lists give fuller information on aids to navigation than can conveniently be shown on the charts, such as the characteristics, candlepower, visibility, and date of establishment of lights, as well as descriptions of light structures and daybeacons, buoys, radiobeacons, and fog signals.[158]

(*h*) *Nautical Chart Manual.*—Although this publication is intended primarily to give practical guidance to the cartographic engineer engaged in the construction and revision of nautical charts, it is classed here as a *chart adjunct* for the user because situations may arise where a specific charting practice may be of considerable importance. This manual should be consulted in such cases as the best authority for the practice. The first such manual was published in 1948 and was an updating and elaboration of a Bureau pamphlet entitled "Rules and Practices Relating to the Construction of Nautical Charts" (*see* note 57 *supra*) and other accumulated instructions. This was followed by a 1952 edition. The latest published revision is the 1956 edition (*see* note 53 *supra*).[159]

157. Tidal current charts are available for Boston Harbor, Narragansett Bay to Nantucket Sound, Long Island Sound and Block Island Sound, New York Harbor, Delaware Bay and River, San Francisco Bay, and Puget Sound.

158. In 1963, the following volumes covered the coasts of the United States: *Atlantic Coast*—Volume I, St. Croix River, Maine to Little River, South Carolina. *Atlantic and Gulf Coast*—Volume II, Little River, South Carolina to Rio Grande, Texas and the Antilles. *Pacific Coast and Pacific Islands*—Volume III.

159. A new edition of this manual was published in Mar. 1964 and is identified as BRUDER, NAUTICAL CHART MANUAL, PUBLICATION 83–1, U.S. COAST AND GEODETIC SURVEY (1963). An integral part of the latest revision will be a reprint of Chart No. 1 showing the symbols and abbreviations used on the nautical charts of the Bureau (*see* Appendix F).

CHAPTER 1

# General Considerations

The shore or littoral is the zone where two great physical provinces meet and where changes in the form of the land take place rapidly. It is the end of the visible continent and the beginning of the submerged margin of its seaward extension. Coastlines are continually changing. Certain portions have had a long history of accretion, while others have had a history of erosion. Still other localities, often lying between two regions of these opposing histories, may show alternate erosion and accretion. In such areas, accretion may have been going on for many years, and suddenly the situation is reversed, and, for reasons unknown, erosion sets in. (*See* fig. 90.)[1] In other localities, sand bars or barrier beaches, separating shallow lagoons or bays from the open ocean, are broken through during storms to form inlets of a temporary or permanent nature.

Some rather dramatic changes in shoreline have taken place along our coasts since the first accurate surveys were made by the Coast and Geodetic Survey. The following are a few examples: In a period of 100 years, the eastern portion of the delta of the Mississippi River has built up as much as 10 miles (*see* Volume One, fig. 26); Rockaway Point on the south shore of Long Island had moved westward 4 miles until arrested by a jetty built in 1933; and Fishing Point on the Virginia coast has moved southward and westward over 4 miles in 66 years, converting an open bight into a natural harbor or refuge. A hurricane in 1938 lashed the south shore of Long Island causing a major breakthrough in the barrier beach fronting Shinnecock Bay and resulting in a navigable inlet 18 feet deep and 300 feet wide. The severe northeaster that battered the Atlantic seaboard during March 1962 caused radical changes in the shoreline at various places, notably at Cape Henlopen, Del., where it had moved several hundred feet

1. Figure 90 shows the maximum consistent recession of the shoreline to have taken place about 2 nautical miles south of Leadbetter Point in approximate latitude 46°36!5. Here the shoreline has receded about 800 feet between 1871 and 1926, and about 400 feet between 1926 and 1950. Southward of this locality, the rate of recession decreases until approximate latitude 46°33' where the trend is reversed and a small accretion is indicated. Northward of latitude 46°36!5, the rate of recession also decreases until it reaches practically zero 1.5 miles away. From here the recession again becomes significant as the northern end of Leadbetter Point is reached, where a maximum recession of about 1,200 feet is indicated.



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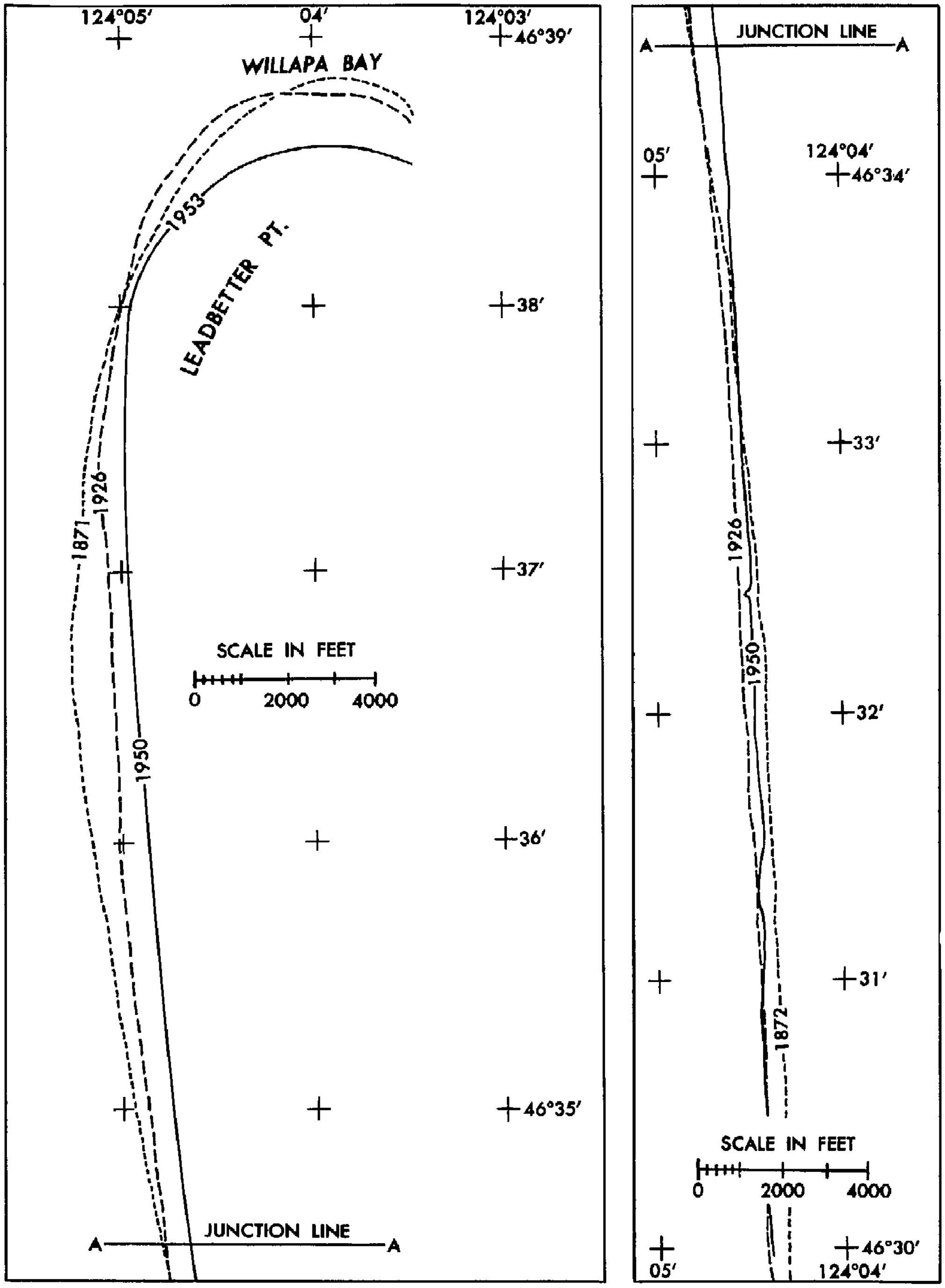


FIGURE 90.—Changes in shoreline in vicinity of Leadbetter Point, Wash., showing both erosion and accretion within a short distance.

to the northwest; and at Fishing Point, Va., where the shoreline was moved 0.4 mile to the west.

While these visible effects on the shoreline are taking place, others not visible to the eye are going on beneath the surface of the water, due to natural processes or to the impact of storms.[2] Bars and channels shift, new shoals form, and old ones disappear.

It is because of these changes that the Bureau has made periodic surveys along many sections of the coasts. These date back to 1834 when the first topographic and hydrographic surveys were made of Great South Bay, Long Island (*see* Part 2, 43, 52). Although subject to certain accuracy limitations, as has been discussed in previous chapters, the early surveys were based on a geodetic control system which prevented the accumulation of major discrepancies in the work. The surveys therefore represent the first authentic record of our coastline. Their periodicity gives them an application far beyond their primary use in the making of nautical charts. Some of these applications are discussed in this chapter.

## 11. COASTAL ENGINEERING

The engineer engaged in harbor improvement, channel development and maintenance, or shore protection must be fortified with a history of beach evolution in order to determine the type of structures most feasible for the area. Waves and currents produced by winds are the principal forces responsible for changes in coastline. By correlating changes based on successive accurate surveys with the attacking forces, the engineer may draw conclusions as to the nature of the component factors and predict the probable changes expectable in the future. From quantitative studies of changes in an area, it is sometimes possible to determine where the eroded material was deposited, whether as accretion to existing coastlines or as contribution to the formation of shoals and bars. Negatively, the study would show where the material could not have been deposited.[3]

Along many beaches exposed to wave attack, inlet migration is a well-known phenomenon (*see* fig. 91). If the alongshore current in one direction pre-

2. Following the March 1962 storm, a survey of Sinepuxent Channel, between Assateague Island and the mainland near Ocean City, Md., disclosed changes in depths of as much as 15 feet (*see* chart 1220).

3. In a study of changes along the New Jersey coast, surveys between 1839 and 1920 indicated (with some fluctuations) a rather steady recession of the beach as a whole. While it was not possible to determine absolutely where the sand was transported, it was possible to state that it was not utilized for building out the termini of the New Jersey beach system, namely, Sandy Hook and Cape May. The surveys showed that Sandy Hook occupied substantially the same position in 1920 as it did in 1835, and that Cape May had remained nearly fixed since the earliest survey in 1842. ON THE EROSION AND PROTECTION OF THE NEW JERSEY BEACHES 20 (and accompanying maps), BOARD OF COMMERCE AND NAVIGATION (1922).

dominates over that in the other, the inlet will migrate in the direction of the dominant current. Debris brought by the currents will be deposited on one side of the inlet with a tendency to narrow it, while the transverse currents through the inlet will cause an erosion of the other side. An excess of deposition on one side accompanied by erosion on the other side results in a lateral migration of the inlet in the direction of the dominant current.[4] Comparative surveys furnish information on the direction of this current and enable the engineer to determine the best method of protection.[5]

A study of underwater slopes adjacent to the shoreline from successive hydrographic surveys would indicate whether there has been a steepening or flattening of the slopes and thus throw light on the probable changes to be expected in the future. A steepening of the slope would subject the shoreline to attack by higher waves and cause increasingly rapid erosion of the beach, while a flattening of the underwater area is to some degree a protection to the beach since it causes higher waves to break and expend their energy a greater distance offshore, with a consequent lessening of destructive wave action.

Periodic surveys, therefore, give the coastal engineer a background of information indispensable in determining the character of the changes his structures must control.

## 12. SHORE PROCESSES AND DEVELOPMENT

Closely related to the problem of beach protection is the study of shore processes and development. To the student of shore forms, successive surveys enable him to trace the recent evolution of our coastline with certainty and to draw conclusions regarding its past history. Nature's processes in forming the coastline are complex and depend upon the configuration of a locality and the activity of the elements. By correlating changes in shoreline with the action

4. JOHNSON, SHORE PROCESSES AND SHORELINE DEVELOPMENT 374 (1919). Between 1839 and 1936, Barnegat Inlet, N.J., migrated a distance of about 1300 yards in a south-southwesterly direction and narrowed from a width of about 1300 yards to 400 yards.

5. This is exemplified by the Beach Erosion Board study at Blind Pass, Fla. It was believed by local interests that currents through the inlet were primarily responsible for denuding an adjacent beach. A study of existing surveys indicated, however, that erosion was being caused principally by the migration of the inlet (a mile in 63 years) rather than by the currents through the inlet. A fixation of the inlet would therefore have produced unsatisfactory results on the beach intended to be protected, because a jetty on either side would have starved the beach by preventing the alongshore drift from reaching the beach. A closing of the inlet was therefore recommended—a conclusion which might not have been reached but for the qualitative data provided by the existing surveys. *Beach Erosion Study at Blind Pass, Fla.*, H. Doc. 187, 75th Cong., 1st sess., 2, 5, 10 (1937).

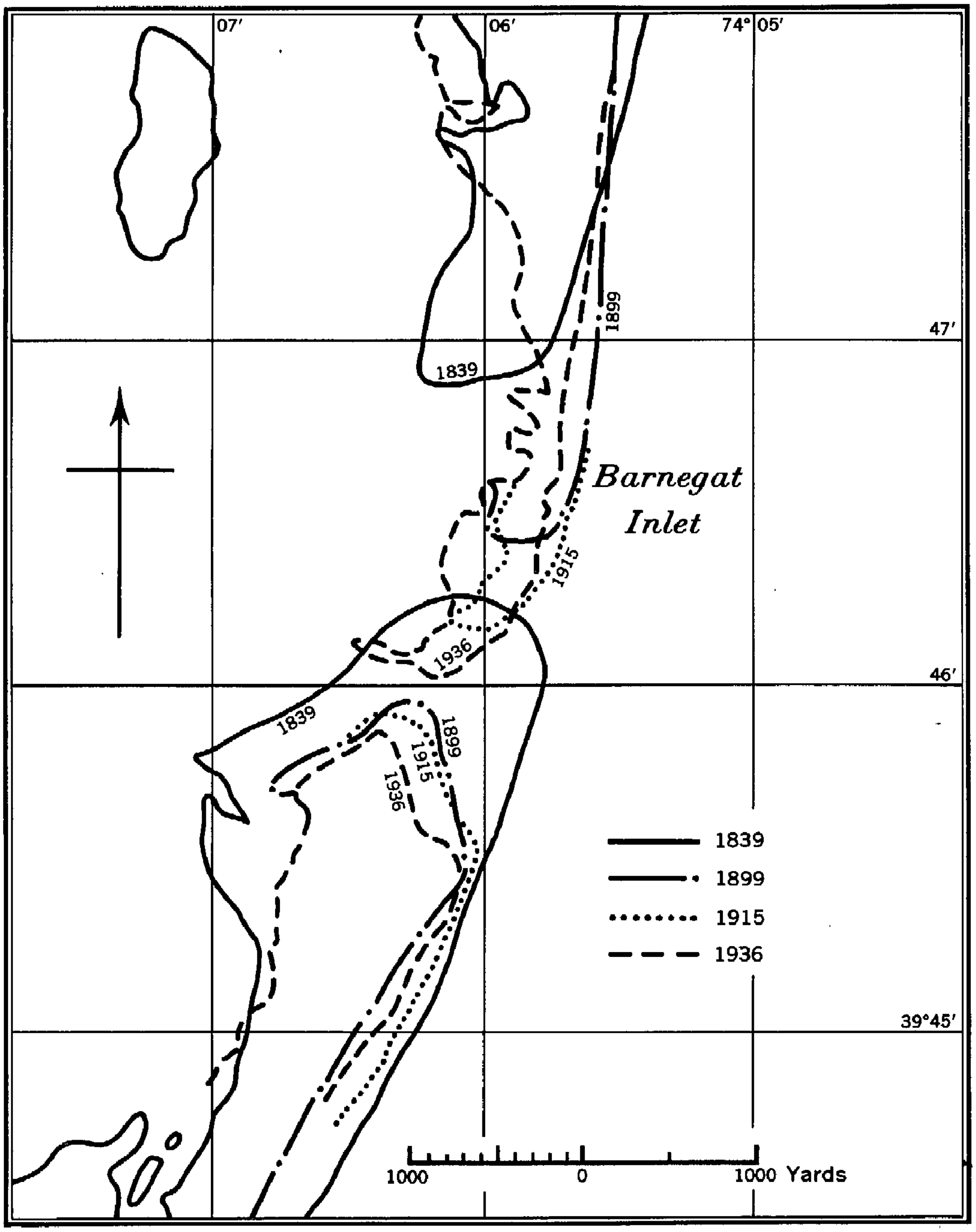


FIGURE 91.—Migration of Barnegat Inlet, N.J., between 1839 and 1936.

and interaction of winds, waves, tides, and currents, laws may be discovered which control the operation of these forces, thereby facilitating the interpretation of shore forms in other regions. Whether a shoreline is one of submergence or emergence (a downwarping or upwarping of the earth's crust or a raising or lowering of sea level), or what stage in its development it has attained (youth, maturity, or old age), can be studied from successive topographic surveys, as can the essential features of land forms such as bars and spits, inlets and lagoons, capes and deltas.

The hydrographic surveys of the Bureau permit the study of submerged land forms beyond the barrier of the shoreline—submarine valleys and canyons, plateaus, the continental shelf and slope, etc. Together with the topographic surveys they serve to emphasize the similarity that exists between the character of the visible land area and the adjacent land beneath the sea. This similarity is strikingly illustrated in many localities. The ridges and valleys of the Maine coast are only partially exposed above sea level, and the visible valley of the Hudson River may be followed as a submarine canyon to the edge of the continental shelf (*see* Volume One, fig. 34). In Alaska, the path of glacial movement is well defined and its general direction as observed on land continues under water and can be traced on the hydrographic surveys. No study of coastal features can be complete which does not consider their seaward continuations as revealed by hydrographic surveys.[6]

A discussion of the major terminology associated with the coastal region is contained in Part 2, 682.

## 13. WATERFRONT PROPERTY DISPUTES

Waterfront properties pose unique problems not common to other lands. The waters often perform in strange fashion, sometimes causing an increment to the land and sometimes a loss. It is a generally well-recognized principle of riparian law that whatever is added to riparian lands as a result of gradual and imperceptible growth through the operation of natural causes belongs to the riparian owner. And, conversely, whatever is taken away from riparian lands

6. The detailed surveys of the Bureau in the northern and eastern quadrants of the Gulf of Mexico contributed to a knowledge of the formation of specific submarine features and to the geology generally of the gulf. Ewing, Ericson, and Heezen, *Sediments and Topography of the Gulf of Mexico*, HABITAT OF OIL (A Symposium) 995 (1958).

under similar circumstances is lost to the upland owner.[7] But if the change is sudden or rapid, as when a river forming the boundary between two states breaks across a bend and forms a cutoff, or where the shoreline has been changed by artificial filling, no alteration is effected in the original boundary. The test of what is a gradual and imperceptible addition within the meaning of the rule is that "Though the witnesses may see, from time to time, that progress has been made, they could not perceive it while the progress was going on." [8] Whether a particular change has been gradual or sudden is a question of fact which must be determined by evidence. The story told by a series of periodic surveys, impartially executed and authenticated, is of great value in determining the rate at which the change took place.[9]

(*a*) *Early Descriptions of Boundaries.*—During the early years of the Nation's history, when land values in general were low, the methods used by land surveyors were crude. Many points then considered of negligible importance have become the subject of litigation because of the great increase in land values. A common practice of that early period was to define the seaward limit of property as the high- or low-water line, or by some generalized description. If the upland (land above high water) was bordered by an area of salt marsh, which was later reclaimed, and the property conveyed had passed by successive conveyances to others, questions may arise as to the boundary of the tract originally conveyed. If one litigant can show by an authentic survey that the area in question was covered with water at low water or high water, which the other litigant maintains was upland, he will have made out a convincing case (*see* Part 2, 4433).

(*b*) *Demarcation of Tidal Boundaries.*—Another facet of the application of Coast Survey data is in the demarcation of waterfront boundaries based on tidal definition. Such boundaries usually involve the mean high-water line or the mean low-water line (*see* Volume One, fig. 20).

7. This is termed the doctrine of accretion and erosion, and is one of the rights—known as riparian rights—that inhere in land by virtue of its bordering the sea. Accretion is the act while alluvion is the deposit itself. It has been stated that the doctrine of accretion was adopted in order to preserve the fundamental riparian right on which all others depend, namely, the right of access to the water. *Lamprey* v. *State and Metcalf*, 53 N.W. 1139 (1893) (Minn.). The reasonableness of the rule is based on the fact that the riparian owner stands to lose land through the operation of eroding forces. Rights to accretion, as with other riparian rights (the right of egress and ingress, the right to build wharves, the right to reclaim the shore), are governed by the laws of the state where the land lies and not by any federal law, unless a federal question is involved. But in either case the riparian rights are subject to the primary right of the United States in navigable waters for the purposes of commerce. For additional discussion of the doctrine of accretion, *see* 4423.

8. *County of St. Clair* v. *Lovingston*, 23 Wall. 46, 68 (90 U.S., 1874).

9. In one investigation which the Bureau made, it was essential to determine whether accretion to a coastline was induced by a jetty constructed several miles down the coast from the locus in question. A study of comparative shorelines extending over a period of nearly 100 years provided unmistakable evidence that accretion had already taken place prior to the building of the jetty.

According to the common law of England (*see* 251), which is the basis for the law in nearly all of the states, the boundary between upland and the shore (land between high- and low-water marks) is ordinary or mean high-water mark.[10] But according to the civil law (*see* 252), which is in effect in a few states, the boundary of the shore (as defined by the Supreme Court of Texas in 1958) extends to mean higher-high-water mark.[11] In either case, the long-period accumulated tidal data of the Bureau, which furnishes the elevations of the various tidal datums with respect to established bench marks on shore (*see* Part 1, 2314), must be used in order to precisely demarcate the boundary on the ground.

## 14. MARITIME BOUNDARIES

In the field of maritime boundaries, whether national or international, Coast and Geodetic Survey data find a special application. A nation's sovereignty extends not only over its land area and over its inland waters (ports, rivers, harbors) but also over a belt of water adjacent to its coast, known as the territorial or marginal sea (*see* Volume One, Part 1, 312, 32). There is universal agreement on this. What has not yet been agreed on is what the width of this belt should be. The United States has thus far consistently adhered to a narrow territorial sea (a 3-mile belt) as best preserving the free seas doctrine—one of the keystones of American foreign policy since 1793.[12] There is unanimous agree-

10. *Borax Consolidated, Ltd.* v. *Los Angeles*, 296 U.S. 10, 22 (1935). This is a landmark case in the law of tidal boundaries, and is reproduced in its entirety as Appendix D. The Court stated that "by the common law, the shore is confined to the flux and reflux of the sea at ordinary tides"; that is, "the land between ordinary high and low-water mark, the land over which the daily tides ebb and flow. When, therefore, the sea, or a bay, is named as a boundary, the line of ordinary high-water mark is always intended where the common law prevails." *Ibid.* This case established for the Federal courts not only the rule to be applied in interpreting the term "ordinary high-water mark" when construing a federal grant, but it also established the first precise standard for the demarcation of such boundary on the ground. The Court said that "in order to ascertain the mean high tide line with requisite certainty in fixing the boundary of valuable tidelands . . . an average of 18.6 years [of tidal observations] should be determined as near as possible." *Id.* at 26–27. For a discussion of the principles of this case in relation to the establishment of tidal boundaries, *see* Volume One, Part 1, 6413.

11. *Luttes* v. *State*, 324 S. W. 2d 167 (1958), clarified the civil law (Spanish law) concept of seashore and held such interpreted references of *Las Siete Partidas* (the body of Spanish law written in the 13th century) as "covered with the water of the latter [the sea] at high tide, during the whole year, whether in winter or in summer," "their highest annual swells," "that part of the land covered by the highest swells in perennial agitation, during the winter as well as during the strong but customary summer storms," to be, in the light of modern conditions and the need for exact application, the line of mean higher high tide as determined from a 19-year period. *Id.* at 178, 182, 192. Pertinent portions of this case dealing with the establishment of tidal boundaries and the acceptance of tide-gage determination are reproduced in Appendix D.

12. This has been reaffirmed on numerous occasions, and the United States has uniformly protested encroachments on this doctrine through extensions of the territorial sea, whether arrived at unilaterally or multilaterally. At the 1958 and 1960 Conferences on the Law of the Sea (*see* Volume One, Part 3, 21, 23), the United States proposed a 6-mile territorial sea with an additional 6-mile fisheries zone in the interest of reaching a compromise, but the Conference failed to reach agreement on any breadth of the territorial sea. This left the preexisting position of the United States intact (*see* Volume One, Part 3, 231, 233).

ment among nations that each should have a territorial sea of at least 3 miles. But wider maritime belts have been claimed by some countries—for example, Norway and Sweden claim 4 miles, Spain 6 miles, Mexico 9 miles, and the Soviet Union 12 miles. For a recent compilation (Feb. 8, 1960) by the United Nations of the various claims of nations to a breadth of the territorial sea and to contiguous zones, *see* Volume One, Appendix J. Subsequent to this compilation, the following countries have made unilateral claims to extended territorial seas or to exclusive fishing zones:

ALBANIA—March 1, 1960, restricted innocent passage in a 10-mile territorial sea, and claimed fishing jurisdiction to 12 miles.

CAMEROON—June 23, 1962, claimed a 6-mile territorial sea.

CHINA (Communist)—claims a 12-mile territorial sea.

DENMARK—June 1, 1963, extended the fisheries limits for Greenland to 12 miles. A similar limit for the Faroes Islands will take effect March 12, 1964. Certain countries are exempted from the Greenland limits until May 31, 1973.

MALAGASY REPUBLIC—February 27, 1963, claimed a 12-mile territorial sea.

MOROCCO—extended fisheries jurisdiction to 12 miles, except for the Strait of Gibraltar, for which such jurisdiction was extended to 6 miles.

NORWAY—extended fisheries jurisdiction to 6 miles on April 1, 1961, and to 12 miles on September 1, 1961.

SENEGAL—June 21, 1961, claimed a 6-mile territorial sea plus a 6-mile contiguous zone.

SUDAN—August 2, 1960, extended the territorial sea to 12 miles.

TUNISIA—July 26, 1962, extended the territorial sea to 6 miles with an additional 6 miles of fisheries jurisdiction for a portion of its coast from the Algerian border to Ras Kaboudia, and extended the territorial sea from there to the Libyan border to the 50-meter isobath line.

URUGUAY—February 21, 1963, claimed a 6-mile territorial sea plus a 6-mile contiguous zone for fishing and other purposes.

Besides the above countries, a number have indicated that they intend to assert extended claims. Legislation has been introduced in Colombia to extend the territorial sea from 6 to 12 miles; in Ghana to establish a 12-mile territorial sea, with an undefined protective area seaward of this, and up to 100 miles of fishing conservation zone; in South Africa, Costa Rica, and Turkey to extend the territorial sea to 6 miles, with a 6-mile contiguous fishing zone; and in the Ivory Coast to extend the territorial sea to 12 miles.

In addition, Canada, on June 4, 1963, extended its exclusive fishing rights to 12 miles in the following proclamation: "With these considerations in mind, the Canadian Government has decided to establish a 12-mile exclusive fisheries zone along the whole of Canada's coastline as of mid-May 1964 and to implement the straight baseline system at the same time as the basis from which Canada's territorial sea and exclusive fisheries zone shall be measured." [13]

13. The above information is based on a report furnished by the Department of State to Senator Gruening, of Alaska, on June 17, 1963. 109 Cong. Rec. 11279–11280 (June 28, 1963). With reference

## 141. The Headland-to-Headland Line

Besides the international boundaries discussed above, there are other maritime boundaries associated with national waters. These concern boundaries at bays and rivers.

The problem of defining the specific limits of a body of water tributary to a larger body is not always a simple one. The solution lies in finding the exact place where the tributary waterway merges into the principal waterway. In the absence of established criteria, a basic consideration is the physical configuration of the waterway.[14] Based on this consideration, the "headland-to-headland" principle has been deduced. This principle considers the boundary between a tributary waterway and a larger body of water to be a line joining the headlands of the tributary. The headland rule has been applied in various contexts, on international, national, and local levels, to bays and rivers.

### 1411. *Boundary at Bays*

(*a*) *Internationally.*—As applied to bays, the headland rule probably had its origin in international law in connection with delimitation of the territorial sea

to the Canadian proclamation, it should be noted that in its reply to the Secretary-General of the United Nations, prior to the Second Geneva Conference on the Law of the Sea, Canada claimed a 3-mile territorial sea and a 12-mile fisheries zone (*see* Volume One, Appendix J). This was evidently a mere claim without implementation. The present proclamation formally establishes this 12-mile fisheries zone with a definite date of implementation. The proclamation does not refer to the territorial sea and presumably this would remain at 3 miles with an additional 9 miles of exclusive fisheries rights. Under this interpretation, the area beyond the 3-mile belt would be part of the high seas insofar as free navigation is concerned. On Mar. 3, 1964, 13 European countries reached an agreement whereby each would have an exclusive right to fish within a 6-mile zone and to impose its regulations in a further zone between 6 and 12 miles which would remain open only to fishermen who had traditionally fished in that zone. Signatories to the agreement were Austria, Belgium, Denmark, France, West Germany, Ireland, Italy, Luxembourg, Holland, Portugal, Spain, Sweden, and the United Kingdom. The *Washington Post,* Mar. 4, 1964, p. D3.

14. Names of bodies of water shown on the nautical charts of the Bureau mark in a general way the limits of the features they represent (*see* Part 2, 6565). But they are intended primarily for navigational use. In their placement on the chart, the best available information is generally consulted, taking into account such factors as long usage and such sources as the Light Lists, the *Coast Pilots,* and decisions of the Board on Geographic Names (*see* Part 2, 6563). The more pronounced the physical features or headlands are, the more closely will the opinions of experts agree as to the boundary of the tributary waterway. For example, there would be little disagreement that the boundary between Providence River and Narragansett Bay (*see* fig. 92) is the line joining Nayatt Pt. and Conimicut Pt. On the other hand, opinions might differ as to the exact boundary between Taunton River and Mt. Hope Bay or between Warren River and Narragansett Bay. Another example of the latter category is Buzzards Bay (*see* chart 1210). While the western limit of the bay is not specifically defined in the *Coast Pilot,* Westport River is described as emptying "into the large bight between Gooseberry Neck and Sakonnet Point," the inference being that the bight is not a part of Buzzards Bay. But in the Light List, the various lights and buoys in the approach to Westport Harbor are listed under Buzzards Bay, apparently considering this bight within the geographic limits of the bay.

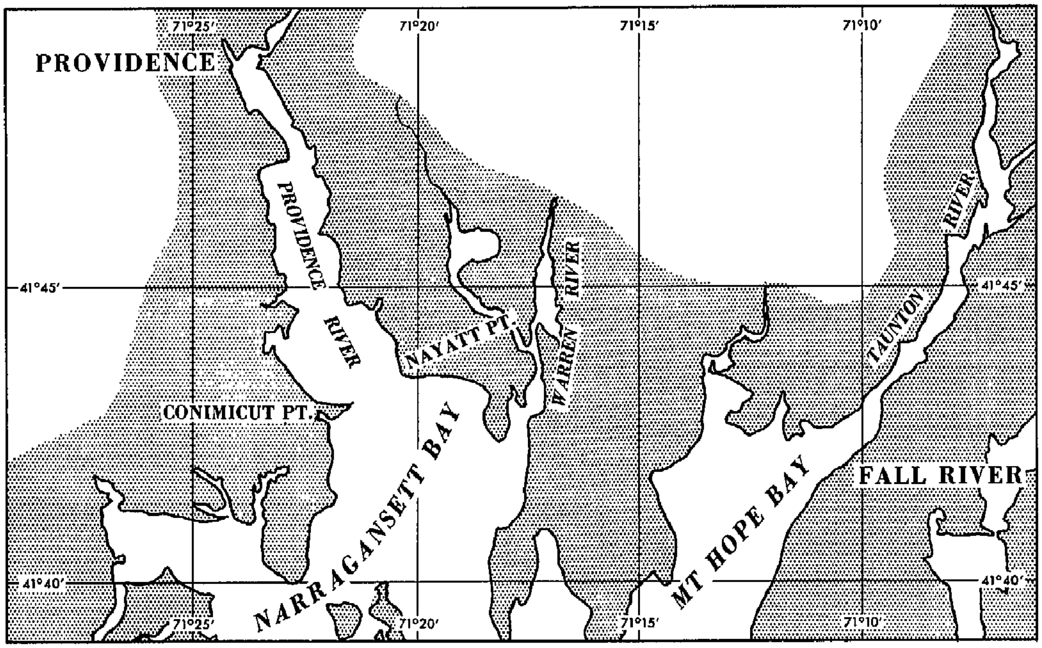


FIGURE 92.—Shoreline in vicinity of Narragansett Bay, R.I., from chart 353. Determining the boundary between a tributary waterway and a principal waterway is not always a simple matter where the physical features are not well pronounced (*see* text).

over which a maritime nation exercises sovereignty.[15] Thus, in *United States* v. *Carrillo et al.*, 13 F. Supp. 121 (1935), it was said: "From a very early date nations have generally acquiesced in the proposition that a nation's territory over which its sovereignty extends ends 3 miles from and into the bordering ocean. . . . Such three miles was not a line following the exact contour of the coast, which would seem impracticable, but was three miles from the line joining headlands or points between which lie indentations or bays." [16]

The question of boundaries at bays was given exhaustive consideration by the Permanent Court of Arbitration at The Hague in 1910, in connection with

15. The principle might be considered a restricted version of the old "King's Chambers" doctrine, proclaimed by James I in 1604, by which England claimed jurisdiction over an area formed by squaring off the British Isles. The chambers were formed by straight lines from one extreme landmark to another around the coast and not necessarily between the headlands of different bays. This doctrine has of course long been abandoned (*see* Volume One, Part 1, 332).

16. Other statements which support the delimitation of the territorial sea as the origin of the headland rule are the following: On Feb. 14, 1884, the Assistant Secretary of State, John Davis, stated: "The general law and rule is understood by this Government to be that beyond the marine league or three-mile limit, all persons may freely catch whale or fish. In computing this limit, however, 'bays' are not taken as a part of the high seas; the three miles must be outside of a line drawn from headland to headland." MOORE, I DIGEST OF INTERNATIONAL LAW 718 (1906). And Jessup, in his work on territorial waters, makes this observation: "A third principle of perhaps less well-defined application is the so-called headland theory. Following this rule the line of territorial waters would be drawn from headland to headland, making all bays territorial, regardless of extent." JESSUP, THE LAW OF TERRITORIAL WATERS AND MARITIME JURISDICTION 358 (1927).

the North Atlantic Coast Fisheries Arbitration between the United States and Great Britain. The arbitration marked the culmination of a century-long dispute over the meaning of the Convention of October 20, 1818, in which the United States renounced the rights of its nationals to fish within 3 marine miles of any of the bays of the British dominions in America. The question to be resolved was from what line the 3 miles was to be measured. The tribunal made the following award: "In case of bays, the three marine miles are to be measured from a straight line drawn across the body of water at the place where it ceases to have the configuration and characteristics of a bay." This in essence is an application of the headland principle. For a fuller discussion of this arbitration, *see* Volume One, Part 1, 411.

The most recent pronouncement internationally with respect to boundaries at bays is the provision adopted in 1958 by the United Nations Conference on the Law of the Sea. Article 7 (par. 4) of the Convention on the Territorial Sea and the Contiguous Zone provides that "If the distance between the low-water marks of the natural entrance points of a bay does not exceed twenty-four miles, a closing line may be drawn between these two low-water marks, and the waters enclosed thereby shall be considered as internal waters." (*See* Volume One, Appendix I.) The 3-mile marginal belt would be measured from this line. This constitutes for all practical purposes a headland-to-headland line.[17]

International law today recognizes still another principle in connection with bay boundaries, to wit, the semicircular rule. This rule postulates that a semicircular bay having its diameter along the line joining the headlands is the theoretical bay which lies on the borderline between a closed and an open bay, that is, between inland waters and the open sea. In other words, before a bay can be considered as part of the inland waters of a nation, so that the 3-mile marginal belt can be drawn from a line joining the headlands of the bay, it must satisfy the criteria set out in international law for such assimilation; otherwise the boundary of inland waters would follow the sinuosities of the shore. Article 7 (par. 2) of the Convention on the Territorial Sea provides: "For the purposes of these articles, a bay is a well-marked indentation whose penetration is in such proportion to the width of its mouth as to contain land-locked waters and constitute more than a mere curvature of the coast. An indentation shall not, however, be regarded as a bay unless its area is as large as, or larger than, that of the semicircle whose diameter is a line drawn across

17. Prior to the 1958 Conference, the closing line for a bay was generally considered to be 10 miles, at least this was the position taken by the United States and by some other nations in their international relations (*see* Volume One, Part 1, 43 and Part 3, 2218(*b*)).

the mouth of that indentation."[18] And Article 3 states: "Except where otherwise provided in these articles, the normal baseline for measuring the breadth of the territorial sea is the low-water line along the coast as marked on large-scale charts officially recognized by the coastal State." (*See* Volume One, Appendix I.)

(*b*) *Nationally.*—On the national level, consideration was given the matter of bays and headlands by a Special Master of the Supreme Court in 1952 in the case of *United States* v. *California,* 332 U.S. 19 (1947). In defining the federal-state boundary along the California coast, which the Supreme Court had said was the ordinary low-water mark and the seaward limits of inland waters, the Master made the following recommendation with respect to bays: "For indentations having pronounced headlands not more than ten nautical miles apart [*see* note 17 *supra*], and having a depth as hereinafter defined, a straight line is to be drawn across the entrance . . . . the requisite depth is to be determined by the following criterion:" (here follows the semicircular rule) (*see* text at note 18 *supra,* and Volume One, Appendix C).

(*c*) *Locally.*—On a local level, some of the state courts have adopted the headland principle in determining proprietary rights in coastal indentations, and for jurisdictional purposes.

In New York, in the case of *Grace* v. *Town of North Hempstead,* 152 N.Y. Supp. 122 (1915) (*affirmed* in 115 N.E. 1040), which involved title to land under the waters of Manhasset Bay in Long Island Sound (*see* chart 1213), it was held that "the Sound or East River means the Long Island Sound and the course 'round the points of the necks till it comes to Hempstead Harbour,' plainly means a boundary run around the outer points or headlands of Great Neck and Cow Neck, by which this bay is plainly comprised." And in the case of *Bliss* v. *Benedict et al.,* 195 N.Y. Supp. 690 (1922) (*affirmed* in 138 N.E. 461), which involved the seaward boundary of Westchester Creek (*see* chart 1213), the court said that "the land in controversy lies . . . under the waters of Westchester creek . . . the mouth of which must be held to lie between the two headlands Clason Point and Old Ferry Point, where it empties into the Sound."

In Massachusetts, a statute was adopted in 1859 (Mass. Gen. Stats., C. 1, sec. 1) which provides as follows: "The territorial limits of this commonwealth extend one marine league from its sea-shore at low-water mark. When an inlet or arm of the sea does not exceed two marine leagues in width between its head-

18. For a discussion of the genesis and development of the semicircular rule and its application to a coastline, *see* Volume One, Part 1, 42, 421.

lands, a straight line from one headland to the other is equivalent to the shore line."

An application of the semicircular rule to such situations would give geometric rationality to the problem of determining the boundary at such waterways.

### 1412. *Boundary at Rivers*

In the case of rivers, cognizance has been taken internationally of the headland-to-headland principle at the 1930 Hague Conference for the Codification of International Law in the proviso contained in the final report of the Second Sub-Committee of the Conference that "When a river flows directly into the sea, the waters of the river constitute inland waters up to a line following the general direction of the coast drawn across the mouth of the river, whatever its width." [19] To the same effect is the recommendation of the International Law Commission in its final report to the United Nations,[20] as is Article 13 of the 1958 Convention on the Territorial Sea and the Contiguous Zone (*see* Volume One, Appendix I), which provides that "If a river flows directly into the sea, the baseline shall be a straight line across the mouth of the river between points on the low-tide line of its banks." [21]

In *United States* v. *California, supra* (*see* 1411(*b*)), a Special Master made the following recommendation regarding the boundary at rivers along the California coast: "Where rivers empty into the sea, the seaward limit of inland waters is a line following the general direction of the coast drawn across the mouth of the river whatever its width." [22]

### 1413. *Termini at Headlands*

In drawing a headland-to-headland line at the boundaries of bays or rivers, certain physiographic and geometric principles are followed in ascertaining the exact points on the headlands between which the line is to be drawn. These are

19. 3 Acts of the Conference for the Codification of International Law (League of Nations Publications V: Legal) 220 (1930).

20. Report of the International Law Commission, 8th Sess. 18 (1956) and recorded in Official Records, U.N. General Assembly, 11th Sess., Supp. No. 9 (1956) (U.N. Doc. A/3159).

21. In international law, the line that divides the inland waters of a nation from its territorial sea is known as the "baseline." It is also the line from which the outer limits of the territorial sea, the inner and outer limits of the contiguous zone, and the inner limits of the continental shelf and high seas are measured (*see* 143, 1431). The normal baseline follows the low-water mark, except where indentations are encountered that fall within the category of "true" bays, in which case the baseline becomes a straight line between the headlands (*see* text following note 17 *supra,* and Volume One, Part 1, 33, 331).

22. Report of Special Master 4, United States v. California, Sup. Ct. No. 6, Original, Oct. Term, 1952 (*see* Volume One, Appendix C).

discussed in Volume One, Part 1, 48, in relation to the *California* case, *supra,* and the method of determining the termini illustrated. The Special Master's recommendation to the Supreme Court in this case was as follows: "Where pronounced headlands exist at tributary waterways, the appropriate landmark is the point of intersection of the plane of ordinary low water with the outermost extension of the natural headland. Where there is no pronounced headland, the landmark is the point of intersection of the ordinary low-water mark with a line bisecting the angle between the general trend line of the ordinary low-water mark along the open coast and the general trend line of the ordinary low-water mark along the shore of the tributary waterway." [23]

## 142. River Boundaries

A river has been defined legally as "a natural stream of water, of greater volume than a creek or rivulet, flowing in a more or less permanent bed or channel, between defined banks or walls, with a current which may either be continuous in one direction or affected by the ebb and flow of the tide." [24]

In addition to the river boundaries dealt with above under the headland principle, there is the situation where the river forms the dividing line between two political jurisdictions, to wit, two nations, two states, etc. These are sometimes referred to as *boundary rivers* in international law to distinguish them from *national rivers,* which are under the sway of one nation, and *international rivers,* which separate or pass through several nations between their sources and their mouths at the open sea.[25]

There are many instances of river boundaries in the United States, some of which have been adjudicated by the Supreme Court.[26]

In delimiting river boundaries, three principal rules have been followed: (1) the geographic middle of the river, or the *medium filum acquae;* (2) the middle of the channel, or the rule of the *thalweg;* and (3) the shore or bank. These will be dealt with following the discussion of definitions associated with river boundaries.

23. *Ibid.* This recommendation followed the Bureau's suggestion to the Department of Justice.

24. Black, Law Dictionary (4th ed.) 1491 (1951), citing *Alabama* v. *Georgia,* 23 How. 505, 513 (64 U.S., 1860) and *Motl* v. *Boyd,* 286 S.W. 458 (1926) (Tex.). A river or stream consists of a bed, banks, and stream of water. *Id.* at 467. Technically, a river has been defined as a stream relatively prominent in any extensive region (Adams, Hydrographic Manual 55, Special Publication No. 143, U.S. Coast and Geodetic Survey (1942)); and as a large stream of running water (Edmonston, Nautical Chart Manual 79, U.S. Coast and Geodetic Survey (1956)).

25. Oppenheim, I International Law (5th ed.) 361 (1937).

26. Reference to these can be found in the Digest of Supreme Court Reports under the classification "Boundaries."

## 1421. *Associated Definitions*

Terms associated with river surveys and boundaries, that have been defined legally and technically, include "bank," "bed," "right bank," "left bank," "ordinary high-water mark," and "ordinary low-water mark."

(*a*) *Bank*.—The bank of a river has been defined by the Supreme Court as "the water-washed and relatively permanent elevation or acclivity at the outer line of the river bed which separates the bed from the adjacent upland, whether valley or hill, and serves to confine the waters within the bed and to preserve the course of the river." [27]

(*b*) *Bed*.—The bed of a river has also been defined by the Supreme Court as "that portion of its soil which is alternately covered and left bare, as there may be an increase or diminution in the supply of water, and which is adequate to contain it at its average and mean stage during the entire year, without reference to the extraordinary freshets of the winter or spring, or the extreme droughts of the summer or autumn." [28]

(*c*) *Right and Left Bank*.—The right bank of a river is the bank on the right-hand side and the left bank is the one on the left-hand side as one proceeds downstream.[29]

(*d*) *Ordinary High-Water Mark*.—Along a navigable river, above the ebb and flow of the tide, the term "ordinary high-water mark" has been held by the Iowa court to refer to "the line to which high water ordinarily reaches," and not the line reached by the water in unusual floods (*State* v. *Sorenson*, 271 N.W. 234, 236 (1937)). Neither does it mean "the line ordinarily reached by the great annual rises of the river, which cover in places lands that are valuable for agricultural purposes. . . . Nor yet does it mean meadowland adjacent to the river, which, when the water leaves it, is adapted to and can be used for grazing or pasturing purposes" (*Welch* v. *Browning*, 87 N.W. 430 (1901)).

27. *Oklahoma* v. *Texas*, 260 U.S. 606, 631 (1923). In interpreting the intention of the Treaty of 1819 between the United States and Spain, the Court held that the boundary between Oklahoma and Texas along the Red River "is on and along the bank at the average or mean level attained by the waters in the periods when they reach and wash the bank without overflowing it." *Id.* at 632. The banks of a river have been variously defined in the state courts. Thus, in California it has been defined as "the boundaries which confine the water to its channel throughout the entire width when the stream is carrying its maximum quantity of water." *Mammoth Gold Dredging Co.* v. *Forbes*, 104 P. 2d 131, 137 (1940). In Louisiana, it has been held to be "the land between the ordinary high-water mark and the ordinary low-water mark." *Seibert* v. *Conservation Commission of Louisiana*, 159 So. 375, 377 (1935). But where there are levees established according to law, the levees form the banks of the river. *Ward* v. *Board of Levee Commissioners*, 92 So. 769, 772 (1922) (La.). In Oregon, the term "bank" has been held ordinarily to be "synonymous with that high-water mark, below which the title was originally in the state, and not in the general government." *Richards* v. *Page Investment Co.*, 228 Pac. 937, 942 (1924). But where the stream is in a ravine, and such was the intention of the parties, the Massachusetts court has held the term to mean the entire slope running along the side of such ravine and not along the high-water mark. *Langevin* v. *Fletcher*, 174 N.E. 194, 195 (1931). Technically, the term "bank" has been defined as the continuous margin along a river where all vegetation ceases (MITCHELL, DEFINITIONS OF TERMS USED IN GEODETIC AND OTHER SURVEYS 9, SPECIAL PUBLICATION NO. 242, U.S. COAST AND GEODETIC SURVEY (1948)); and as the rising ground bordering a lake, river, or sea (*Technical Report No. 4*, U.S. Beach Erosion Board (1954)).

28. *Oklahoma* v. *Texas*, *supra* note 27, at 631. The term has also been defined by the state courts as the "soil which is submerged so long or so frequently, in ordinary seasons, that vegetation will not grow upon it" (*City of Cedar Rapids* v. *Marshall*, 203 N.W. 932, 933 (1925) (Iowa)); and as "that portion of its [the stream] soil covered by the waters under normal conditions and seasons" (*King* v. *Schaff*, 204 S.W. 1039, 1042 (1918) (Texas)). Technically, the bed of a stream or river has been defined as the area within the high-water lines—the area which is kept practically bare of vegetation by the wash of the waters from year to year. MITCHELL (1948), *op. cit. supra* note 27, at 12.

29. MANUAL OF INSTRUCTIONS FOR THE SURVEY OF THE PUBLIC LANDS OF THE UNITED STATES 234, U.S. BUREAU OF LAND MANAGEMENT (1947).

(*e*) *Ordinary Low-Water Mark.*—The usual or ordinary stage of a river when the volume of water is not increased by rains or freshets occasioned by melted snow, or diminished below such usual stage or volume by long continued drought to extreme low-water mark (*Goodall* v. *T. L. Herbert & Sons,* 8 Tenn. App. 265 (1928)).

### 1422. *Geographic Middle of a River—Medium Filum Acquae*

The use of the geographic middle of a river, or the *medium filum acquae* or *filum acquae,* as it is sometimes called, is a rule laid down by Grotius, the Dutch jurist who lived during the late 16th and early 17th centuries, and who is considered the father of the free or open seas doctrine (*see* Volume One, Part 3, 223).[30]

In construing a boundary convention between Georgia and South Carolina, the Supreme Court held the boundary line to be the thread of the Savannah and other rivers—the middle of the stream—when the water is at ordinary stage, regardless of the channel of navigation.[31]

The rule of *medium filum acquae* had for its principal objection, at least insofar as navigable rivers were concerned, the fact that it disregarded the main channel, thereby resulting in inequities to the nation which happened to be the more remote therefrom. The result was that at the beginning of the 19th century a new rule, known as the *thalweg,* was substituted for medium filum acquae.[32]

The rule of the geographic middle of a river being the boundary is still applicable to non-navigable rivers.

30. *Filum acquae* has been defined as a thread; a line of water; the middle line of a stream of water supposed to divide it into two equal parts, and constituting in many cases the boundary between the riparian proprietors on each side. BLACK (1951), *op. cit. supra* note 24, at 757, citing *Ingraham* v. *Wilkinson,* 21 Mass. 268 (1827), 16 Am. Dec. 342. This is identical with a median line, every point of which is equidistant from the nearest points of the baselines on the opposite shores (*see* Volume One, Part 3, 2212).

31. *Georgia* v. *South Carolina,* 257 U.S. 516, 521, 522 (1922). The Court stated the general rule to be that "where a river, navigable or non-navigable, is the boundary between two States, and the navigable channel is not involved, in the absence of convention or controlling circumstances to the contrary, each takes to the middle of the stream," citing *Handly's Lessee* v. *Anthony,* 5 Wheat. 374, 379 (18 U.S., 1820). Since the convention between the two states secured free navigation on the boundary rivers to each state, the Court ruled out the *thalweg doctrine* (*see* 1423), insofar as the precise location of the boundary was concerned. It also held that where islands exist, the boundary line is midway between the island bank and the South Carolina shore when the water is at ordinary stage. *Georgia* v. *South Carolina, supra,* at 523.

32. In *Iowa* v. *Illinois,* 147 U.S. 1, 8–9 (1893), the Supreme Court cites CREASY, FIRST PLATFORM ON INTERNATIONAL LAW (1876) for the statement that the *medium filum acquae* "will be regarded *prima facie* as the boundary line, except as to those parts of the river as to which it can be proved that the vessels which navigate those parts keep their course habitually along some channel different from the *medium filum.*"

## 1423. *Rule of the Thalweg*

The rule of the *thalweg* holds that where a navigable river separates two nations, the middle of the main channel is the boundary between them. The thalweg, as the derivation of the word indicates, is the downway, or the course followed by vessels of largest tonnage in descending the river.[33] The thalweg bears no necessary relationship to the median line of a river; they may cross each other at many points.

The various treaties of the United States, involving river boundaries, lack uniformity of expression. Thus, the Treaty of 1783 with Great Britain referred to the "middle" of boundary rivers; the Treaty of 1908, concerning the Canadian international boundary along the St. Croix River, provided that the line should "follow the center of the main channel or thalweg as naturally existing" (this is the first boundary convention of the United States in which the term thalweg is used); the Treaty of 1795 with Spain declared that the boundary along the St. Mary's River should follow the "middle thereof," while another article of the treaty declared the "western boundary of the United States" to be the "middle of the channel or bed of the river Mississippi"; and in the Treaty of Guadalupe Hidalgo with Mexico in 1848, the boundary was to proceed up the "middle" of the Rio Grande, "following the deepest channel where it has more than one." [34]

The doctrine of the thalweg was fully considered and applied by the Supreme Court in the settlement of the boundary between New Jersey and Delaware in the lower Delaware River and in the bay. In deciding the case, the Court applied what it believed to be the principles of international law. "International law," it said, "to-day divides the river boundaries between states by the middle of the main channel, when there is one, and not by the geographical centre, half way between the banks . . . . It applies the same doctrine, now known as the doctrine of the *Thalweg,* to estuaries and bays in which the dominant sailing channel can be followed to the sea . . . . The *Thalweg,* or downway, is the track taken by boats in their course down the stream, which is that of the strongest current . . . . The underlying rationale of the doctrine of

33. On the derivation of the word "thalweg," Westlake, in his treatise on international law, states: "When a river forms the boundary between two states it is usual to say that the true line of demarcation is the *thalweg,* a German word meaning literally the 'downway', that is the course taken by boats going downstream, which again is that of the strongest current, the slack current being left for the convenience of ascending boats . . . . *Thal* in the sense of valley enters into *thalweg* only indirectly. The immediate origin of the word lies in the use of *berg* and *thal* to express the upward and downward directions on a stream." WESTLAKE, I INTERNATIONAL LAW (2d ed.) 144 and n. 1 (1910).

34. HYDE, 1 INTERNATIONAL LAW CHIEFLY AS INTERPRETED AND APPLIED BY THE UNITED STATES 244–245 (1922).

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the *Thalweg* is one of equality and justice . . . . If the dividing line were to be placed in the centre of the stream rather than in the centre of the channel, the whole track of navigation might be thrown within the territory of one state to the exclusion of the other . . . . If the boundary be taken to be the *Thalweg,* it will follow the course furrowed by the vessels of the world."[35] Where there is more than one channel in a river and if the boundary reference is merely to the center of the channel, then the boundary would be held to be the center of the main channel.[36]

### 1424. *The Shore or Bank*

The third form of river boundary is where the entire river is part of the domain of one state so as to make the farther shore the boundary line between the two states. This is an exceptional case that is usually created by charter, immemorial possession, or treaties of the United States regarding international boundaries. Thus, the boundary between Maryland and Virginia is along the Potomac River on the Virginia shore, having been created by the charter of 1632 from Charles I to Lord Baltimore (*see* 4211);[37] the boundary between Delaware and New Jersey, within the 12-mile circle centered on Newcastle, is along the low-water mark on the New Jersey shore of the Delaware River, the title in Delaware being traceable to a grant made in 1682 by the Duke of York to William Penn;[38] and the Red River boundary of Texas follows the south bank of that river, being traceable to the Spanish-American Treaty of 1819, which provided that the Red River and all the islands therein should belong to the United States (8 Stat. 252 (1819)).[39]

35. *New Jersey* v. *Delaware,* 291 U.S. 361, 379, 380, 385 (1934). The decision with respect to the boundary in the lower river was in favor of the claim of New Jersey (*see* 1424). Other cases which have held the mid-channel of a river to be the boundary line are: *Iowa* v. *Illinois,* 147 U.S. 1 (1893), involving the Mississippi River (the Court here held that by international law as shown in the usage of European States, the term "middle of the stream" and "mid-channel" are synonymous, but this hardly seems correct and geographically it would be better to consider the first as the geographic middle of the river (*see* 1422)); *Nebraska* v. *Iowa,* 143 U.S. 359 (1892), involving the Missouri River; *Arkansas* v. *Tennessee,* 246 U.S. 158 (1918), also involving the Mississippi River; and *Louisiana* v. *Mississippi,* 202 U.S. 1, 50 (1906), where the Court applied the doctrine to estuaries and bays in which the dominant sailing channel can be followed to the sea.

36. *Washington* v. *Oregon,* 211 U.S. 127 (1908). The Court held here that the boundary between the two states was the middle of the north channel of the Columbia River because it was so provided in the statute admitting Oregon as a state. And it further said: "The courts have no power to change the boundary thus prescribed and establish it at the middle of some other channel. That remains the boundary, although some other channel may in the course of time become so far superior as to be practically the only channel for vessels going in and out of the river." *Id.* at 135.

37. By the original charter, the boundary line of Maryland was set at the high-water mark along the Virginia shore, but in the Award of 1877, Virginia's immemorial usage of her shore to low-water mark was recognized and the boundary set along that line (*see* 4211).

38. *New Jersey* v. *Delaware, supra* note 35, at 364, 374.

39. *Oklahoma* v. *Texas, supra* note 27, at 624. The Supreme Court held this to mean the south bank of the river even though the treaty did not mention the bank as it did in the case of two other boundary rivers specified in the same treaty.

This type of river boundary also arises where one state is the original proprietor of the territory through which the river flows and grants territory on one side of the river only, retaining the river within its own domain. The state created out of the ceded territory extends to the river only. This is exemplified by the state boundaries along the Ohio River. The cession by Virginia to the United States of the territory "situate, lying and being to the north-west of the river Ohio," has been held to have conveyed territory on the far side of the river only, Virginia retaining dominion over the entire Ohio River to the ordinary low-water mark on the opposite shore, that is, on the north and northwestern sides of the Ohio River. The states that were carved out of the territory retained by Virginia (West Virginia and Kentucky) succeeded to Virginia's rights in the Ohio River, and their boundaries extend to the ordinary low-water mark on the north and northwest shores, and this is the boundary line of these states with the States of Ohio, Indiana, and Illinois which were formed out of the Northwest Territory.[40]

### A. RIPARIAN BOUNDARIES ALONG INTERSTATE RIVERS

Where a state boundary is on the opposite shore of an interstate river, it does not necessarily follow that a riparian owner's title also extends to the far shore. Thus, although the boundary between Indiana and Kentucky is the low-water mark on the north shore of the Ohio River (*see* note 40 *supra*), the

40. *Handly's Lessee* v. *Anthony, supra* note 31, at 379; *Indiana* v. *Kentucky,* 136 U.S. 479 (1890); *Point Pleasant Bridge Co.* v. *Point Pleasant,* 9 S.E. 231 (1889) (W. Va.); and *Church* v. *Chambers,* 33 Ky. 274 (1835), where it was held that the whole of the Ohio River bordering Kentucky, from shore to shore, is within the boundaries of Kentucky. Other cases involving state boundaries, where one shore or the other of the river is the boundary, are: *Alabama* v. *Georgia, supra* note 24, at 514, in which it was held that the western bank of the Chattahoochee River is the boundary between Georgia and Alabama and is based upon the words in the contract of cession between the United States and Georgia (*but see Florida Gravel Co.* v. *Capitol City Sand Co.,* 154 S.E. 255 (1930) (Ga.), where the court said the middle of the Chattahoochee River was the boundary between Georgia and Florida under the terms of the Treaty of Sept. 3, 1783, with Great Britain); *Maryland* v. *West Virginia,* 217 U.S. 577 (1910), in which the low-water mark along the south bank or West Virginia side of the Potomac River was adjudged the boundary between the two states (since West Virginia was but a successor of Virginia in title, this decision is in accord with the Award of 1877 in the Maryland-Virginia boundary dispute (*see* note 37 *supra*) and thus gives Maryland a uniform southern boundary along Virginia and West Virginia); and in *Vermont* v. *New Hampshire,* 289 U.S. 593 (1933), the boundary line between the two states was held to follow the low-water mark on the Vermont side of the Connecticut River. The boundary between Louisiana and Texas originally followed the west bank of the Sabine River, this having been the eastern boundary of the Republic of Texas. DOUGLAS, BOUNDARIES, AREAS, GEOGRAPHIC CENTERS, AND ALTITUDES OF THE UNITED STATES AND THE SEVERAL STATES (2d ed.) 169, BULLETIN No. 817, U.S. GEOLOGICAL SURVEY (1932). In 1848, Congress consented to extending the eastern boundary of Texas "to include within her limits one half of Sabine Pass, one half of Sabine Lake, also one half of Sabine River, from its mouth as far north as the thirty-second degree of north latitude" (9 Stat. 245).

title of riparian owners on the Kentucky side was held to stop at the thread of the river.[41]

### 143. High Seas Boundaries

In international law, the term "high seas" is defined as "all parts of the sea that are not included in the territorial sea or in the internal waters of a State." [42] The high seas thus begin at the outer limits of the territorial or marginal sea and extend seaward for an indefinite distance. The territorial sea begins at the low-water line and the seaward limits of inland waters and extends, in this country, for a distance of 3 nautical miles.[43] But since the territorial sea concept was carved out of the open sea, or free seas, doctrine (*see* Volume One, Part 1, 32, 321), it follows that, in a boundary context, the line dividing the inland waters from the territorial sea is, in effect, the line dividing them from the high seas. This line, then, is the landward or inner boundary of the high seas. The principles developed for the delimitation of such lines are dealt with in Volume One, Part 3, 2211 A, C.

High seas boundaries fall into two categories: (1) outer or exterior boundaries, and (2) lateral boundaries.

#### 1431. *Exterior Boundaries*

Strictly speaking, the high seas have no exterior boundaries since they extend seaward an indefinite distance and are incapable of appropriation by

41. *Bedford-Nugent Co.* v. *Herndon,* 244 S.W. 908 (1922) (Ky.). But in *Jones* v. *The Water Lot Co. of Columbus,* 18 Ga. 539 (1855), the Georgia court held that a grant of land bounded by the Chattahoochee River extended to the opposite shore, thus following the boundary line between Georgia and Alabama (*see* note 40 *supra*).

42. Article 1 of the 1958 Geneva Convention on the High Seas (*see* Volume One, Appendix I).

43. Over the territorial sea, a coastal nation exercises exclusive sovereignty—the same as it does over its land territory and its inland waters—except for the right of innocent passage of foreign vessels. This sovereignty includes the prevention of fishing by foreign vessels and applies to the bed and subsoil of the territorial sea (*see* Volume One, Part 3, 221). While the right to enforce this sovereignty is a well-recognized principle of international law, the United States has heretofore never enacted legislation spelling out specific sanctions for such violations. On Oct. 1, 1963 (109 Cong. Rec. 17554–17561), the Senate approved, and sent to the House, S. 1988, a bill prohibiting (with certain exceptions) any foreign vessel from taking fish within the territorial waters of the United States (including the territories and possessions and the Commonwealth of Puerto Rico) or from taking any fishery resources of the continental shelf which appertain to the United States. Sec. 2 provides for penalties involving a fine of $10,000 or imprisonment for not more than a year, or both, for any person violating the provisions of the act, and authorizes the seizure and forfeiture of the vessel and all fish taken in violation of the act. S. Rept. 500, 88th Cong., 1st sess. (1963) (to accompany S. 1988). As amended by the House (in which the Senate concurred) and sent to the White House on May 6, 1964, the act embodies the 1958 Geneva convention definition of the Continental Shelf and the sedentary fisheries definition (see Volume One, Appendix I). The act also defines such terms used in the bill as "fisheries" and "fish." In the House report on S. 1988, it is stated that "the powers of the States in dealing with trespassers of their territorial waters would not be preempted by the passage of this bill." H. Rept. 1356, 88th Cong., 2d sess. 5 (1964). The act was approved by the President on May 20, 1964, and became Public Law 88–308 (78 Stat. 194).

any nation. In actuality, when considered in the context discussed above, the high seas encompass the territorial sea, the contiguous zone, and the continental shelf (*see* Volume One, fig. 51), in each of which international law recognizes certain rights as exclusive in the coastal State and therefore give rise to seaward boundary problems (*see* Volume One, Part 3, 221, 2215, 2222). Nationally, there are also the seaward boundaries of the states under the Submerged Lands Act, which in turn are the dividing lines between federal and state ownership of the submerged lands and associated natural resources, and these also give rise to boundary problems.

### A. DELIMITATION OF THE TERRITORIAL SEA

The exterior boundary of the territorial sea is delimited cartographically by an "envelope line." This is defined as a line every point of which is at a distance from the nearest point of the baseline (the line that divides the inland waters from the territorial sea) equal to the breadth of the territorial sea (*see* Volume One, Part 3, 2211 B). The principles on which the envelope line is based and the reasons for its adoption by the 1958 Geneva Conference on the Law of the Sea are dealt with in Volume One, Part 2, 1621(*c*) and will not be repeated here. What is considered in this section is the application of the line to various geographic situations where islands and low-tide elevations exist and the effect each has on the delimitation of the territorial sea (*see* fig. 93). The broken line in the figure that parallels the coastline is the boundary of the territorial sea unaffected by islands or low-tide elevations. This is referred to in subsequent paragraphs as the "main territorial sea."

The basic principle of delimitation of the territorial sea in the vicinity of islands and low-tide elevations is that an island, no matter where situated, carries its own territorial belt, while a low-tide elevation generates such belt only if it lies within the territorial sea. Represented in the figure are the following situations:

At *A* is an island within the main territorial sea, and at *B* is an island outside the territorial sea. In either case, the island will generate its own territorial sea.

At *C* is a low-tide elevation outside the main territorial sea. This situation calls for no modification of the territorial sea. The same result obtains if the low-tide elevation is outside the territorial sea of an island.[44]

44. Article 11 of the Convention on the Territorial Sea and the Contiguous Zone defines a low-tide elevation as "a naturally formed area of land which is surrounded by and above water at low-tide but submerged at high tide" (*see* Volume One, Appendix I). Such elevations are the same as "drying rocks" and "drying shoals," the terminology used by the International Law Commission. In Coast Survey terminology, they are called "rocks awash" and "shoals awash." Rocks awash are defined as "those exposed at any stage of the tide between mean high water and the sounding datum, or that are exactly awash at these planes." JEFFERS, HYDROGRAPHIC MANUAL 209, PUBLICATION 20-2, U.S. COAST AND GEODETIC SURVEY (1960, 3d ed.).

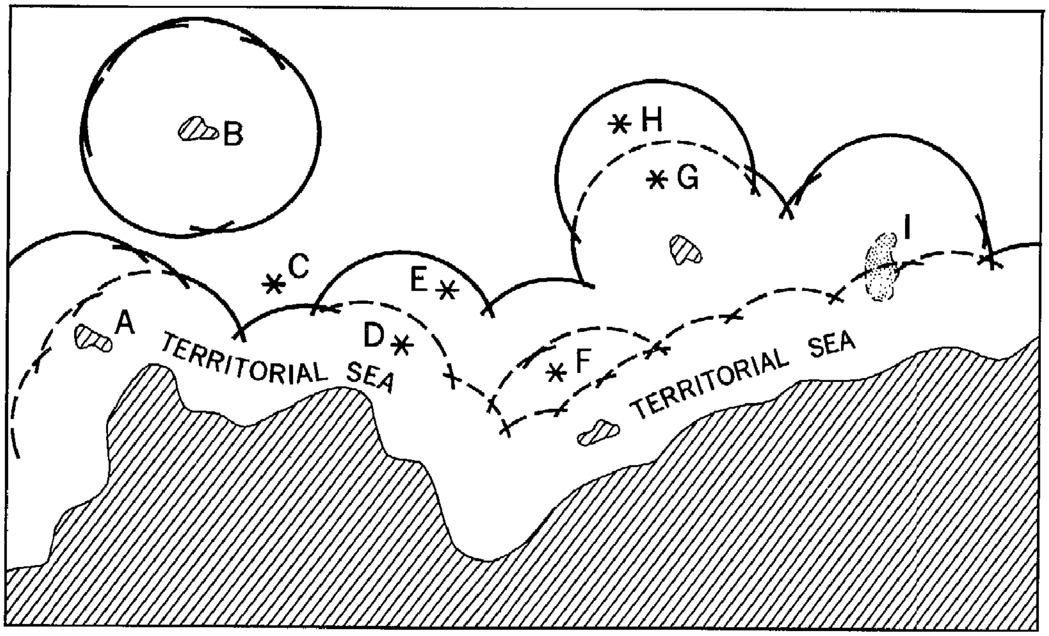


FIGURE 93.—Application of the "envelope line" to a composite coastal area to illustrate the delimitation of the territorial sea under various geographic situations.

At *D* is a low-tide elevation within the main territorial sea. In this situation, the low-tide elevation will generate a territorial sea of its own to produce the bulge shown in the figure. This also applies to low-tide elevations situated within the territorial sea of an island.

At *E* is a low-tide elevation outside the main territorial sea but within the territorial sea generated by a low-tide elevation. Such elevation generates no new territorial sea and the situation remains as though the outer elevation did not exist.[45]

At *F* is a low-tide elevation within the territorial sea generated by an island situated within the main territorial sea. Such elevation generates a new territorial sea, in the same manner as the case of an island situated outside the main territorial sea (*see G*).[46]

At *G* is a low-tide elevation situated within the territorial sea generated by an island that lies outside the main territorial sea. Such elevation generates a new territorial sea. If this elevation were outside the territorial sea of the island, for example at *H*, no change would be effected and the situation would remain as though the elevation did not exist.

At *I* is the situation of a low-tide elevation partly within and partly without the main

45. This follows from par. 2 of Art. 11 of the Convention on the Territorial Sea and the Contiguous Zone (*see* Volume One, Appendix I), which states that where a low-tide elevation is "at a distance exceeding the breadth of the territorial sea *from the mainland or an island*, it has no territorial sea of its own." (Emphasis added.)

46. This follows from the fact that no distinction is made in the convention (*see* note 45 *supra*) between an island lying within and an island lying without the territorial sea. Therefore, the rules applicable to the mainland would be applicable to all islands.

territorial sea. In such case, Article 11 of the Convention on the Territorial Sea (*see* note 45 *supra*) provides that "the low-water line on that elevation may be used as the baseline for measuring the breadth of the territorial sea." The effect of this is to generate a new territorial sea using the portion of the low-tide elevation outside the main territorial sea for generating the new territorial sea.[47]

### B. DELIMITATION OF THE CONTIGUOUS ZONE

The contiguous zone in international law is an area of the high seas, outside and adjacent to the territorial sea of a country. The zone may not extend beyond 12 miles from the *baseline* from which the breadth of the territorial sea is measured (*see* Volume One, Part 3, 2215).

In the 1958 Convention on the Territorial Sea and the Contiguous Zone (*see* Volume One, Appendix I), no specific provision is made for the method of delimiting the exterior limits of the contiguous zone. But inasmuch as the measurement is made from the baseline, there is no reason why the same method that the convention provides for drawing the outer limits of the territorial sea should not be used for the contiguous zone, that is, by the use of an envelope line. All the reasons advanced for the use of this method in the first case is equally applicable to the second case (*see* A, above).

### C. DELIMITATION OF THE CONTINENTAL SHELF

The 1958 Geneva Convention on the Continental Shelf defines the continental shelf as the seabed and subsoil of the submarine areas adjacent to the coast to a depth of 200 meters (approximately 100 fathoms) (*see* Volume One, Part 3, 2221). Therefore, the delimitation of the exterior boundaries of the shelf requires no geometric construction, but is determined by the charted location of the 100-fathom, or 200-meter, depth contour on world nautical charts. For the coasts of the United States, the shelf has been surveyed and charted by the Coast and Geodetic Survey and is continuously delineated on its series of General charts (approximate scale of 1:400,000 for the Atlantic and Gulf coasts and 1:200,000 for the Pacific coast).

### D. SEAWARD BOUNDARIES UNDER SUBMERGED LANDS ACT

Another category of exterior boundaries is the "seaward boundaries" of the states under the Submerged Lands Act of 1953 (67 Stat. 29). This act established titles in the states to lands beneath navigable waters within state boundaries. For Atlantic and Pacific coast states the titles extend seaward 3 geographic miles

47. For a comment on this treatment, *see* Volume One, Part 3, 2211 D(*c*) note 48.

from the "coast line" of each state.[48] For the Gulf coast states, the act sets a possible maximum of 3 marine leagues (9 geographic miles) from the "coast line" of each state, provided a state can meet certain tests as to the preexistence of a boundary in excess of 3 miles (*see* Volume One, Part 2, 1541). In considering these boundary provisions, the Supreme Court found that only Texas and Florida met these tests and decreed a 3-league boundary for Texas and for the west coast of Florida, but limited the States of Louisiana, Mississippi, and Alabama to boundaries of 3 geographic miles from their coasts, for purposes of the Submerged Lands Act.[49] In either case, the seaward boundaries would be measured from the respective "coast lines" (wherever they may be) in the same manner and by the same method as is used for delimitation of the territorial sea (*see* A, above).[50]

Before the seaward boundaries of the states can be delimited, the important question of the location of the "coast line" under the Submerged Lands Act will have to be settled—by agreement or by adjudication. Thus far, no judicial proceeding has been instituted for the adjudication of this aspect of the boundary problems, insofar as the Gulf states are concerned. However, in March 1963, the United States filed a motion for leave to file a supplemental complaint, or an original complaint, against the State of California, for the purpose of determining what constitutes the "coast line" of California, under the Submerged Lands Act. In the proceeding, the Government seeks to utilize, to the extent

48. Sec. 2(c) of the act defines "coast line" as "the line of ordinary low water along that portion of the coast which is in direct contact with the open sea and the line marking the seaward limit of inland waters" (*see* Volume One, Appendix G).

49. *United States* v. *Louisiana et al.*, 363 U.S. 1, 64, 79, 81, 82 (1960); *United States* v. *Florida*, 363 U.S. 121, 129 (1960). The Court held the purposes of the act to be purely domestic and saw no irreconcilable conflict between the national 3-mile boundary and the fixing of the seaward boundaries of some states in excess of 3 miles. It noted that a nation may extend its national authority into the adjacent sea to varying distances from its seacoasts and for various purposes—for example, for customs control, for enforcing sanitary regulations, and for defense, such practices being recognized in international law. "A nation," the Court said, "which purports to exercise any rights to a given distance in the sea may be said to have a maritime boundary at that distance." *Id.* at 34. For a discussion of departures by the United States from the 3-mile limit, *see* Volume One, Part 1, 3211. In the 88th Cong., 1st sess., S. 1109 was introduced on Mar. 15, 1963, to amend the Submerged Lands Act so as to establish the seaward boundaries of Alabama, Mississippi, and Louisiana as extending 3 marine leagues into the Gulf of Mexico and providing for the ownership and use of the submerged lands within such boundaries, to be effective as of May 22, 1953. Thus far (Mar. 1964), the bill has not been acted on. A number of similar bills were also introduced in the House during this session but without any further action.

50. The question as to what constitutes the "coast lines" of the states, under the Submerged Lands Act, was not reached by the Court in *United States* v. *Louisiana et al., supra* note 49, nor was it put in issue. The sole question there was how far into the Gulf do the seaward boundaries of the states extend. After determining this, the Court specifically noted: "We do not intend, however, in passing on these motions, to settle the location of the coastline of Louisiana or that of any other State." *Id.* at 67 n. 108.

applicable, the findings of the Special Master in *United States* v. *California,* 332 U.S. 19 (1947), on the ground that the present dispute involves the same legal and factual issues that were considered by the Special Master.[51] In that case, the matter to be adjudicated was the federal-state boundary, which the Supreme Court held to be the ordinary low-water mark and the seaward limits of inland waters. The basic question involved was where to draw the line that defines the seaward limits of the inland waters along the California coast. The Special Master found the channels and other water areas between the mainland and the offshore islands along the southern California coast not to be inland waters, and that no one of the seven coastal segments recommended for immediate adjudication was a bay constituting inland waters (*see* Volume One, Part 1, 71).[52] Under the Submerged Lands Act, the federal-state boundary has been moved 3 geographic miles seaward from the "coast line" as defined in the act. This definition is strikingly similar to the phraseology used by the Supreme Court in *United States* v. *California, supra,* to describe the line from which federal paramount rights are to be measured. The legislative history of the act seems to indicate that the term "coast line" was understood to be the same as the baseline from which the territorial sea is measured. Therefore, as of the date of the act (May 22, 1953), the inland waters along the California coast comprised what was then the position of the United States in its international relations. (*See* Volume One, Part 2, 1611, 1612.)[53]

### 1432. *Lateral Boundaries*

Besides the exterior boundaries described above, other high seas boundaries are involved in delimiting the boundaries through the territoral sea and the

51. Motion for Leave to File Supplemental Complaint or Original Complaint, 7–8, United States v. California, Sup. Ct. No. 5, Original, Oct. Term, 1962. On Dec. 2, 1963, the motion of the United States was granted by the Supreme Court and the motion of California to dismiss the Government's complaint was denied. California was allowed 60 days to answer the complaint, and both parties were allowed 60 days to file additional exceptions to the Special Master's Report, together with briefs in support of the exceptions. *United States* v. *California,* 375 U.S. 927 (1963).

52. The seven segments constituted the following: Crescent City Bay, Monterey Bay, San Luis Obispo Bay, Point Conception to Point Hueneme, Santa Monica Bay, San Pedro Bay, and Area east of San Pedro Bay. These were considered as representative of physiographic conditions along the entire California coast (*see* Volume One, Part 1, 2111).

53. There is now pending (Apr. 1964) in the United States District Court for the District of Alaska an action by the United States against the State of Alaska for the purpose of confirming title of the United States to certain submerged lands in Yakutat Bay (Civil Action No. A–51–63). The bay is approximately 17 geographic miles wide at its entrance points, that is, Point Manby to Ocean Cape (*see* chart 8455).

continental shelf between contiguous States or between States opposite each other. These are termed lateral boundaries. In delimiting such boundaries, the objective is to apportion the sea area in such manner as will be equitable to both States. The Geneva Conference on the Law of the Sea adopted the principle of equidistance as the guiding rule in the delimitation of boundaries through the territorial sea and the continental shelf. The basis for the rule and the method of constructing a boundary line between adjacent coastal nations and nations with coasts opposite each other are discussed in detail and illustrated in Volume One, Part 3, 2212, 2224.[54]

### 1433. *Status of Conventions on the Law of the Sea*

As of March 9, 1964, the various conventions adopted at Geneva in 1958 had been ratified or acceded to by the following countries:[55]

*Convention on the Territorial Sea and the Contiguous Zone.*—Australia, Bulgaria, Byelorussia, Cambodia, Czechoslovakia, Haiti, Hungary, Israel, Madagascar, Malaysia, Nigeria, Portugal, Rumania, Senegal, Sierra Leone, Ukraine, South Africa, U.S.S.R., United Kingdom, United States, and Venezuela. (*21 nations.*)

This brings in issue the question whether the seaward limit of inland waters in the bay is at this line (the state's contention), or whether it is at a line within the bay where the width is 10 geographic miles (the Government's contention). The United States position is predicated on the fact that prior to the admission of Alaska as a state on Jan. 3, 1959, the United States was the owner of all the submerged lands of the Territory of Alaska from the line of mean high tide seaward to the edge of the continental shelf; that Alaska, upon its admission into the Union, received, by virtue of its sovereignty, title to the tidelands along its coast to the line of mean low water and title to the lands underneath the waters of bays out to the point where the bays do not exceed 10 geographic miles in width, the position taken by the United States in its international relations prior to Mar. 24, 1961 (*see* note 55 *infra* and Volume One, Part 3, 2218(*b*)); and that under the Submerged Lands Act, which became effective on May 22, 1953, Alaska received title to the submerged lands underlying a 3-mile belt of territorial waters immediately seaward of the tidelands and the submerged lands acquired by virtue of its sovereignty. Since the United States, on Mar. 24, 1961, ratified the Convention on the Territorial Sea and the Contiguous Zone, which was adopted at the First Law of the Sea Conference at Geneva in 1958, and since that convention provides for a 24-mile closing line for bays (*see* Volume One, Part 3, 2211 C(*c*)), the question is raised as to the effect of this ratification on the scope of the Submerged Lands Act, insofar as inland waters are concerned. As of Mar. 9, 1964, 21 nations had ratified the convention out of a necessary 22 required to bring it into force (*see* 1433). On Aug. 19, 1964, the district court entered judgment for the United States.

54. The principle being geometric in nature is applicable to the delimitation of the lateral boundaries between the states under the Submerged Lands Act (*see* Volume One, Part 2, 1622).

55. Information furnished by the United Nations Secretariat at New York, Mar. 9, 1964. The conventions enter into force on the thirtieth day following the deposit of the twenty-second instrument of ratification or accession with the Secretary-General of the United Nations. Thus far, the Convention on the High Seas is the only one of the four conventions that is presently operative, having entered into force on Sept. 30, 1962. The Optional Protocol of Signature became operative on the same date for those countries having ratified the Protocol or having signed it without reservation as to ratification and as to matters arising under an operative convention (*see* Volume One, Appendix I). The four conventions were ratified by the President of the United States on Mar. 24, 1961. 44 DEPT. STATE BULLETIN 609 (1961). The ratification of the United States was deposited with the Secretary-General of the United Nations on Apr. 12, 1961, and the Convention on the High Seas was proclaimed by the President of the United States on Nov. 9, 1962. *Treaties and Other International Acts Series 5200*, DEPARTMENT OF STATE (1963). For pertinent events leading up to ratification, *see* Volume One, Part 3, 2271.

*Convention on the Continental Shelf.*—Australia, Bulgaria, Byelorussia, Cambodia, Colombia, Czechoslovakia, Denmark, Guatemala, Haiti, Israel, Madagascar, Malaysia, Poland, Portugal, Rumania, Senegal, Ukraine, South Africa, U.S.S.R., United Kingdom (*Washington Post*, May 14, 1964), United States, and Venezuela. (*22 nations.*)

*Convention on the High Seas.*—Afghanistan, Australia, Bulgaria, Byelorussia, Cambodia, Central African Republic, Czechoslovakia, Guatemala, Haiti, Hungary, Indonesia, Israel, Madagascar, Malaysia, Nepal, Nigeria, Poland, Portugal, Rumania, Senegal, Sierra Leone, Ukraine, South Africa, U.S.S.R., United Kingdom, United States, and Venezuela. (*27 nations.*)

*Convention on Fishing and Conservation of the Living Resources of the High Seas.*—Australia, Cambodia, Colombia, Haiti, Madagascar, Malaysia, Nigeria, Portugal, Senegal, Sierra Leone, South Africa, United Kingdom, United States, and Venezuela. (*14 nations.*)

*Optional Protocol of Signature Concerning the Compulsory Settlement of Disputes.*—Austria, Haiti, Madagascar, Malaysia, Nepal, Portugal, Sierra Leone, and United Kingdom. (*8 nations.*)

## 1434. *Lines of Allocation*

Since the high seas are *res communis* (the property of all) and incapable of appropriation by any nation, no boundary problems arise except in the portions covered by the contiguous zone and by the continental shelf (*see* 1431). Lines of allocation are, however, sometimes delimited through the high seas for the purpose of allocating lands without conveying sovereignty over the waters. Such lines are not true boundaries because they do not affect the waters of the high seas, at least insofar as the rights of countries not signatory to such arrangement are concerned, but represent a dividing line for the inclusion or exclusion of certain land and island areas under a particular agreement. The charted line in the Bering Sea and Bering Strait between Russia and the United States is a case in point (*see* charts 9302 and 9400).

(*a*) *United States—Russian Convention Line.*—By the Convention of March 30, 1867, between Russia and the United States (proclaimed June 20, 1867 (15 Stat. 539)), Russia ceded Alaska to the United States. The ceded area, insofar as the western limit is concerned, is described as follows:

> The western limit within which the territories and dominion conveyed, are contained, passes through a point in Behring's straits on the parallel of sixty-five degrees thirty minutes north latitude, at its intersection by the meridian which passes midway between the islands of Krusenstern, or Ignalook [Little Diomede], and the island of Ratmanoff, or Noonarbook [Big Diomede], and proceeds due north, without limitation, into the same Frozen ocean. The same western limit, beginning at the same initial point, proceeds thence in a course nearly southwest through Behring's straits and Behring's sea, so as to pass midway between the northwest point of the island of St. Lawrence and the southeast point of Cape Choukotski, to the meridian of one hundred and seventy-two west longitude; thence, from the intersection of that meridian, in a southwesterly direction, so as to pass midway between the island of Attou and the Copper island of the Kormandorski couplet or group in the North Pacific ocean, to the meridian of one hundred and ninety-three degrees west longitude, so as to include in the territory conveyed the whole of the Aleutian islands east of that meridian.

After the acquisition of Alaska by the United States, Congress passed several statutes regulating seal fisheries in the Bering Sea, but none of these contained any definition of the area within which the regulations were enforceable. Nevertheless, the statutes were construed by the Executive Branch of the Government as applying to the Bering Sea beyond the 3-mile limit, on the basis that this jurisdiction was asserted by Russia for more than 90 years and jurisdiction over the waters east of the cession boundary was transferred to the United States by the Convention of 1867.

The Supreme Court of the United States upheld these interpretations in the case of *In Re Cooper,* 143 U.S. 472 (1892),[56] on the ground that the Court was bound by the actions of the Executive Branch in its interpretation of the Convention of 1867 and of the laws of Congress enacted on the basis of what the United States acquired by the treaty.

Following the decision of *In Re Cooper,* Great Britain protested these seizures and after a series of diplomatic exchanges between the two governments, the matter was submitted to arbitration, commonly known as the Bering Sea Fur Seal Arbitration. In the oral argument for the United States, the position taken in *In Re Cooper* was disavowed and the tribunal advised that the United States did not assert a territorial claim to the waters of the Bering Sea beyond the 3-mile limit.[57]

The line shown on charts 9302 and 9400 through Bering Strait and Bering Sea is therefore no more than a line of allocation of territory and carries with it no extraterritorial rights in the high seas.[58]

## 1435. *Limits of Oceans and Seas*

The water areas of the world are divided into the major oceanic basins and the lesser subdivisions, comprising seas, gulfs, and bays.[59] Except for the

56. The case involved the arrest of a British schooner, engaged in seal fishing in the waters of the Bering Sea 59 miles from land, for violating the laws of the United States which prohibited the killing of fur seals in the waters of the Alaska Territory.

57. *12 Fur Seal Arbitration 107–110, Proceedings of the Tribunal at Paris, 1893.* The issue submitted to the tribunal by agreement of the parties was "what right of protection or property" the United States had "in the fur seals frequenting the islands of the United States in Behring Sea when such seals are found outside the ordinary three-mile limit?" A majority of the tribunal answered that it had no right of protection or property.

58. On July 7, 1911, the United States, Great Britain, Russia, and Japan entered into a treaty prohibiting the killing, taking, and hunting of seals within the Pacific Ocean north of 30° north latitude, including the seas of Bering, Kamchatka, Okhotsk, and Japan. The seals may only be captured on land by the littoral States concerned. U.S. Treaty Series No. 2 (1912). For later developments regarding their multilateral treaty during and following World War II, *see* Colombos, International Law of the Sea 357–358 (1959).

59. The water area (including all oceans and adjacent seas) has been calculated to be 70.8 percent of the surface, leaving 29.2 percent as the land area. However, the amount of land in the Northern

oceans, there are no exact criteria for defining the secondary features. The result is that a geographic configuration in one locality may be termed a "gulf" and in another locality a similar configuration may be termed a "sea"—witness, for example, the Gulf of Siam and the Adriatic Sea. In many cases, the nomenclature represents long, historic usage which has not been deemed advisable to disturb. Sverdrup notes the indiscriminate use of the term "sea" and cites as examples its use in connection with inland salt lakes, such as the Caspian Sea; with relatively isolated bodies of the ocean, such as the Mediterranean Sea; with less isolated areas, such as the Caribbean Sea; and even for some areas with no land boundaries, such as the Sargasso Sea in the western North Atlantic.[60]

### A. DELIMITATION BY INTERNATIONAL HYDROGRAPHIC BUREAU

In 1953, the International Hydrographic Bureau (IHB) published the third edition of a publication entitled "Limits of Oceans and Seas." [61] The publication consists of text material in which the proposed limits of oceans and seas and certain gulfs, bays, and straits are described and shown on three accompanying diagrams. The publication states that the limits have no political significance and are not to be regarded as representing the result of full geographic study, but have been drawn up solely for the convenience of National Hydrographic Offices when compiling their *Sailing Directions, Notices to Mariners,* etc., so as to ensure that all such publications headed with the name of an ocean or sea will deal with the same area. The bathymetric results of various oceanographic expeditions were however taken into consideration as far as possible.

The limits given for the oceans exclude the seas lying within each of them.

Hemisphere is more than twice that in the Southern Hemisphere, and the water covers only 60.7 percent of the former and 80.9 percent of the latter. SVERDRUP, JOHNSON, AND FLEMING, THE OCEANS 13 and Tables 3 and 4 (1942).

60. *Id.* at 12. In its usual geographic sense, an *ocean* is any one of the greater tracts of water that cover the globe, such as the Atlantic Ocean. The term "seven seas" has been applied figuratively to all the waters or oceans of the world, but generally it is applied to the seven oceans—Arctic, Antarctic (*see* note 62 *infra*), North Atlantic, South Atlantic, North Pacific, South Pacific, and Indian. *Sea* is defined as a large or considerable body of oceanic water partly or almost entirely enclosed by land, as, for example, the Bering Sea and the Mediterranean Sea. *Gulf* is defined as the tract of water within an indentation or curve of the coastline, in size between a bay and a sea—the Gulf of California, for example. A *bay* (in the general sense) is defined as an indentation of the coast, a subordinate adjunct to a larger body of water—Chesapeake Bay, for example. In the context of international law, a bay is defined much more specifically (*see* Appendix A).

61. LIMITS OF OCEANS AND SEAS, SPECIAL PUBLICATION NO. 23, INTERNATIONAL HYDROGRAPHIC BUREAU (1953). This edition of the publication was drawn up and approved by the 1952 International Conference which took into account proposals made at various hydrographic conferences up to and including the 1952 conference, and by certain scientific institutions, including the report of a sub-committee of the Association of Physical Oceanography on "The Criteria and Nomenclature of the Major Divisions of the Ocean Bottom," issued in 1940.

The boundary line between the North Atlantic and South Atlantic Oceans and the North Pacific and South Pacific Oceans is the equator. The southern boundary line between the South Atlantic and South Pacific Oceans is the meridian of Cape Horn (60°04′ W.).[62]

### B. THE WESTERN HEMISPHERE

Figure 94 is a portion (on a reduced scale) of one of the diagrams accompanying the IHB publication to show the limits of the oceans and the seas of the Western Hemisphere. The numbering of the areas follows the numbering in the publication. The diagram is on the Mercator projection and meridians and parallels or rhumb lines were used as far as possible for the limits. The descriptions follow those in the publication but in a modified form. The bodies of water are numbered from (1) to (66) inclusive, but only selected bodies are given below:

(12) *Chuckchi Sea.*—Bounded on the west by the eastern limit of the East Siberian Sea (11); on the north by a line from Point Barrow (71°20′ N., 156°20′ W.), Alaska, to the northernmost point of Wrangel Island (179°30′ W.); and on the south by the Arctic Circle between Siberia and Alaska.

(13) *Beaufort Sea.*—Bounded on the north by a line from Point Barrow, Alaska, to Lands End (76°16′ N., 124°08′ W.), Prince Patrick Island; and on the east from Lands End through the southwest coast of Prince Patrick Island to Griffiths Point, thence a line to Cape Prince Alfred, the northwestern extremity of Banks Island, through its west coast to Cape Kellet, the southwestern point, and thence by a line to Cape Bathurst (70°36′ N., 127°32′ W.) on the mainland.

(14) *The Northwest Passages.—See* figure 94.

(14 A) *Baffin Bay.*—Bounded on the north by a line from Cape Sheridan (82°35′ N., 60°45′ W.), Grant Land, to Cape Bryant, Greenland; on the east by the west coast of Greenland; on the south by the parallel of 70° N. between Greenland and Baffin Land; and on the west by the eastern limits of the Northwest Passages (14).

(15) *Davis Strait.*—Bounded on the north by the southern limit of Baffin Bay (14 A); on the east by the southwest coast of Greenland; on the south by the parallel of 60° N. between Greenland and Labrador; and on the west by the eastern limit of the Northwest Passages (14) south of 70° N. and of Hudson Strait (16 A).

(15 A) *Labrador Sea.*—Bounded on the north by the south limit of Davis Strait (15); on the east by a line from Cape St. Francis (47°45′ N., 52°27′ W.), Newfoundland, to Cape Farewell, Greenland; and on the west by the east coast of Labrador and Newfoundland and the northeast limit of the Gulf of St. Lawrence (24).

(16) *Hudson Bay.*—Bounded on the north by a line from Nuvuk Point (62°21′ N., 78°06′ W.) to Leyson Point, the southeastern extremity of Southampton Island, through the

62. The Antarctic or Southern Ocean has been omitted from the publication because the majority of opinions received by the IHB since the issue of the second edition in 1937 were to the effect that there exists no real justification for applying the term "ocean" to this body of water, the northern limits of which are difficult to lay down owing to their seasonal change. The limits of the Atlantic, Pacific, and Indian Oceans have therefore been extended south to the Antarctic Continent. Hydrographic Offices who issue separate publications dealing with this area are left to decide the northern limits for themselves (Great Britain uses latitude 55°S.). *Id.* at 4.

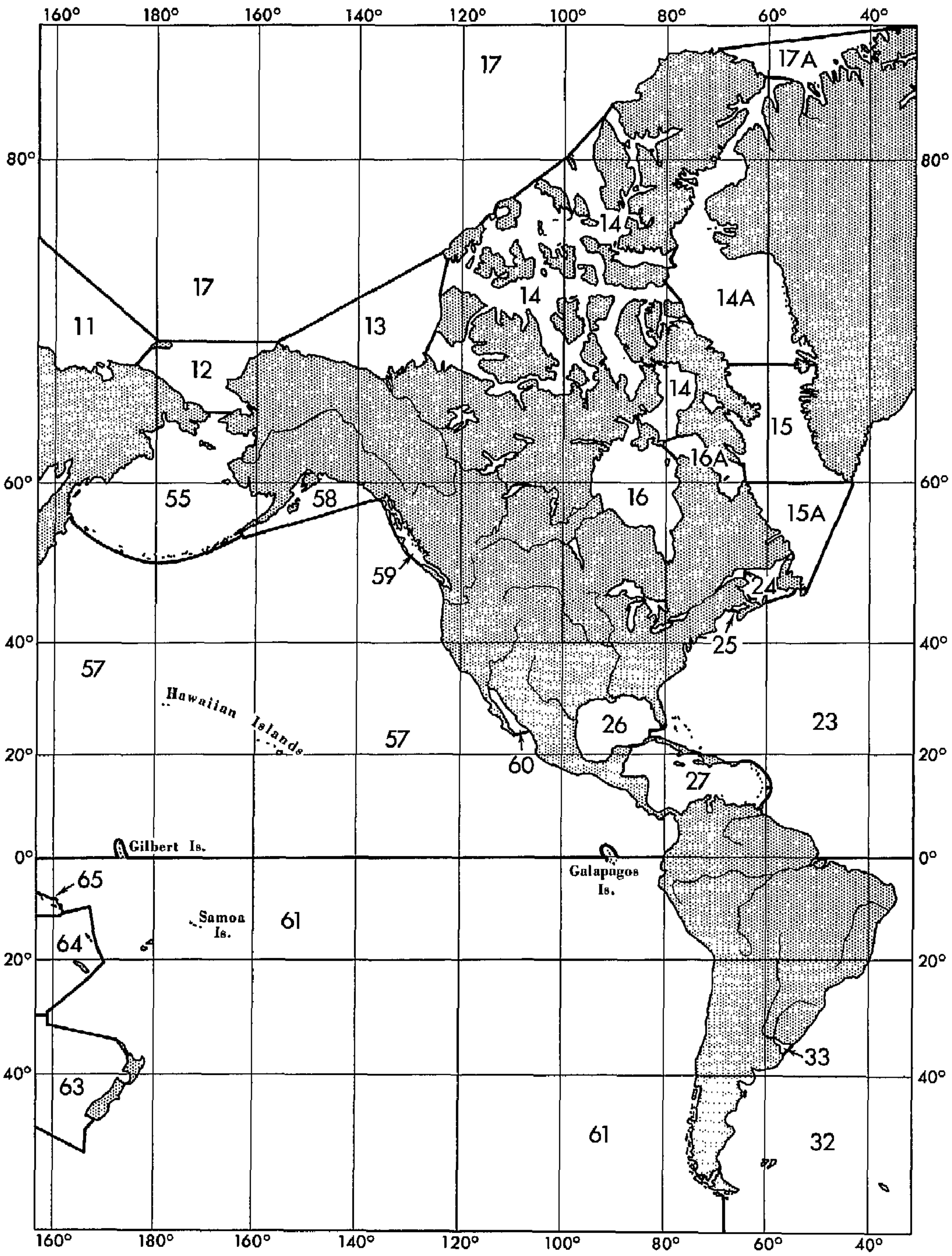


FIGURE 94.—Limits of oceans and seas of the Western Hemisphere. (*After Special Publication No. 23, International Hydrographic Bureau.*)

southern and western shores of Southampton Island to its northern extremity, thence by a line to Beach Point (66°03′ N., 86°06′ W.) on the mainland.

(16 A) *Hudson Strait.*—Bounded on the west by a line from Nuvuk Point to Leyson Point, thence by the eastern shore of Southampton Island to Seahorse Point, its eastern extremity, thence by a line to Lloyd Point (64°25′ N., 78°07′ W.) on Baffin Island; on the north by the south coast of Baffin Island between Lloyd Point and East Bluff; on the east by a line from East Bluff, the southeast extremity of Baffin Island (61°53′ N., 65°57′ W.), to Point Meridian, the western extremity of Lower Savage Islands, along the coast to its southwestern extremity and thence by a line across to the western extremity of Resolution Island, through its southwestern shore to Hatton Headland, its southern point, thence by a line to Cape Chidley (60°24′ N., 64°26′ W.), Labrador; and on the south by the mainland between Cape Chidley and Nuvuk Point.

(17) *Arctic Ocean.*—*See* figure 94.

(17A) *Lincoln Sea.*—Bounded on the north by a line from Cape Columbia to Cape Morris Jesup, Greenland; and on the south by a line from Cape Columbia through the northeastern shore of Ellesmere Island to Cape Sheridan to Cape Bryant, Greenland and through Greenland to Cape Morris Jesup.

(23) *North Atlantic Ocean.*—Bounded on the west by the eastern limits of the Caribbean Sea (27), the southeastern limits of the Gulf of Mexico (26) from the north coast of Cuba to Key West, the southwestern limit of the Bay of Fundy (25), the southeastern limit of the Gulf of St. Lawrence (24), and the eastern limit of the Labrador Sea (15 A),[63] the southeastern coast of Greenland from Cape Farewell to Cape Nansen; on the north by the southwestern limit of the Greenland Sea and the Norwegian Sea from Greenland to the Shetland Islands; on the east from the northwestern limit of the North Sea, the northern and western limits of the Scottish Seas, the southern limit of the Irish Sea, the western limits of the Bristol and English Channels, of the Bay of Biscay, and of the Mediterranean Sea; and on the south by the equator, from the coast of Brazil to the southwestern limit of the Gulf of Guinea.

(24) *Gulf of St. Lawrence.*—Bounded on the northeast by a line running from Cape Bauld (north point of Kirpon Island, 51°40′ N., 55°25′ W.) to the eastern extremity of Belle Isle and on to the Northeast Ledge (52°02′ N., 55°15′ W.), thence by a line joining this ledge with the eastern extremity of Cape St. Charles (52°13′ N.) in Labrador; on the southeast by a line from Cape Canso (45°20′ N., 61° W.) to Red Point (45°35′ N., 60°45′ W.) in Cape Breton Island, through this island to Cape Breton and on to Pointe Blanche (46°45′ N., 56°11′ W.) in the island of St. Pierre, and thence to the southwest point of Morgan Island (46°51′ N., 55°49′ W.); and on the west by the meridian of 64°30′ W., but the whole of Anticosti Island is included in the Gulf.

(25) *Bay of Fundy.*—Bounded on the southwest by a line running northwesterly from Cape St. Mary (44°05′ N.), Nova Scotia, through Machias Seal Island (67°06′ W.) and on to Little River Head (44°39′ N.) in the State of Maine.

(26) *Gulf of Mexico.*—Bounded on the southeast by a line joining Cape Catoche Light (21°37′ N., 87°04′ W.) with the light on Cape San Antonio in Cuba, through this island to the meridian of 83° W. and to the northward along this meridian to the latitude of the south point of the Dry Tortugas (24°35′ N.), along this parallel eastward to Rebecca Shoal (82°35′ W.), thence through the shoals and Florida Keys to the mainland at the eastern end of Florida Bay, all the narrow waters between the Dry Tortugas and the mainland being considered to be within the Gulf.

63. The IHB text includes the Labrador Sea within the limits of the North Atlantic Ocean, but this is contrary to the explanation given at the beginning of the publication that the limits given for the oceans "exclude the seas lying within each of them." The text has therefore been modified accordingly.

(27) *Caribbean Sea.*—Bounded in the Yucatan Channel by the same limit as that described for the Gulf of Mexico (26); on the north, in the Windward Channel, by a line joining Caleta Point (74°15′ W.) and Pearl Point (19°40′ N.) in Haiti, and in the Mona Passage by a line joining Cape Engano and the extremity of Agujereada (18°31′ N., 67°08′ W.) in Puerto Rico; and on the east by a line from Point San Diego, Puerto Rico, northward along the meridian thereof (65°39′ W.) to the 100-fathom depth curve, thence eastward and southward in such a manner that all islands, shoals, and narrow waters of the Lesser Antilles are included in the Caribbean Sea as far as Galera Point (northeast extremity of the island of Trinidad), thence through Trinidad to the southeast extremity of Galeota Point, and thence to Baja Point (9°32′ N., 61° W.) in Venezuela.

(32) *South Atlantic Ocean.*—Bounded on the southwest by the meridian of Cape Horn (68°04′ W.) from Tierra del Fuego to the Antarctic Continent, and by a line from Cape Virgins (52°21′ S., 68°21′ W.) to Cape Espiritu Santo, Tierra del Fuego, the eastern entrance to Magellan Strait; on the west by the limit of the Rio de La Plata (33); on the north by the southern limit of the North Atlantic Ocean (23); on the northeast by the limit of the Gulf of Guinea; on the southeast by a line from Cape Agulhas along the meridian of 20° E. to the Antarctic Continent; and on the south by the Antarctic Continent.

(33) *Rio de La Plata.*—Bounded to the eastward by a line joining Punta del Este (34°58′.5 S., 54°57′.5 W.), Uruguay, and Cabo San Antonio (36°18′ S., 56°46′ W.), Argentina.

(55) *Bering Sea.*—Bounded on the north by the southern limit of the Chuckchi Sea (12); and on the south by a line running from Kabuch Point (54°48′ N., 163°21′ W.) in the Alaskan Peninsula, through the Aleutian Islands to the southern extremities of the Komandorski Islands and on to Cape Kamchatka in such a way that all the narrow waters between Alaska and Kamchatka are included in the Bering Sea.

(57) *North Pacific Ocean.*—Bounded on the southwest by the northeastern limit of the East Indian Archipelago from the equator to Morotai Island;[64] on the west and northwest by the eastern limits of the Philippine Sea and the Japan Sea and the southeastern limit of the Sea of Okhotsk; on the north by the southern limits of the Bering Sea (55) and the Gulf of Alaska (58); on the east by the western limit of the coastal waters of Southeast Alaska and British Columbia (59), and the southern limit of the Gulf of California (60); and on the south by the equator, but excluding those islands of the Gilbert and Galapagos groups which lie to the northward thereof.

(58) *Gulf of Alaska.*—Bounded on the north by the coast of Alaska; and on the south by a line drawn from Cape Spencer, the northern limit of (59) to Kabuch Point, the southeast limit of (55), in such a way that all the adjacent islands are included in the Gulf of Alaska.

(59) *The Coastal Waters of Southeast Alaska and British Columbia.*—Bounded on the southwest by a line running from the northwestern extremity of Cape Flattery to Tatoosh Island (48°23′ N.), and thence to the southern extremity of Bonilla Point (124°42′ W.) in Vancouver Island; and on the west by a line running westerly from Black Rock Point (50°44′.5 N.) in Vancouver Island through the Scott Islands in such a way that all the narrow waters between these islands are included in the coastal waters, thence to Cape St. James (the southern extremity of the Queen Charlotte Islands), through this group in the same way, then from Cape Knox (54°10′ N., 133°06′ W.) northward to the western extremity of Langara Island and on to Point Cornwallis (132°52′ W.) in the Prince of Wales group, thence along the western shores of this group, of Baranof, Kruzof, Chichagof, and Yakobi Islands, so that all the narrow waters between them are included in the coastal

64. The IHB text gives this as "Luzon Island," but this is obviously an error since it does not conform to the boundary line shown on the diagram accompanying the IHB publication (*see* text following note 61 *supra*).

waters, and, finally, from Cape Bingham (58°04′ N.) in Yakobi Island to Cape Spencer (58°12′ N., 136°39′ W.).

(60) *Gulf of California.*—Bounded on the south by a line joining Piastla Point (23°38′ N.) in Mexico, and the southern extremity of Lower California.

(61) *South Pacific Ocean.*—Bounded on the west by a line from Southeast Cape, the southern point of Tasmania, down the meridian of 146°55′ E. to the Antarctic Continent; on the northeast and northwest by the southern, eastern, and northeastern limits of the Tasman Sea (63), the southeastern, eastern, and northern limits of the Coral Sea (64), the northeastern limits of the Solomon Sea (65) and the Bismarck Sea, along the northern coast of New Guinea to its western extremity, and along the northeastern limit of the East Indian Archipelago from New Guinea to the equator;[65] on the north by the equator, but including those islands of the Gilbert and Galapagos groups which lie to the northward thereof; on the east by the meridian of Cape Horn (68°04′ W.) from Tierra del Fuego to the Antarctic Continent, and a line from Cape Virgins (52°21′ S., 68°21′ W.) to Cape Espiritu Santo, Tierra del Fuego, the eastern entrance to Magellan Strait; and on the south by the Antarctic Continent.

## 1436. *Administrative Boundary Lines*

High seas boundaries are sometimes established for administrative purposes rather than as a division of sovereignty. In this category would fall the authority that a regulatory or enforcing agency has in establishing boundary lines for purposes of carrying out its functions under a statute of authorization. Such delineations would be limited to the purposes intended. Examples of such boundary lines are the lines established by the United States Coast Guard in the Gulf of Mexico for separating the areas where the International Rules of the Road apply from those where the Inland Rules apply. These lines were established under the Act of February 19, 1895 (28 Stat. 672), and extend in places 10 to 25 miles from shore (*see* fig. 83 and charts 1116 and 1117). Rules of the road boundary lines have been held to have no application other than determining what rules of navigation are to be followed. *United States* v. *Newark Meadows Improvement Co.,* 173 Fed. 426, 428 (1909). For a discussion of the rules—their history, application to nautical charts, and their judicial and administrative interpretation—*see* Part 2, 67 *et seq.*

Another form of administrative boundary line is that used by the Bureau of the Census for measuring the area of the United States for the Sixteenth Census in 1940. Special definitions were adopted for state waters, inland waters, and land area in order to determine the outer limits of the United States (*see* 381).

Thus, from the very nature of the Bureau's accumulated technical data, it has been called upon over the years to render various types of assistance and

65. This is a modification of the IHB text in the interest of clarification and to achieve greater conformity to the boundary line shown on the diagram accompanying the IHB publication (*see* text following note 61 *supra*).

advice in helping to resolve many legal and technical problems arising out of waterfront property disputes. As a preliminary to the consideration more specifically of some of the areas in which Coast Survey records were applied or services utilized, brief discussions will be given of the judicial structure in the United States and the basis for land ownership. The following two chapters deal with these matters.

CHAPTER 2

# Judicial Structure in the United States

## 21. GENERAL STATEMENT

The United States of America constitutes a State in the international sense with internal and external sovereignty. The states which comprise the Union are not nations in the international sense but are, except for the Union, independent of each other. They are political communities, occupying separate territories, and possessing powers of self-government in respect to almost all matters of local concern. Each has its own constitution and laws and its own government.

The American system of government had its roots in the early life of the colonists who brought with them a common English heritage. They developed town and county governments based on the needs of a frontier people. With the passage of time, differences arose between the colonies and the mother country. Seeking unified action, the colonists convened the First Continental Congress in 1774. This constituted the first step toward union. This was followed by the Declaration of Independence, which was signed on July 4, 1776, and the Thirteen Colonies became the Thirteen Original States. Each state thus became completely sovereign. The need for concerted action during the Revolutionary War led to the adoption of the Articles of Confederation and Perpetual Union and these were submitted to the states for ratification in 1777, the last ratification taking place in 1781. Thus was formed the "United States of America." This provided a semblance of national government, but as thus constituted was dependent on the states. There were inherent weaknesses in this arrangement, the most serious of which were the absence of a national executive branch and a national judiciary. Failure to delegate to the Confederation the power to regulate interstate and foreign commerce led to economic wars among the various states,[1] and made a national commercial policy impos-

1. The controversy between Virginia and Maryland over fishing and navigation rights in the Potomac River culminated in the Compact of 1785, by which Maryland, who owned the river, gave Virginia certain fishing rights in return for free passage of Maryland ships through the lower Chesapeake Bay (*see* 342).

sible. It therefore became necessary to "form a more perfect Union" by establishing a constitution which would provide the central authority with adequate powers, and which would clarify the relationship between it and the component states. Such a document was devised by the constitutional convention which met in 1787. On September 28, 1787, Congress submitted the Constitution to the states for ratification, and on March 4, 1789, the Constitution became legally operative [2] and was ordained and established by the people of the United States as the "Constitution for the United States of America."

## 211. The American Constitutional System

One of the most striking features of the American constitutional system is its federal character. This federalism, as it is sometimes called, is defined as the division of political power between a central government, with authority over the entire territory of a nation, and the states, or local governments, which individually include only limited portions of the country, but which collectively cover the entire area. This dual sovereignty between the states and the Federal Government—each within its own sphere of operation—is the basis, as will be seen, for the existing diversity of legal doctrines in the area of waterfront boundaries and related matters. To better understand these doctrines and their impact on the subject matter of this publication, certain background material will be presented touching on the relationship of these two sovereignties in the judicial and legislative fields.

### 2111. *Federal–State Relationship*

Federalism entails a balancing of powers between the national and state governments. To accomplish this the framers of the Constitution devised a plan by which the powers of the National Government were enumerated in rather precise fashion leaving it to be inferred that all remaining powers were reserved to the states.[3] This is the fundamental principle governing the division of powers between the Federal Government and the states. Under this doctrine, the Federal Government is often referred to as one of limited, delegated, and

2. *Owings* v. *Speed,* 5 Wheat. 420 (18 U.S., 1820).

3. This, however, was not long left to inference, for almost immediately the 10th amendment was added to the Constitution, which expressly provides that "The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people." The first 10 amendments, known as the Bill of Rights, were all proposed by Congress on Sept. 25, 1789. They were ratified and adoption certified on Dec. 15, 1791.

enumerated powers, including all those powers that may reasonably be implied from those expressly stated.[4]

A case in point is the power of Congress to control navigation. Actually, the Constitution is silent with respect to navigation as such. But Article I, section 8, clause 3 (known as the commerce clause), gives Congress the power "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes." This was interpreted by the Supreme Court of the United States, in the case of *Gibbons* v. *Ogden,* 9 Wheat. 1 (22 U.S., 1824), to apply to the control and protection of navigation on navigable interstate rivers and other bodies of water as a necessary incident of the power to regulate commerce. (*See* 43.)[5]

There is one important exception to the basic principle that the Federal Government is one of enumerated powers only, and that is in the field of foreign relations. The Supreme Court has held that in conducting its foreign relations the United States is a sovereign nation and must be held to possess with respect to those relations all the powers that other sovereign nations enjoy, and these powers are not limited to those which are delegated to it by the Constitution. The Court has distinguished those powers of the Federal Government in respect of domestic or internal affairs from those in respect of foreign or external affairs, and has said: "In that field [internal affairs], the primary purpose of the Constitution was to carve from the general mass of legislative powers *then possessed by the states* such portions as it was thought desirable to vest in the federal government, leaving those not included in the enumeration still in the states . . . . That this doctrine applies only to powers which the states had, is self evident. And since the states severally never possessed international powers, such powers could not have been carved from the mass of state powers but obviously were transmitted to the United States from some other source."[6]

Governmental powers, in the American federal system, may be classified generally as (1) exclusively national, (2) exclusively state, and (3) concurrent.

4. The classic statement on the scope of the implied powers of Congress is contained in one of the early landmark cases in which the Supreme Court said: " . . . the sound construction of the constitution must allow to the national legislature that discretion, with respect to the means by which the powers it confers are to be carried into execution, which will enable that body to perform the high duties assigned to it, in the manner most beneficial to the people. Let the end be legitimate, let it be within the scope of the constitution, and all means which are appropriate, which are plainly adapted to that end, which are not prohibited, but consist with the letter and spirit of the constitution, are constitutional." *McCulloch* v. *Maryland,* 4 Wheat. 316, 421 (17 U.S. 1819).

5. The Act of Feb. 10, 1807 (2 Stat. 413), which authorized a survey of the coast and set in motion the machinery for the establishment of a federal agency (later to be known as the Coast and Geodetic Survey) to conduct such survey was also an exercise of an implied power growing out of the enumerated power to regulate commerce.

6. *United States* v. *Curtiss-Wright Export Corp.,* 299 U.S. 304, 316 (1936). This doctrine of national external sovereignty was advanced by the Supreme Court as one of the reasons for upholding federal paramount rights in the submerged lands of the marginal belt. *United States* v. *California,* 332 U.S. 19 (1947) (*see* Volume One, Part 1, 112).

The first two fall within the delegated and reserve powers, respectively. The third is an outgrowth of the first—the exclusively national powers. A few matters are exclusively national, not because conferred in terms of exclusion, but because their character is such that they may be exercised by only one authority—for example, in the fields of foreign relations and naturalization. Other matters are exclusively national because granted to the United States and expressly forbidden to the states—for example, the power to declare war. But there are still other national powers that are exercisable by the states in the absence of federal action, or with congressional consent. This is the area of concurrent powers.[7]

What powers of the National Government are of such a nature as to fall within the category of concurrent powers is not always easy of determination. The principle which has been applied is that there is a difference between those powers the exercise of which by the states would be, under any circumstances, inconsistent with the general theory of the Constitution, and those that are not of such a character—the first are outside the area of concurrent jurisdiction, the second are within. The question as to the extent to which national action precludes state action in a particular field is largely one of fact.

Among the more important subjects which have been held to be subject to state control, in the absence of federal legislation, because they lend themselves to local regulation, are pilotage (*see* 43), ferries, bridges, harbor regulations.[8]

### 2112. *Tripartite Systems*

A fundamental principle of the American system, accepted alike in the federal and state governments, is that the exercise of legislative, executive, and judicial powers be vested in separate and independent branches. This tripartite version of government has as its central theme the idea that the same persons or body should not make the laws, enforce them, and pass judgment on persons accused of their violation.

The principle of the separation of powers is not formally set forth or de-

7. Such powers are not concurrent in the sense of equal power with the Nation; they are subordinate to the superior authority and are superseded whenever the power of Congress is exercised. *Southern Ry. Co.* v. *Reid,* 222 U.S. 424 (1912).

8. In *Covington Bridge Co.* v. *Kentucky,* 154 U.S. 204 (1894), the cases are reviewed and summarized. The inspection and regulation of vessels has been held as a permissible field of state action in *Kelly* v. *Washington,* 302 U.S. 1 (1937). And in *Hagan* v. *City of Richmond,* 52 S.E. 385 (1905) (Va.), it was held that the Act of Mar. 3, 1899 (30 Stat. 1121, 1154), relating to removal of obstructions from navigable waters of the United States, did not invest the Secretary of War with exclusive jurisdiction for such removal but with discretionary power only which he might exert or leave to the enforcement of local authorities, citing the Supreme Court of the United States in *County of Mobile* v. *Kimball,* 12 Otto 691 (102 U.S., 1881), which sustained a law of Alabama providing for the improvement of the river, bay, and harbor of Mobile.

fined at any one place in the Constitution. But its equivalent is found in the clauses which provide that "All legislative Powers shall be vested in a Congress of the United States" (Art. I), that "The executive Power shall be vested in a President of the United States of America" (Art. II), and that "The judicial Power of the United States shall be vested in one supreme Court, and in such inferior Courts as the Congress may from time to time ordain and establish" (Art. III).[9]

Strictly speaking, there is no complete separation of powers because the system of checks and balances that has been worked into the Constitution enables each branch to exercise a certain restraint on the other two. The veto power of the President and the power of Congress to override a veto, and the power of the Supreme Court to hold unconstitutional acts of Congress and acts of the President are examples of how this system works in practice.[10]

In the United States, it is the role of the legislature to establish policy in general terms; it is the role of the court to apply that policy to specific situations. A unique characteristic of the American judiciary is the existence side by side of two entirely separate court systems—the federal judiciary and the state judiciaries. This results from the federal system which provides that both national and state governments make and enforce the law. Thus, it is the primary function of the state courts to enforce state law and of the Federal courts to enforce federal law. This multiple sovereignty in the legislative and judicial fields accounts for the lack of uniformity in the laws relating to riparian rights and related matters.[11] This is what makes it difficult to say what the rule is in the United States and why a certain rule is often spoken of as a majority rule, and why it is necessary to distinguish between the rule in the Federal courts and the rule in state courts.

A second characteristic of the judicial structure in the United States, federal and state, is its hierarchical arrangement. At the base are found the trial courts or courts of original jurisdiction with general authority to hear and decide the

9. There is nothing in the Constitution that requires the states to organize their governments along such lines, but all have voluntarily observed this principle.

10. In recent years, in order to meet modern problems in the technological and other fields without sacrificing the fundamental structure, a so-called fourth branch of government has made its appearance—the *administrative* branch. Administrative agencies perform varied activities which often represent a fusion of legislation, execution, administration, and adjudication. They are usually staffed with experts in the respective fields. Under the Administrative Procedure Act of June 11, 1946 (60 Stat. 237 (Part 1)), procedural protections surrounding the administrative process are established as well as the standards of judicial review. RODEE, ANDERSON, AND CHRISTOL, INTRODUCTION TO POLITICAL SCIENCE 486–489 (1957).

11. In *Iowa* v. *Carr,* 191 Fed. 257, 261 (1911), it was stated: "The settled decisions of the courts of a state and its laws . . . determine the title to the beds of navigable streams and the extent of the rights of riparian owners . . . in that state." And in *Barney* v. *Keokuk,* 4 Otto 324, 338 (94 U.S., 1877), the Supreme Court, even more significantly, said: "If they [the states] choose to resign to the riparian proprietor rights which properly belong to them in their sovereign capacity, it is not for others to raise objections."

great mass of cases which arise. These courts hear evidence, ascertain facts, and apply the law.

Above these trial courts are the courts of appeals. These are generally intermediate appellate and final appellate. The theory behind appellate courts is that there should be a uniform interpretation of the law. By providing for an appeal of those cases in which the meaning of law is involved, an authoritative ruling as to the doubtful legal issue can be obtained and thereafter followed by all of the lower courts. Appellate courts function without juries and no new evidence is presented.

## 22. THE FEDERAL JUDICIARY

The federal system of courts has its origin in the Constitution of the United States, which provides, in Article III, section 1, that "The judicial Power of the United States, shall be vested in one supreme Court, and in such inferior Courts as the Congress may from time to time ordain and establish." Like the National Government generally, the federal judicial branch has only delegated and enumerated powers. The Federal courts decide only the types of cases assigned to them by the Constitution. These include cases arising under the Constitution, laws, and treaties of the National Government; admiralty and maritime cases; cases affecting ambassadors, ministers, and consuls; controversies between two or more states; cases in which the United States is a party; controversies between citizens of different states; controversies between a state, or the citizens thereof, and foreign states, citizens, or subjects; controversies between a state and citizens of another state; and controversies between citizens of the same state claiming lands under grants of different states (Art. III, sec. 2, cl. 1). All others remain the responsibility of the state courts. But the Constitution does not require that all of the classes of cases listed be tried exclusively by Federal courts, and Congress may designate types of cases which can be tried either in Federal or state courts or can assign some to the state courts on a concurrent or even exclusive basis.[12]

The provision which gives Federal courts jurisdiction over controversies "between a State and Citizens of another State" was interpreted by the Supreme Court, in the very early case of *Chisholm* v. *Georgia*, 2 Dall. 419 (2 U.S., 1793), to permit states to be sued on the basis that a dispute between a state and an

12. CARR, MORRISON, BERNSTEIN, SNYDER, AMERICAN DEMOCRACY IN THEORY AND PRACTICE 413–414 (1951). Congress has designated exclusive federal jurisdiction over the following cases: all admiralty, maritime, patent, copyright, and bankruptcy cases; all cases of crimes under federal statutes; all civil actions wherein the United States or a state is a party (except cases between a state and its own citizens); and all cases affecting foreign diplomats and consuls.

individual is also a dispute between an individual and a state. But this doctrine was soon overruled by the 11th amendment to the Constitution which provides that "The Judicial power of the United States shall not be construed to extend to any suit . . . against one of the United States by Citizens of another State, or by Citizens or Subjects of any Foreign State." [13]

### 221. District Courts

At the bottom level of the federal judicial hierarchy is the district court. These courts were established by the original Judiciary Act of 1789 (1 Stat. 73). At least one district court is located in each state but some states have more than one. No district crosses state boundaries. The District of Columbia has one district court. Cases ordinarily are first heard in the district courts, which are the trial courts in the national system. These are the only Federal courts where juries are used. They have no appellate jurisdiction. The great majority of district court judgments, if they are reviewed at all, are reviewed by a court of appeals (*see* 222) and go no higher. Certain cases, however, may be appealed directly to the Supreme Court (*see* 223). District courts have original jurisdiction of civil cases at common law, in equity, in admiralty, in the enforcement of acts of Congress, and of all prosecutions for crime cognizable under the authority of the United States (*see also* note 30 *infra*).[14]

### 222. United States Courts of Appeals

The middle layer of the national judicial pyramid is made up of the United States courts of appeals. There is one such court in each of the ten judicial circuits into which the country is divided. The District of Columbia also has an appellate court known as the United States Court of Appeals for the District of Columbia.[15] The new states of Alaska and Hawaii are included within

13. The 11th amendment was proposed to the legislatures of the several states by the Third Congress on Mar. 5, 1794, and was declared by the President on Jan. 8, 1798, to have been ratified by three-fourths of the states. Although not specifically prohibited, the amendment has been construed to prevent a state being sued without its consent by its own citizens (*Hans* v. *Louisiana*, 134 U.S. 1 (1890)), or by a foreign State (*Monaco* v. *Mississippi*, 292 U.S. 313 (1934)).

14. Smith, Handbook of Elementary Law 378 (1939). Cases decided in the district courts of the United States which have sufficient general interest to merit publication are recorded in volumes designated as "Federal Supplement" (cited "F. Supp."). The series began in 1932, and as of Sept. 1963 there were 219 volumes issued. From 1880 to 1932, selected district court decisions were reported in the "Federal Reporter" (*see* note 17 *infra*). A complete citation to a case in the Federal Supplement would be "*United States* v. *5.324 Acres of Land*, 79 F. Supp. 748 (1948)," meaning that it is recorded in volume 79 at page 748 and was decided in 1948.

15. This court has a unique position in the judicial structure. It is equal in all respects to the 10 other courts of appeals, but at the same time it is, in many respects, the same as the highest court

the ninth circuit which also includes the seven westernmost states. The jurisdiction of these courts, as the name suggests, is exclusively appellate; they have no original jurisdiction. They hear cases (civil and criminal) from the district and other Federal courts that operate in each particular circuit. They were created by Congress in 1891 (26 Stat. 826), as amended by 45 Stat. 1346 (1929), to lighten the work of the Supreme Court, and serve to screen cases so that only the most important ones go to the highest tribunal. The courts of appeals have no jurisdiction to review the decisions of the state courts and cases from the highest state courts go directly to the Supreme Court of the United States (*see* 223). It is also an accepted principle that where the solution of novel and serious constitutional questions depends on the interpretation to be given a state statute, not yet construed by the state courts, the Federal courts should abstain from interpreting the state statute.[16] In cases where a court of appeals has held a state statute invalid on the ground of repugnancy to the Constitution or a law or treaty of the United States, an appeal may be taken to the Supreme Court; in all other cases its decisions are final except as they may be reviewed by the Supreme Court at the latter's discretion.[17]

### 223. Supreme Court

At the top of the federal judiciary is the Supreme Court of the United States, and is the only Federal court specifically provided for in the Constitution. It is the final arbiter of the American constitutional system. Its opinions on the nature and scope of federal and state power, on the functions of the various departments of government, and on the meaning of the written language of the Constitution have built up a great body of constitutional law. It not only stands at the apex of the federal judicial pyramid, but it is actually the highest court of the land. As such it may accept cases for review directly from the state courts in some situations, as, for example, those in which the validity of a state or federal statute under the Federal Constitution is in question. Its opinions are definitive statements of the law which the lower courts must follow

in each of the 50 states. This dual role, plus the jurisdiction which it exercises over decisions of the administrative agencies of the Federal Government by virtue of its location, gives it an added importance.

16. This principle of abstention was followed in *Williams* v. *Hot Shoppes*, 293 F. 2d 835, 840 (1961), where the question before the United States Court of Appeals for the District of Columbia was the meaning of a Virginia statute whose constitutionality had not yet been passed on by the state court.

17. Smith (1939), *op. cit. supra* note 14, at 379. Cases decided in the courts of appeals are recorded in volumes designated as "Federal Reporter" (cited "Fed."). In Oct. 1963, there were two series of this reporter, the second being designated as "Federal Reporter 2d Series" (cited "F. 2d"). The first series covers volumes 1 to 300 and includes cases decided between 1880 and 1924. The second series covers at present volumes 1 to 319 and includes cases decided between 1924 and 1963. A complete citation for a case in the second series of the Federal Reporter would be "*Hinman* v. *Pacific Air Transport*, 84 F. 2d (1936)" (*see* note 14 *supra*).

in all cases. Its appellate jurisdiction can, however, be curtailed by Congress, the only irrevocable jurisdiction being original, that is, in those cases in which the Court takes jurisdiction in the first instance. These reach only to cases affecting ambassadors, public ministers, and consuls, or cases in which a state is a party.[18] But this original jurisdiction is not exclusive, and Congress has in fact, in a number of instances, granted such jurisdiction to the lower Federal courts.[19]

The Supreme Court cannot take most cases until at least one and generally two courts have heard and decided them. Also, as an appellate court, it properly can act only on the state of facts revealed by the record made in the court below, supplemented sometimes by general information of which it may take judicial notice. With few exceptions, Congress has found it necessary to make review in the Supreme Court not a matter of right but within the discretion of the Court. The grant of review is not intended to give the litigant another chance, nor does it depend on the amount of money involved, but upon the importance of the case to a uniform and just system of federal law.[20]

There are four avenues by which cases flow to the Supreme Court. The first is from the state courts.[21] These comprise cases in which the validity of a state or federal statute under the Federal Constitution is in question. The second is from the Federal district courts in cases where the court holds against the constitutionality of a federal statute and the United States is a party. The Government may under such circumstances appeal directly to the Supreme Court. The third avenue is from the courts of appeals. This category comprises cases where the decisions of different courts are conflicting on the same point of law, and cases where the Supreme Court thinks a court of appeals may

18. Where the Supreme Court has original jurisdiction it does not function exactly as a Federal trial court. Through briefs submitted by the litigants it passes on questions of law, leaving the ascertainment of facts, which may require the taking of evidence, to a Special Master or Referee whose recommendations they accept, reject, or modify. This was the procedure followed in the case of *United States* v. *California*, 332 U.S. 19 (1947). After the Supreme Court rendered its decision and decree establishing a rule of law to be applied, it named a Special Master to ascertain with greater particularity how the law was to be applied to the federal-state boundary along certain portions of the California coast (*see* Volume One, Part 1, 2111).

19. WILLOUGHBY, PRINCIPLES OF THE CONSTITUTIONAL LAW OF THE UNITED STATES 400 (1922). In the *California* case, *supra* note 18, the original action was begun in a Federal district court and was later removed to the Supreme Court.

20. JACKSON, THE SUPREME COURT IN THE AMERICAN SYSTEM OF GOVERNMENT 12–14 (1955).

21. In *Cohens* v. *Virginia*, 6 Wheat. 264 (19 U.S., 1821), the Supreme Court, under authority of the Judiciary Act of 1789 (Sec. 25), sustained its right to review decisions of state courts involving constitutional rights in suits brought by a state against an individual. The 11th amendment (*see* 22), it held, did not prevent such appeal by the individual.

have misconstrued or misapplied an earlier Supreme Court decision. The last avenue is from the Court of Claims (*see* 224), the Customs Court, and the Court of Customs and Patent Appeals.[22]

The appellate jurisdiction of the Supreme Court may be contrasted with the jurisdiction of the intermediate Federal appellate courts with the observation that the Supreme Court's work is now confined in good part to cases which present constitutional issues or questions of statutory interpretation in which the people as a whole, as well as the litigants, have a major interest, whereas the Federal courts of appeals have become in large measure the final courts for deciding cases important primarily to the litigants.[23]

The uniqueness of the Supreme Court as a judicial body lies in its power to hold unconstitutional and judicially unenforceable an act of the President, of Congress, or of a constituent state of the Union. "That power is not expressly granted in the Constitution, but rests on logical implication. It is an incident of jurisdiction to determine what is the law governing a particular case or controversy. In the hierarchy of legal values, if the higher law of the Constitution prohibits what the lower law of the legislature attempts, the

22. These courts, although technically outside the national judicial system, are tied in with it through procedures for review of their findings either in courts of appeals or by the Supreme Court. They are often designated as "legislative courts,"—in contradistinction to the courts discussed above, which are termed "constitutional courts"—because they are not authorized by Art. III of the Constitution but are established under authority implied from constitutional provisions other than Art. III; for example, by the 18th grant of power in Art. I, sec. 8, which permits Congress "To make all Laws which shall be necessary and proper" for carrying out any of its expressly granted powers. Constitutional courts share in the exercise of the judicial power defined in Art. III of the Constitution (*see* 22), and their judges are appointed for life or good behavior and can only by removed by the impeachment process. The functions of legislative courts, on the other hand, are always directed toward the execution of one or more of such powers as are prescribed by Congress, independently of Art. III, and their judges hold for such term as Congress may prescribe, whether it be a fixed term of years or during good behavior. *Ex parte Bakelite Corp.*, 279 U.S. 438, 449 (1929). In 1953, Congress declared the Court of Claims to be a court established under Art. III of the Constitution (67 Stat. 226), and in 1958 the same designation was accorded the Court of Customs and Patent Appeals (72 Stat. 848). For a comprehensive statement on the constitutional character of these two courts prior to the 1953 and 1958 declarations, *see The Glidden Co.* v. *Zdanok*, 370 U.S. 530 (1962), in which the Supreme Court upheld the validity of judges from these courts sitting as regular Federal judges in the courts of appeals and in the district courts.

23. CARR, etc. (1951), *op. cit. supra* note 12, at 418. In *Landman* v. *Miedzinski*, 358 U.S. 644 (1959), the Supreme Court declined to review a Maryland Court of Appeals decision, upholding a Maryland statute which prohibited the operation of gaming machines in the Potomac River, unless such machines could be reached from Maryland soil by foot, on the ground that it presented no substantial federal question. Yet the Court took jurisdiction of a case, involving a double-indemnity insurance policy, where the question was whether the death of a North Dakota farmer of gun wounds was suicide or accidental. *Dick* v. *New York Life Insurance Co.*, 359 U.S. 437 (1959). *But see* the vigorous dissent by Mr. Justice Frankfurter on the basis that the case involved no question of state or federal law and laid down no broad rules of application for the guidance of lawyers. *Id.* at 447.

latter is a nullity."[24] But there is a reluctance on the part of the Supreme Court to hold acts of Congress invalid because of the doctrine of separation of powers, and if a case can be disposed of without reaching the constitutional question, the Court will invariably do so.

Another facet of the Court's functions, is to maintain the system of checks and balances upon which the American Government is based, namely, between the Executive and Congress, between the National Government and the states, and between state and state. In the last category, Congress was by the Constitution made a supervisor of their compacts and agreements (Art. I, sec. 10) (*see* 342) and the Supreme Court was made the arbiter of their controversies (Art. III, sec. 2) (*see* 3421). Under this head, the Court has settled many disputes over river boundaries.[25]

## 2231. *Supreme Court Reports*

Cases decided by the Supreme Court are recorded in volumes designated as "United States Reports" and cited as "U.S." These are the official reports of the decisions and are printed by the Government.[26] As of October 1963, there was but one series of these reports covering volumes 1 to 372. Prior to 1882, the volumes of the United States Reports were designated by the name of the official reporter and a number—for example, 1 Dallas, 16 Peters, 3 Howard,

24. JACKSON (1955), *op. cit. supra* note 20, at 22. This doctrine of the supremacy of the Constitution, when in conflict with an act of Congress, was firmly enunciated in the early case of *Marbury* v. *Madison*, 1 Cr. 137 (5 U.S., 1803). Although the case dealt with the relatively unimportant situation of the issuance of a commission by an outgoing President to a justice of the peace, which the new Secretary of State refused to deliver, the constitutional question at issue was whether under the provision of the Judiciary Act of 1789 (Sec. 13) the Supreme Court could issue writs of mandamus to public officers. The Court answered this in the negative on the principle that the Constitution prescribed specifically the cases in which the Supreme Court was to have original jurisdiction and that Congress had no power to alter such jurisdiction. This established, by judicial interpretation, the great constitutional doctrine of the power of the Supreme Court to declare an act of Congress invalid, if it is repugnant to the Constitution.

25. Among these are *Maryland* v. *West Virginia*, 217 U.S. 1 (1910) (Potomac River); *Indiana* v. *Kentucky*, 136 U.S. 479 (1890) (Ohio River); *New Jersey* v. *Delaware*, 291 U.S. 361 (1934) (Delaware River); *Alabama* v. *Georgia*, 23 How. 505 (64 U.S., 1860) (Chattahoochee River); *Arkansas* v. *Tennessee*, 269 U.S. 152 (1925) (Mississippi River). For other river boundary disputes settled by the Supreme Court, *see* 1422, 1423, and 1424.

26. In addition, there are two unofficial series—the "Lawyer's Edition of the Supreme Court Reports" and the "Supreme Court Reporter." The first covers the entire set of the United States Reports. Although the text is identical with that of the official edition, editorially it is quite different. Each case is summarized, the headnotes are rewritten in somewhat expanded form, and briefs of counsel are summarized. A distinctive feature of this series is the annotations for many cases; that is, points of law decided are written up, with citations to authorities. Reference to this series is made thus: "62 L. Ed. 968 (1918)" (*see* note 14 *supra*). The second series is a unit of the National Reporter System (*see* 2312). Coverage is from the Oct. 1882 term or 16 Otto (106 U.S.) to date. Reference to this series is made thus: "38 Sup. Ct. 473 (1918)." Parallel citations of a case are often given in this form: *United States* v. *United Shoe Machinery Co.*, 247 U.S. 32, 38 Sup. Ct. 473, 62 L. Ed. 968 (1918). In this publication, citations are given only to the official series.

etc. Later, a serial number was added which carries through to the present time. In this publication, cases in the early series are cited by giving both the original reference and the serial reference, thus: 16 Pet. 367 (41 U.S., 1842), meaning volume 16 of the Peters reports at page 367, which is serial volume 41, decided in 1842.[27] A complete citation to a case in the United States Reports would be "*United States* v. *United Shoe Machinery Co.*, 247 U.S. 32 (1918)" (*see* note 14 *supra*).

### 224. United States Court of Claims

Of the courts referred to in note 22 *supra* and accompanying text, the Court of Claims is one of the most important because of its broad field of operation. It was originally created in 1855 (10 Stat. 612) as a special tribunal to investigate claims against the Government and report its findings to Congress. Subsequent acts of Congress have given it the status of a court of special jurisdiction with power to hear and determine (with some few exceptions) all claims against the United States founded on any act of Congress, on any regulation of an executive department, on any contract with the Government, or for damages, in cases not in the nature of tort actions, in respect to which the party would be entitled to redress if the United States were suable; claims of government disbursing officers for relief from responsibility for loss while in the line of duty; and questions of fact or law submitted by heads of departments for their guidance or to obtain an adjudication.[28]

## 23. STATE JUDICIARIES

It has already been noted (*see* 2112) that in our dual system of government two judicial systems function side by side—the federal and the state. The state system follows a pattern similar to the federal with the trial courts at the base, the intermediate appellate courts at the middle, and the final appellate courts

27. In order of issue, there were 4 reports by Dallas (Dall.) (serial Nos. 1 to 4) for the years 1790 to 1800; 9 by Cranch (Cr.) (serial Nos. 5 to 13) for 1801 to 1815; 12 by Wheaton (Wheat.) (serial Nos. 14 to 25) for 1816 to 1827; 16 by Peters (Pet.) (serial Nos. 26 to 41) for 1828 to 1842; 24 by Howard (How.) (serial Nos. 42 to 65) for 1843 to 1860; 2 by Black (Bl.) (serial Nos. 66 and 67) for 1861 and 1862; 23 by Wallace (Wall.) (serial Nos. 68 to 90) for 1863 to 1874; and 17 by Otto (Otto) (serial Nos. 91 to 107) for 1875 to 1882.

28. Smith (1939), *op. cit. supra* note 14, at 380. For present status of the court as a constitutional court, *see* note 22 *supra*. Decisions of this court are reported in two series of official reports entitled "Court of Claims Reports" (cited "Ct. Cl."), the first, unnumbered, from 1855 to 1862; and the second (current), beginning with 1863. There are at present (in Oct. 1963) 151 bound volumes of these reports. Tax claims decisions of this court are also reported in the Federal Reporter through 60 F. 2d (*see* note 17 *supra*) in 1932, and in the Federal Supplement (*see* note 14 *supra*) from 1 F. Supp. in 1932 through 181 F. Supp. in 1960, then in the Federal Reporter from 276 F. 2d in 1960 to date.

at the top. The names given to the state courts at the different levels may vary from state to state.[29]

Essentially, state courts, as opposed to Federal courts, concern themselves with suits arising under the state constitutions and with laws enacted by the state legislatures. But it is not always easy to draw the line between the case that may be heard in the state courts and the case that may be heard in the Federal courts. For one thing the subject matter of a case may involve both federal and state laws. Secondly, Congress has by law left part of the area of federal jurisdiction as set forth in the Constitution to be exercised by state courts, either concurrently with Federal courts or even exclusively.[30] This, however, is not a jurisdiction conferred on them by federal statute, but one which they possess under state law. And it has been held that Congress is without power to confer jurisdiction upon any courts which it does not create.[31]

The Judiciary Act of 1789 (1 Stat. 73) infringed on the function of state courts in two respects: It provided for a review by the Supreme Court of final judgments of the highest state courts in which federal questions are involved, and it also established a system of Federal trial courts throughout the United States and vested them with jurisdiction of controversies in cases of diversity of citizenship, regardless of whether a federal law was involved or not. And the Supreme Court has held that except in matters governed by the Federal Constitution or by acts of Congress, the law to be applied by the Federal courts is the law of the state, and decisions of the highest state courts are a part of that law.[32]

### 231. State Court Reports

Decisions of the state courts are usually published in two forms—official and unofficial reports. Official reports are published under statutory direction,

29. A frequent designation in the ascending order is County Court, Superior Court, and Supreme Court. This is the nomenclature followed in the New Jersey system. In the Maryland system, the highest court is called the Court of Appeals. Courts of special probate jurisdiction are usually styled "probate courts," but in Pennsylvania such a court is called the "orphans court," and in New York the "surrogate court." Small-cause courts are known as "justice of the peace courts," "police courts," or "municipal courts."

30. Congress has provided that Federal district courts may take jurisdiction over civil suits between citizens of different states, or arising under federal statutes, only if the amount involved exceeds $3,000, but the parties may still elect to take their dispute to a state court. Under the Act of June 25, 1948 (62 Stat. 931), the $3,000 limitation does not apply and district courts have jurisdiction of any civil action arising under any act of Congress regulating commerce or protecting trade and commerce against restraints and monopolies. *See*, for example, *United Air Lines, Inc.* v. *Public Utilities Commission of California*, 109 F. Supp. 13 (1952), where a district court took jurisdiction under this act in a controversy involving the question of state or federal authority over air line rates.

31. *Houston* v. *Moore*, 5 Wheat. 1 (18 U.S., 1820).

32. *Erie R. Co.* v. *Tompkins*, 304 U.S. 64, 80 (1938).

while unofficial reports usually are not. But both use identical texts as far as the opinions and judgments are concerned, and these are supplied by the courts. Both are citable in court.[33] The most widely used of the unofficial state reports are those in the National Reporter System (*see* 2312). Because of their greater availability citations in this publication, wherever possible, are to this system rather than to the official state reports (*see* 2311).

### 2311. *Official State Reports*

It is not always clear as to what makes a report official. Those prepared and published under statutory authorization are definitely official. Prior to about the middle of the 19th century it was customary for the official reporter to publish reports at his own expense or profit and the reports carried his name—for example, *Shivers* v. *Wilson,* 5 Harr. & John. 130 (Md. App. 1820). These reports, whether considered official or not in the current sense, are nevertheless acceptably cited in any legal writing.[34]

### 2312. *The National Reporter System*

The decisions of state courts—appellate courts and some courts of first instance—are reported in a series of unofficial reports known as the National Reporter System. Begun in 1879 with the "North Western Reporter," it now covers the entire country including a special series for the courts of record of New York (the New York Supplement).[35] The text of the opinions in this system follows the official state reports. A typical citation to the National Reporter System would be the following: *Lively* v. *Mundy,* 40 S.E. 2d 62 (1946) (Ga.). This is the form used in this publication.[36]

33. PRICE AND BITNER, EFFECTIVE LEGAL RESEARCH 94, 114 (1953).

34. *Id.* at 116. Current official reports are cited by a title frequently with a parallel citation to the National Reporter System (*see* 2312)—for example, *Wynn* v. *Sullivan,* 294 Mass. 562, 3 N.E. 2d 236 (1936).

35. In this system, the country is divided into seven regional areas, each with its own designation, as follows: *Atlantic Reporter* (cited "Atl." and "A. 2d") includes Maine, New Hampshire, Vermont, Rhode Island, Connecticut, New Jersey, Pennsylvania, Delaware, Maryland, and the District of Columbia; *North Eastern Reporter* (cited "N.E." and "N.E. 2d") includes Massachusetts, New York, Ohio, Indiana, and Illinois; *South Eastern Reporter* (cited "S.E." and "S.E. 2d") includes Virginia, West Virginia, North Carolina, South Carolina, and Georgia; *Southern Reporter* (cited "So." and "So. 2d") includes Florida, Alabama, Mississippi, and Louisiana; *South Western Reporter* (cited "S.W." and "S.W. 2d") includes Kentucky, Tennessee, Missouri, Arkansas, and Texas; *Pacific Reporter* (cited "Pac." and "P. 2d") includes Oklahoma, Kansas, New Mexico, Colorado, Wyoming, Montana, Idaho, Utah, Arizona, Nevada, California, Oregon, Washington, Alaska, and Hawaii; and *North Western Reporter* (cited "N.W." and "N.W. 2d") includes Michigan, Wisconsin, Iowa, Minnesota, North Dakota, South Dakota, and Nebraska.

36. The National Reporter System also includes the Supreme Court Reporter (*see* note 26 *supra*), the Federal Reporter (*see* note 17 *supra*), and the Federal Supplement (*see* note 14 *supra*).

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## 24. THE JUDICIAL PROCESS

Through the enactment of statutes, the legislature fixes standards of conduct which govern human affairs; through the rendering of decisions, courts apply these standards to specific cases. Such is the theory of the legislative function and the judicial function. The judicial process is the set of principles that courts have developed to govern their decisions. In its broadest concept, it involves more than the mere weighing and counting of precedents on either side of a controversy; it includes as well the whole field of judicial backgrounds, experiences, and philosophies by which judges interpret the law and determine its meaning when new problems and situations arise.

### 241. Case or Controversy

It is a cardinal rule in the Federal courts that there must be a bona fide dispute between opposing parties with a true conflict of interests before the court will accept the dispute for adjudication. If these elements do not exist, then the matter is beyond the jurisdiction of the Federal courts.[37] This stems from the provision in Article III, section 2, of the Constitution, which limits the scope of the judicial power of the United States to "cases" and "controversies" (*see* 22).[38]

It follows, therefore, that a "moot" or "advisory" case is not the proper subject of judicial action, in the absence of a specific constitutional provision sanctioning such a proceeding, for the reason that such an action violates the basic requirement that judicial proceedings be both adversary and effective. And it has been held that the judicial power of the United States does not extend to the furnishing of opinions as to the constitutionality of an act of Congress in advance of a justiciable controversy involving the statute. And even where litigants are actually involved, if the net result of the litigation is merely to furnish advice as to rights, it is held to be beyond the judicial function.[39]

37. In *United States* v. *Appalachian Electric Power Co.,* 311 U.S. 377, 423 (1940), the Supreme Court said: "The courts deal with concrete legal issues, presented in actual cases, not in abstractions" (citing *Cherokee Nation* v. *Georgia,* 5 Pet. 1, 75 (30 U.S., 1831), and *New Jersey* v. *Sargent,* 269 U.S. 328 (1926)).

38. "Cases" have been held to be broader in scope than "controversies" and to apply to suits of both a civil and criminal nature, whereas controversies are confined to civil suits only. In common usage, however, the two are not distinguishable, and the term "cases and controversies" implies the existence of present or possible adverse parties, whose contentions are submitted to the court for adjudication.

39. *Muskrat* v. *United States,* 219 U.S. 346 (1911). In several of the states, advisory opinions at the request of the Governor or legislature are authorized by their constitutions. Dodd, Cases on Constitutional Law 156 (1949). Complicated factual situations may sometimes present themselves as to whether there is a justiciable case or controversy. This very question arose in *United States* v. *California,* 332 U.S. 19 (1947) (the so-called "tidelands" case). (*See* Volume One, Part 1, 11, 112.)

## 242. The Doctrine of Stare Decisis

One of the most important developments in the judicial process was the appearance of the rule of *stare decisis* ("adhere to the decision"), or the doctrine of precedent. This was a logical outgrowth of the common-law system of jurisprudence, which is based on case law, as distinguished from the civil-law system, which is based on established codes (*see* 251). The theory of Anglo-American law is that the principle underlying the decision in one case will be deemed to control decisions in like cases in the same court or in lower courts within the same jurisdiction. The underlying reason for the emergence of this doctrine was the need for securing continuity and certainty in the law, especially as the great body of decisional law expanded. The rationale of the doctrine was stated by Chancellor Kent as follows: "A solemn decision upon a point of law arising in any given case, becomes an authority in a like case, because it is the highest evidence which we can have of the law applicable to the subject, and the judges are bound to follow that decision so long as it stands unreversed, unless it can be shown that the law was misunderstood or misapplied in that particular case." [40]

Were this otherwise there would be a perpetual uncertainty as to the law and no safe advice could be given in any set of circumstances. The doctrine of precedent is of course subject to qualifications. The determination of what is a "like case" that makes it imperative for a court to follow is what gives flexibility to the doctrine.

In dealing with a case at common law, three avenues of approach are open to the court: It can follow precedents established in previous decisions; it can overrule such precedents (unless it is a lower court and hence compelled to follow decisions of the higher court); or it can "distinguish" those cases that stand in the way of the decision at which it wishes to arrive.[41]

Where a rule has been judicially declared and private rights created thereunder, the courts will not depart from the doctrine except under the greatest of compulsions and in the clearest cases of error. But when public interests are involved, and especially where the question is one of constitutional construc-

40. Kent, 1 Commentaries on American Law 476 (1896).

41. To "distinguish" a case means pointing out how and why the former case does not apply to the instant case, and, therefore, why it does not constitute a precedent which the court is obliged to follow. In *Glidden* v. *Zdanok, supra* note 22, at 584, the Supreme Court, in holding that the Court of Claims and the Court of Customs and Patent Appeals were constitutional courts, "distinguished" this case from two previous cases—*Ex parte Bakelite Corp., supra* note 22, and *Williams* v. *United States,* 289 U.S. 553 (1933)—which held these courts to be legislative courts, on the ground that the factors considered in the *Glidden* case were not considered in the former cases. While in a sense the Court distinguished these cases, in effect it overruled the former. However, in the particular case the question of overruling had become academic, inasmuch as Congress had, subsequent to the former cases, provided by statute what amounted to an overruling (*see* note 22 *supra*).

tion, the approach is more liberal, in view of the fact that a constitution, and particularly the Federal Constitution, may be changed only with great difficulty. On the justification of departure from the doctrine, it was stated by Mr. Justice Brandeis, in dissenting from the decision that Congress may not by statute bring injuries in maritime work under the state workmen's compensation laws: "The doctrine of *stare decisis* should not deter us from overruling that case and those which follow it. The decisions are recent ones. They have not been acquiesced in. They have not created a rule of property around which vested interests have clustered. They affect solely the matters of a transitory nature. On the other hand, they affect seriously the lives of men, women and children, and the general welfare. *Stare decisis* is ordinarily a wise rule of action. But it is not a universal, inexorable command. The instances in which the court has disregarded its admonition are many." [42]

## 2421. *Rule of Property*

The doctrine of stare decisis finds particular force in decisions relating to real property. Stability is especially requisite in this area of judicial determination. Such decisions become *rules of property*, and many titles may be injuriously affected by their change. In an early case, the Supreme Court said on this matter: "Legislatures may alter or change their laws, without injury, as they affect the future only; but where courts vacillate and overrule their own decisions on the construction of statutes affecting the title to real property, their decisions are retrospective and may affect titles purchased on the faith of their stability. Doubtful questions on subjects of this nature, when once decided, should be considered no longer doubtful or subject to change." [43]

A "rule of property" has been defined as a settled legal principle governing ownership and devolution of property. To constitute such a rule, a judicial

42. *Washington* v. *W. C. Dawson & Co.*, 264 U.S. 219, 235, 238 (1924). For a list of cases overruled by the Supreme Court, *see* dissent by Mr. Justice Brandeis in *Burnet* v. *Coronado Oil & Gas Co.*, 285 U.S. 393, 405 (1932). A more recent list of overruled cases appears in the opinion of the Court in *Smith* v. *Allwright*, 321 U.S. 649 (1944). One of the noteworthy cases in which the Supreme Court expressly overruled its former decisions was *The Genesee Chief* v. *Fitzhugh*, 12 How. 443 (53 U.S., 1851). By this action, the Court, in defining the scope of the admiralty jurisdiction in this country, overturned the tidal test for navigability and adopted the principle that the test was the actual navigable capacity of a waterway and not the extent of tidal influence. The Court thereby overruled *The Thomas Jefferson*, 10 Wheat. 428 (23 U.S., 1825), which it had decided 26 years before. On the justification for not adhering to the rule of stare decisis, the Court said: "The case of the *Thomas Jefferson* did not decide any question of property, or lay down any rule by which the right of property should be determined. If it had, we should have felt ourselves bound to follow it. . . . But the decision referred to has no relation to rights of property. It was a question of jurisdiction only." *Id.* at 458.

43. *Minnesota Co.* v. *National Co.*, 3 Wall. 332 (70 U.S., 1866). The existence of the doctrine of the rule of property is one of the reasons why early court decisions are often cited as authority in modern cases involving land ownerships.

declaration must be fixed, long-continued, and relied on by persons acquiring property, so that its repudiation would amount to a denial of due process.[44] The rule remains even when the decision is erroneous, unless it appears that the evils resulting from the principle established is more mischievous than can possibly ensue from disregarding the previous adjudications upon the subject.[45] The theory on which adherence to the rule is based is that if any change in the law is necessary it should be made by the legislature.[46]

Decisions of executive departments of government have been held not to be covered by the rule except in the clearest cases of long and continued promulgation and reliance.[47]

### 2422. *Obiter Dictum*

There is one situation where the rule of stare decisis is held not to apply. It is where the court in rationalizing its decision uses language broader than is needed for the disposition of the point at issue. Such language is known as *obiter dictum* ("that which is said in passing"), and dicta are not regarded as precedents within the rule. The reason is obvious. Not being at issue before the court, they have not been given the investigation and consideration that the question before it has. The test seems to be whether or not the court's statement is required in the determination of the issues presented; if it is merely illustrative or background material, then it is not and it then falls within the category of dictum.[48]

44. *United States* v. *Standard Oil Co. of Cal.*, 20 F. Supp. 427, 458 (1937).

45. *Brekke* v. *Crew*, 178 N.W. 146, 154 (1920) (S.D.). The court here held that even if the previous decision (a single decision) established a rule of property, under the existing facts it would not invoke the maxim of stare decisis. *Ibid.*

46. *Stewart* v. *Stewart*, 249 Pac. 197, 207 (1926) (Calif.). On the question of the retroactive effect of overruled decisions, the Supreme Court has taken the position that "A state in defining the limits of adherence to precedent may make a choice for itself between the principle of forward operation and that of relation backward. It may say that decisions of its highest court, though later overruled, are law none the less for intermediate transactions" or it may hold "the reconsidered declaration as law from the beginning." *Great Northern Railway* v. *Sunburst Co.*, 287 U.S. 358, 364, 365 (1932).

47. *United States* v. *Standard Oil Co. of Cal., supra* note 44, at 458.

48. In *Myers* v. *United States*, 272 U.S. 52 (1926), the Court upheld the right of the President to remove a postmaster from office without restraint by Congress. Although this was the narrow point decided, the opinions consisted of 243 pages. In the majority opinion, language was used to the effect that the power of removal extended to the members of the independent regulatory commissions. But when in a later case, *Humphrey's Executor* v. *United States*, 295 U.S. 602 (1935), the Government invoked the language in the *Myers* case and sought to apply it to a member of such a commission (the Federal Trade Commission), the Court held such language as dicta and therefore not controlling in the disposition of the later case.

## 243. The Role of Authority in the Judicial System

In the judicial process, as has been noted, the doctrine of stare decisis is a form of authority which courts generally follow in order to give continuity and stability to the law. But strictly speaking the process is one of precedent rather than authority. "Authority" in the judicial set-up deals more with the weight to be accorded court decisions, statutes, and textbooks and other writings on the law. It is generally of two kinds—*mandatory* and *persuasive*. The first, also called imperative authority, is binding on courts; the second is not, but may or may not be followed.

The dual sovereignty systems in the United States include courts of different jurisdiction and rank, and the relative authority and force of their decisions in the courts vary accordingly. Thus, decisions of the United States Supreme Court, the highest court in the land, are mandatory on all inferior Federal courts, and on all state courts in cases involving federal questions, such as those arising under the Constitution, statutes, and treaties of the United States. But its decisions are only persuasive in state courts on all other matters. A court of one rank is not bound to follow a decision of another court of the same rank. So that decisions of the intermediate Federal appellate courts (*see* 222), while binding on all lower Federal courts within its circuit, are only persuasive in other Federal appellate courts and in the lower Federal courts outside its circuit.

On the state level, the decisions of the highest court of a state are binding on the intermediate appellate courts and the trial courts of the state, and the decisions of the intermediate appellate courts are binding on the trial courts below them within their respective districts; but the decision of any inferior court is not binding on another court of the same rank, although it may be followed for the sake of uniformity, nor is the decision binding on any state court of higher rank with appellate jurisdiction over it. The decisions of a court of one state applying common-law principles or construing a state statute may be persuasive authority to the courts of other states in cases involving analogous problems and enactments, but they are not binding authority. And the decisions of the highest court of a state are conclusive in regard to the meaning of state statutes and their validity under the state constitution. The precedents established by the highest court of a state are binding on the Federal courts in all cases originating in the state, except as to questions arising under the Constitution, statutes, or treaties of the United States.

Dicta, strictly speaking, have not, even persuasive authority, because the subject matter by definition was not necessarily raised and considered in the decision in which the dicta were uttered (*see* 2422). But in actual practice, well-considered dicta may be entitled to respect, some to such an extent that their original status is overlooked or forgotten, and they are cited as authority.

There is another form of authority, sometimes called *secondary* authority, in contradistinction to the types of authority discussed above and generally considered *primary*. Secondary authority is not really authority, but comprises instead indexes to authority, such as digests and legal encyclopedias, and text books, law review articles, and other treatises. These can be highly persuasive and are frequently cited in judicial decisions.[49]

## 25. LEGAL SYSTEMS IN THE UNITED STATES

There are many definitions for the law, but in its ordinary sense it consists of the legal prescriptions enacted by duly constituted bodies and promulgated for the purpose of governing human conduct. The prescriptions, once made, are subject to interpretation by a court which may consider their constitutionality as well as their application to particular factual situations. So, in its broader aspects, law comprises both the legislative enactments and the decisional law evolved by the courts.

Two of the world's great legal systems, applicable in the United States and its possessions, are the *common law*, or that derived from the English law, and the *civil law*, or that having its antecedents in the Roman law. The common-law system was accepted in the English speaking countries of the world and their possessions, while the civil-law system was accepted in continental European countries, especially those having a Latin origin.[50] There are some significant differences under the two systems in the areas of riparian property law and the law of navigable waters. To cite one example: According to the common law, the inshore boundary of tidelands is ordinary or mean high-water mark,[51] whereas under the civil law it has been variously defined as "the line of highest advance of water," "the line reached by the highest waves in winter," "the highest tide of the year," and "the line of highest tide." [52] Other differences will be noted in the subsequent consideration of the specialized legal areas. To better understand these differences, a brief account will be given of the two systems.

49. PRICE AND BITNER (1953), *op. cit. supra* note 33, at 3.

50. GAVIT, INTRODUCTION TO THE STUDY OF LAW 44 (1951).

51. *Borax Consolidated, Ltd.* v. *Los Angeles*, 296 U.S. 10 (1935).

52. Diamond, *The Effect of Common and Civil Law on Tidal Boundaries*, 9 BAYLOR L. REV. 40 (1957). Recently, the Supreme Court of Texas defined "shore" as the line of mean-higher-high tide. *Luttes* v. *State*, 324 S.W. 2d 167 (1958) (*see* Appendix D).

## 251. The Common Law

The common law, as understood in this country, had its origins in the legal precepts adopted, developed, and formulated by the decisions of the courts of England following the Norman Conquest in 1066. These decisions were based in part upon customary usages and in part upon their own common sense. There was thus developed a body of judicial rulings, said to be derived from the "common custom of the realm," which later became known as *common law*. Common law is thus judge-made law, or case law. It is unwritten law as opposed to statute, or written, law. Under the common-law system, cases decided by judges are regarded as a valid, major source of law, and therefore the doctrine of stare decisis, or precedent, has an important role in this system (*see* 242). The common-law system is nevertheless a flexible system and one of its merits is its adaptability to a shifting environment.[53]

The English common law forms the foundation for the system of law in this country. It was brought to the American colonies at an early date and was continued by the Original Thirteen States and has been accepted by the other states upon their admission to the Union, except in the case of Louisiana (*see* 252). This original inheritance of English law has been modified by legislation or judicial decisions. Thus, as cases arose in each state for which there was no precedent in that state, the courts had to declare what the common-law rule was. It was in these decisions that the English common law was departed from in order to make them responsive to the local environment. There are, therefore, many systems of common law in the states, all manifesting a general likeness because of their common origin and extensive borrowing from each other, yet diverting from English law and from one another in many particulars. On many matters there have developed two rules—a majority and a minority rule. This means that numerically the number of states accepting one rule outnumber those which accept a contrary or modified rule. Sometimes different rules are described by the source of their origin, or principal exponent. Thus, reference is sometimes made in decisions to a *New York* rule, as distinguished from a *Massachusetts* rule, each followed in a varying number of states.

The common law of the states is applied in the Federal courts under a federal statute which provides that "The laws of the several states, except where the constitution, treaties or statutes of the United States shall otherwise require

53. Thus, in *The Genesee Chief* v. *Fitzhugh, supra* note 42, the Supreme Court, in reexamining the federal admiralty jurisdiction, departed from the common-law doctrine of the tidal test of navigability and substituted the actual navigable capacity of a waterway as the test, on the basis that the former reflected an English environment, where the limit of the tide was also the limit of practical navigation, and was inapplicable in this country because of the broad difference between the topography of the British island and the American Continent.

or provide, shall be regarded as rules of decision in trials at common law in the courts of the United States in cases where they apply."[54] In construing this statute, the Supreme Court has said: "Except in matters governed by the Federal Constitution or by Acts of Congress, the law to be applied in any case is the law of the State. And whether the law of the State shall be declared by its Legislature in a statute or by its highest court in a decision is not a matter of federal concern."[55]

### 2511. *Statutory Law*

The common law in the United States has been modified by statute from time to time. This is known as *statutory law*. In its broad sense, statutory law is used to refer to the enacted law, including such enactments as written constitutions or treaties. The most numerous illustrations of enacted law in the United States and in the states are the statutes enacted by the legislative departments of government, namely, the Congress and the state legislatures, respectively.[56]

In relation to the common law, statutes may declare or supplement, or they may supersede. A statute is declaratory of the common law when it merely affirms existing principles, while it is supplementary only when it does not displace the common law any more than is clearly necessary. But a statute supersedes when it is inconsistent with the common law.

There is one limitation on statutory law, whether legislatively created or the result of an administrative regulation, that overrides everything else—it must be in conformity with the Constitution of the United States. If it is not, then the Constitution must prevail.[57]

54. Judiciary Act of 1789 (1 Stat. 73, 92).

55. *Erie R. Co.* v. *Tompkins,* 304 U.S. 64, 78 (1938).

56. Insofar as is pertinent to the subject matter of this publication, statutory law may be subdivided into the following categories: (1) federal and state constitutions; (2) federal and state statutes; (3) federal treaties; (4) executive orders and proclamations of the President and of the state governors; and (5) administrative regulations of heads of departments, boards, and commissions, when authorized by statutes.

57. This is because Art. VI, cl. 2 of the Constitution makes it the supreme law of the land. This doctrine of supremacy and of the power of the courts to pass on the constitutionality of legislation was finally fixed by the Supreme Court in the case of *Marbury* v. *Madison, supra* note 24. The court did not claim a general power to nullify acts of Congress; the review of legislation arises incidentally in the decisions of cases. The theory on which the Court operates is that the Constitution is the final source of power and if a rule of lesser authority is in conflict with the basic law, the judiciary will act as though the lesser rule did not exist. GAVIT (1951), *op. cit. supra* note 50, at 49. It is pertinent in this regard to note here that in passing on the constitutionality of legislation the duty of the court is to determine the intention of the people from whom the constitution emanated. In this process of construction, no rules or principles have yet been formulated that reduces it to a purely mechanical one. A rule may be employed in one instance and rejected in another. The most important single factor in construing and interpreting the Constitution is the language in which it is expressed. Words are to be taken in their natural sense, except legal and technical terms which are given their technical meaning. Where ambiguities in

In the construction of statutes by the courts, the underlying object is to ascertain the meaning and will of the enacting body. This meaning is sought first in the language of the statute itself. If the language is clear and unambiguous, the statute will be interpreted according to the plain meaning of the words used. But where the language is ambiguous and is susceptible of two or more interpretations the intended meaning must be sought by the aid of all pertinent and admissible considerations. One of these sources is the legislative history of the statute, including committee reports and congressional debates.

## 252. The Civil Law

The civil law is characterized by emphasis upon statutes and also upon codes of law. Much of this system is traceable to the code prepared for the Roman Emperor Justinian and known as the Justinian Code of 533 A.D. One of the more famous civil codes, also founded on the Roman law, is that of France, prepared for Napoleon in 1804, and known as the Code Napoleon.[58] Acceptance of this system in a country means that basically the entire law is stated in a written code. It is legislation, sometimes in a most general form. On many important subjects the written statement is quite brief. The function of the court under such a system is to apply a pertinent statutory rule or principle to the facts in hand, rather than to a prior decision under the rule of stare decisis, as in the common-law system.

Because of its Spanish and French background, Louisiana adopted the civil-law system and much of its law is based on the Code Napoleon, but statute and judicial practice have resulted in many departures from the basic civil code and have brought the law a long way towards conformity to the common law.[59]

### 2521. *Application in Common-Law States*

In states where the common law now prevails, grants of land made by foreign governments before the land became part of the United States are held

language exist, they are resolved by resort to extraneous aids for discovering the intent of the framers. These may include a consideration of the history of the times when the provision was adopted and of the purposes aimed at in its adoption, the debates of constitutional conventions, contemporaneous construction, and practical construction by legislative and executive departments. Rottschaefer, Constitutional Law 18, 19 (1939) (citing cases in support of these rules).

58. Rodee, etc. (1957), *op. cit. supra* note 10, at 65.

59. By act of Congress, the situation in Puerto Rico is similar to that in Louisiana. This was originally true as to Hawaii, but only a limited amount of its civil law background is now in effect. Alaska is a common-law jurisdiction. Gavit (1951), *op. cit. supra* note 50, at 44. In Texas, the civil law was in force up to 1840, when its congress adopted the common law. Act of congress of Jan. 20, 1840, Laws 1840, sec. 2, p. 1.

to be governed by the law in force at the time of the grant. Thus, it was held undisputed that land in San Pablo Bay, Calif., which was originally granted by Mexico to one Castro, was governed by the Mexican law [the civil law] and that, under that law, the title of an owner of land bordering on navigable waters ran to the line of the highest high tide.[60]

## 26. LAWS AND THEIR RANK

Laws in the United States rank in authority in the following order: (1) the Constitution of the United States; (2) the statutes and treaties of the United States; (3) the constitutions of the states; (4) the statutes of the states; and (5) the common law.[61]

It has already been noted in 2511 that the Constitution is the supreme law of the land, consequently if one of its provisions is applicable in a controversy no other law need be looked to. The statutes and treaties of the United States are of coordinate rank, a later treaty superseding a prior, inconsistent statute, and a later statute superseding a prior, inconsistent treaty.[62] While the constitution and statutes of a state must give way to the Constitution, statutes, and treaties of the United States, where only the law of a particular state is involved the constitution of the state is supreme. Finally, where a conflict exists between the common law and enacted precepts, the latter prevail.

Under the separation of powers principle of American government (*see* 2112), the general rule is that Congress (or the state legislatures) cannot delegate the power to make laws. But having enacted statutes and laid down the general rules of action, it may invest executive officers or boards or commissions with authority to make rules and regulations for the practical administration of such statutes in matters of detail and to enforce the same, and also to determine the facts on which application of the law depends.[63]

60. *Stewart* v. *United States*, 316 U. S. 354, 359 (1942). In New York, the titles to considerable bodies of land are based on grants by the Dutch Government, and therefore the courts interpret such grants according to the law which the Dutch accepted and practiced at the time of the grant. Thus, in *Grace* v. *Town of North Hempstead*, 152 N. Y. Supp. 122 (1915), where the question at issue was the title to the waters and bed of Manhasset Bay in Long Island Sound, under a grant made in 1644 by the Dutch Governor to the Town of Hempstead, it was held that under the Roman-Dutch law (the civil law) of that date rivers and their beds were alienable and subject to proprietary rights. Therefore, the grant of ports and havens to the Town of Hempstead was valid and it in turn had authority to alienate. (There was indication that the *early* Roman-Dutch law recognized such water rights as common to all and not subject to private appropriation.)

61. SMITH (1939), *op. cit. supra* note 14, at 79.

62. *Foster* v. *Neilson*, 2 Pet. 253 (27 U.S., 1829).

63. *Interstate Commerce Commission* v. *Goodrich Transit Co.*, 224 U.S. 194, 214 (1912).

Similarly, the President has authority to issue Executive orders and his subordinates have authority to promulgate rules for the regulation of the internal affairs and procedure of the executive departments and its subdivisions, but such rules and orders are not statutes in any sense, and in a proper case courts may inquire into the validity of the regulation.[64] Principles analogous to these apply in general to the similar regulations issued by state executive officers, boards, and commissions.

64. In *Boyle* v. *United States*, 309 F. 2d 399 (1962), the United States Court of Claims reversed the action of the Civil Service Commission (concurred in by the Comptroller General) in deducting from the amounts payable to plaintiff, who was employed by the Government on a contractual basis after retirement, portions of his retirement annuity as was allocable to the period of the services rendered. But in *Baehr* v. *United States*, the Court of Claims, in a court order of May 18, 1962 (no written opinion), denied to federal employees the right to appeal Civil Service Commission's job classification standards which determine their salaries. On appeal, the Supreme Court, in an unwritten opinion, refused to hear arguments from the employees involved, thereby upholding the Commission's position that its job classification standards are not subject to further review or appeal. *Baehr* v. *United States*, 371 U.S. 888 (1962).

# CHAPTER 3

# Land Ownership in the United States

## 31. GENERAL STATEMENT

All the land in the United States, now owned by individuals, formerly belonged either to the Federal Government, to an individual state, or to a foreign nationality which disposed of it to an individual proprietor before that particular territory became a part of this country.

The British claim of dominion over the territory included within the Original Thirteen Colonies was based upon discovery, consummated by possession, the wandering Indian tribes being regarded as having a mere right of occupancy.[1] The dominion and ownership thus acquired was, in some of the colonies, granted by the British Crown to individual proprietors or proprietary companies, by whom parts of the land were in turn granted to individuals.

1. *Johnson* v. *McIntosh,* 8 Wheat. 543 (21 U.S., 1823). This case involved a claim to land based upon grants made by certain Indian tribes which conflicted with the claims of Virginia under her charter of 1609. The question of titles to Indian lands was thoroughly examined by the Supreme Court and the conclusion reached that the fee to Indian lands is in the United States, and, therefore, the Indians are not able to grant titles to the same which the courts would recognize. But the Indian's right of occupancy has always been held to be sacred; something not to be taken from him except by his consent, and then upon such consideration as should be agreed upon. *Minnesota* v. *Hitchcock,* 185 U.S. 373 (1902).

As between the United States and the Indians, the long held rule has been that Indian claims to land may be extinguished by the sovereign without compensation and its justness is not open to the courts unless the Federal Government has recognized them. *Johnson* v. *McIntosh, supra.* The decade from 1930, however, marked a notable period in the history of Indian legislation, and one of the important acts passed by Congress was that of Aug. 26, 1935 (49 Stat. 801), which conferred jurisdiction upon the Court of Claims to adjudicate all claims arising out of the original Indian title to lands occupied by certain tribes and bands in Oregon. Under the Supreme Court's interpretation of this act, the Indians are entitled to recover compensation for lands taken without their consent even though Congress has never formally recognized their claims. *United States* v. *Alcea Band of Tillamooks,* 329 U.S. 40, 53 (1946). An even greater liberal attitude toward Indian claims was manifested by Congress in the Act of Aug. 13, 1946 (60 Stat. 1049), known as the Indian Claims Commission Act, under which "claims based upon fair and honorable dealings that are not recognized by any existing rule of law or equity" may be submitted to the Commission with right of judicial review by the Court of Claims. On the matter of the taking of Indian lands by the United States under the power of eminent domain, *see Federal Power Commission* v. *Tuscarora Indian Nation,* 362 U.S. 99 (1960), where it was held that the prohibition against the alienation of lands from any Indian nation without the consent of Congress, under section 177 of the U.S. Code, does not apply to the United States or its licensees.

In other colonies the title to the soil remained in the British Crown, and grants were made to individuals by the Governor of the colony in the name of the King. After the Revolution, the title of the Crown to lands still undisposed of passed to the states, and lands belonging to the original proprietaries were in some cases confiscated.

The title to all land within the Thirteen Original States is therefore derived, directly or indirectly, from the British Crown, except for considerable bodies of land in the State of New York which are based on grants by the Dutch Government. These grants were recognized and confirmed by the British Crown upon the conquest of that territory.[2]

Land ownership in the United States can thus be divided into three categories—federal (*see* 35), state (*see* 36), and private (*see* 37). These give rise to a variety of waterfront boundary disputes the adjudication of which frequently involves the surveys, particularly the early ones, of the Bureau. An understanding of the background and development of these classes of ownership, and of the authority and methods by which the United States may acquire territory, will aid in better comprehending some of the legal implications involved in these ownerships.

## 32. POWER OF THE UNITED STATES TO ACQUIRE TERRITORY

The Constitution does not expressly confer upon the United States the power to acquire territory additional to that held at the time of the adoption of the Constitution in 1789. This, however, has not prevented it from acquiring territory both within and without the continental area of North America.

### 321. Earliest Acquisition—The Louisiana Purchase

The earliest acquisition of foreign territory by the United States was in 1803 when the Louisiana Territory was purchased from France (*see* 351). There was a body of opinion at the time of this acquisition, and of the later annexation of Texas (*see* 351), that held that there was no constitutional authority to annex foreign territory. Even President Jefferson had doubts as to the constitutionality of the Louisiana Purchase although, upon grounds of political expediency, he urged that the treaty providing for it be ratified, and, if necessary, a constitutional amendment be adopted authorizing an extension of our boundaries. But Jefferson's difficulty seemed to be not so much with

2. Tiffany, A Treatise on the Modern Law of Real Property 830 (1912).

the power of acquiring territory under the Constitution as with the power to incorporate it in the United States as a part thereof. In January 1803, he wrote to Secretary of the Treasury Gallatin as follows: "There is no constitutional difficulty as to the acquisition of territory, and whether when acquired it may be taken into the Union by the Constitution as it now stands will become a question of expediency. I think it will be safer not to permit the enlargement of the Union but by the amendment of the Constitution." [3]

The precedent thus established was acquiesced in and supported by the later decision of the Supreme Court, impliedly first,[4] and expressly later, when it held, shortly after Florida was purchased from Spain, that "The constitution confers absolutely on the government of the Union the powers of making war and of making treaties; consequently, that government possesses the power of acquiring territory, either by conquest or by treaty." [5]

## 322. Sources of Power

Besides the power to acquire territory based on the war-making and treaty powers, other sources of power have been said to be derived from the power to admit new states into the Union, and from the power as a sovereign nation to acquire territory by discovery and occupation, or by any other methods recognized as proper by international usage.[6] The power derived from national sovereignty has been recognized by the Supreme Court in the case of *Jones* v. *United States,* 137 U.S. 202, 212 (1890), where it said: "By the law of nations, recognized by all civilized States, dominion of new territory may be acquired by discovery and occupation, as well as by cession and conquest." [7]

3. Willoughby, The Constitutional Law of the United States (2d ed.) 411 (1929).

4. *Ex parte Bollman,* 4 Cr. 75 (8 U.S., 1807) and *Sere and Laralde* v. *Pitot,* 6 Cr. 332 (10 U.S., 1810).

5. *American Insurance Co.* v. *Canter,* 1 Pet. 511, 542 (26 U.S., 1828). This principle was subsequently reaffirmed by the Court in *Mormon Church* v. *United States,* 136 U.S. 1, 42 (1890), when it said, "The territory of Louisiana, when acquired from France . . . became the absolute property and domain of the United States." The rule has remained unaltered in the years that have followed.

6. Willoughby (1929), *op. cit. supra* note 3, at 408.

7. This case upheld the power of the United States to acquire territory under the Act of Aug. 18, 1856 (11 Stat. 119), the so-called Guano Act, which constituted a blanket grant of authority to the President to proclaim the "appurtenancy" to the United States of certain guano islands. Specifically, the act provides: "That when any citizen or citizens of the United States may have discovered, or shall hereafter discover a deposit of guano on any island, rock, or key, not within the lawful jurisdiction of any other government, and not occupied by the citizens of any other government, and shall take peaceable possession thereof, and occupy the same, said island, rock, or key may, at the discretion of the President of the United States, be considered as appertaining to the United States." The guano islands are scattered all over the Pacific Ocean and the Caribbean Sea. For a description of some of the more important ones and references to source material pertaining to others, *see* Douglas, Boundaries, Areas, Geographic Centers, and Altitudes of the United States and the Several States (2d ed.) 54–56, Bulletin 817, U.S. Geological Survey (1932).

The Oregon Territory (*see* 351) was acquired in 1846 through discovery, occupation, and convention with England.

### 323. Modes of Acquiring Territory

A history of the territorial expansion of the United States shows that territories have been annexed principally by the following three methods: (1) by treaty, (2) by joint resolution of the two Houses of Congress, and (3) by statute.

Annexation by treaty or convention has been the method most used and was followed in the case of the Louisiana Territory, Florida, the Mexican cessions, Alaska, the Samoan Islands, Puerto Rico, the Philippines, and the Virgin Islands.[8] In two instances, that of Texas and Hawaii, sovereignty of the United States was extended over new territory by means of a joint resolution.[9] The least used method is by simple statute and executive action authorized thereby. This was the method used to acquire territory under the Guano Act (*see* note 7 *supra*).

(*a*) *Land Acquisition Within States.*—What has been considered thus far is the power and mode of acquisition of territory by the Federal Government outside the states of the Union. But mention should also be made of the acquisition of land by the Government within the states. This has been done by purchase, a power granted to it by the Constitution,[10] and by an exercise of the right of eminent domain, which is a recognized attribute of sovereignty. Under the first method, the Federal Government has acquired territory in practically every state. In most cases it has been acquired with the consent of the state; in some cases it has been acquired without consent.[11]

Under the second method, that is, the right of eminent domain, the Fed-

8. Willoughby (1929), *op. cit. supra* note 3, at 426. In the case of the Philippines, it was a stewardship which terminated on July 4, 1946, by Presidential Proclamation No. 2695, signed the same date (60 Stat. 1352), but which was authorized by the Congress in 1934 (48 Stat. 456). The islands then became an independent republic. Under the Philippine Rehabilitation Act of 1946 (60 Stat. 128), the Coast and Geodetic Survey continued survey operations in the islands until June 30, 1950.

9. The difference between annexation by treaty and annexation by joint resolution is that under the first a two-thirds favorable vote in the Senate is required, whereas under the second only a simple majority in each of the two legislative branches (with the approval of the President) is required. *Ibid.*

10. Art. I, sec. 8, cl. 17 provides that Congress shall have power "to exercise like Authority [as over the Seat of Government of the United States] over all Places purchased by the Consent of the Legislature of the State in which the Same shall be, for the Erection of Forts, Magazines, Arsenals, dock-Yards, and other needful Buildings."

11. If consent has not been obtained as provided in the Constitution (*supra* note 10), the political jurisdiction of the state is not ousted. The possession of the United States, unless political jurisdiction has been ceded in some other way, is simply that of an ordinary proprietor. In that case, the property, unless used as a means to carry out the purposes of the Government, is subject to the legislative authority and control of the states equally with the property of private individuals. *Fort Leavenworth R.R. Co.* v. *Lowe*, 114 U.S. 525 (1885). But the ownership and use of lands for public purposes, without more, do not withdraw the lands from jurisdiction of the state. *Surplus Trading Co.* v. *Cook*, 281 U.S. 647 (1930).

eral Government has also acquired property in the several states. This right may be defined as the power which inheres in every politically organized society to condemn private property for a public use.[12] It is thus vested in the United States and in each of the several states. As to the United States, the Federal Constitution does not expressly include the power of eminent domain among those conferred upon the General Government, but the 5th amendment impliedly recognizes that the United States possesses the power by providing that private property shall not be taken for public use without just compensation. It also flows from the power expressly granted for carrying into execution the specific powers delegated to the Federal Government. This power is thus not without limit but must be exercised in compliance with the constitutional requirement of "just compensation." Subject to this limitation, the Federal Government's right of eminent domain extends over every foot of its territory. When thus obtained, the lands, like those acquired by direct purchase and without the consent of the states, remain subject to the general political jurisdiction of the states in which they are located. But as property of the United States, they are not subject to taxation by the states.[13]

(*b*) *Extent of Land Acquisition Within States.*—As of June 30, 1961, the Federal Government had acquired, by purchase and otherwise, 56,889,369.3 acres in the various states (including the District of Columbia), of which 16,878.6 acres were in Alaska and 265,706.6 in Hawaii. In addition, it owned

12. *Kohl* v. *United States*, 1 Otto 367 (91 U.S., 1876).

13. *Van Brocklin* v. *Tennessee*, 117 U.S. 151 (1886). Upon admission of the states into the Union, the exemption of lands of the United States from taxation is usually declared. *Id.* at 163. And the legislatures of most of the states have affirmed the same principle by inserting in their general tax acts an exemption of property belonging to the United States. For an enumeration of the existing statutes in the several states *see id.* at 171 *et seq.* As to the right of eminent domain in the several states, it must be exercised in compliance with the "due process" requirement of the Fourteenth Amendment to the Constitution. In addition, the constitutions of most of the states also contain a provision for "just compensation" as in the Federal Constitution. The power of eminent domain, both federal and state, is to be distinguished from the taxing power. Although the latter is also a taking of property for a public use, it is not, in itself, considered a taking without due process, nor does actual compensation have to be made since that would defeat the very purpose of the taxation, but compensation is considered to arise from the benefits of government. A state's police or regulatory power must also be distinguished from the power of eminent domain. No constitutional principle requires a state to pay for property that may have been taken or destroyed in the exercise of such power, if it be a legitimate exercise and does not violate constitutional guarantees. *Pacific Gas and Electric Co.* v. *Police Court*, 251 U.S. 22 (1919).

An important element in the doctrine of eminent domain is the "taking," which raises the problem of what constitutes a "taking." This is usually a question of fact to be deduced from the evidence in a particular case and no generalization is possible other than to note that any interference with ownership, enjoyment, or the value of private property is usually considered as a taking. Thus, interference with the adjacent airspace has been held a taking under certain factual situations (*see* text at note 114 *infra*). And a destruction or impairment of a landowner's riparian rights in a navigable stream that cannot be justified on the basis of some superior public right is considered a taking. *Yates* v. *Milwaukee*, 10 Wall. 497 (77 U.S., 1870). For a comprehensive discussion of "What Constitutes Taking of Property," with citations to authorities, *see* ROTTSCHAEFER, CONSTITUTIONAL LAW 710–718 (1939). *See also* CLARK, A TREATISE ON THE LAW OF SURVEYING AND BOUNDARIES (3d ed.) 596–601 (1959).

349,727,310.5 acres of the public domain in conterminous United States and 361,149,755.6 acres in Alaska.[14]

## 33. STATES, TERRITORIES, AND POSSESSIONS

From the very beginning, the American constitutional system has included other political units than the states. For example, in 1781 New York ceded part of its territory to the General Government. This act was followed by other states and these lands became the first territories of the United States. This was later followed by the acquisition of other lands, some of which acquired territorial status.

Alaska and Hawaii were the only remaining territories of the United States until their admission into the Union in 1959 (*see* 3431 and 3432), all others having been admitted to full statehood. Areas subject to the dominion of the United States which do not have state or territorial status are called "insular possessions," existing examples being the Virgin Islands and Samoa.[15] Insular possessions, while subject to the sovereignty of the United States, are not incorporated as a part of it and hence do not come under the protective clauses of the Constitution. In the case of territories, such as Alaska and Hawaii were, the Constitution was extended to them by statute.[16]

### 331. The District of Columbia

The District of Columbia stands in a different category from areas heretofore mentioned. It was organized under a special provision of the Constitution enabling the United States to acquire territory for the seat of government.[17]

14. GSA, Inventory Report on Real Property Owned by the United States Throughout the World 47 (June 30, 1961). For jurisdictional status of federal lands, *see* GSA, Inventory Report on Jurisdictional Status of Federal Areas Within the States 26–27 (June 30, 1957).

15. Puerto Rico was in the category of an insular possession until July 3, 1952, when Congress approved the constitution of the Commonwealth of Puerto Rico as adopted by the people of the island, and it was given commonwealth status (66 Stat. 327).

16. The Philippine Islands were in the category of an insular possession, but Congress did enact fundamental laws for them and for Puerto Rico which were identical with many of the provisions of the Constitution of the United States. The other possessions are governed under statutes enacted by Congress but their governments are more those of dependencies than is that of Puerto Rico. Weaver, Constitutional Law and Its Administration 139 (1946).

17. Art. I, sec. 8, cl. 17 provides that Congress shall have power "To exercise exclusive Legislation in all Cases whatsoever, over such District (not exceeding ten Miles square) as may, by Cession of particular States, and the Acceptance of Congress, become the Seat of the Government of the United States." The original boundaries of the District of Columbia included cessions from Maryland in 1788 and from Virginia in 1789 and 1791, and included lands on both sides of the Potomac River. For details regarding the present boundaries of the District, and for a discussion of the most recent demarcation of the District of Columbia-Virginia boundary line by the Bureau and the long dispute leading thereto, *see* 422.

The District is neither a state nor a territory in the sense, for example, that Maryland is a state or that Alaska was a territory. It does not possess the attributes of sovereignty as a state does, nor does it have a complete territorial government as a territory would have. In an early case, it was declared by the Supreme Court that the District of Columbia was not a state of the Union within the meaning of Article III, section 2, clause 1, of the Constitution, which gives to the Federal courts jurisdiction in suits between *citizens of different states*.[18] But it is a state as that word is used in treaties with foreign powers in respect to the ownership, disposition, and inheritance of property.[19]

The District is under the exclusive jurisdiction of Congress. It has no self-government (in 1963), but is governed by a board consisting of two commissioners and an officer of the Corps of Engineers of the Department of the Army, usually designated as the Engineer Commissioner, all appointed by the President with the approval of the Senate.

The Federal courts in the District are the District Court of the United States for the District of Columbia and the United States Court of Appeals for the District of Columbia. They have the same powers and exercise the same jurisdiction as the district courts (*see* 221) and the courts of appeals (*see* 222) of the United States. The other courts, such as the Court of General Sessions (formerly the Municipal Court), are non-Federal courts.

## 34. ADMISSION OF NEW STATES

The creation of new states out of existing territory of the United States, to wit, the Northwest Territory (*see* note 61 *infra*), or out of territory subsequently acquired, is derived from Article IV, section 3, clause 1, of the Constitution, which provides that "New States may be admitted by the Congress into this Union." [20] Thus, statehood lies wholly within the discretion of Congress and no

18. *Hepburn and Dundas* v. *Ellzey*, 2 Cr. 445 (6 U.S., 1804). The effect of this decision was to close the Federal courts in the states to inhabitants of the District of Columbia when the sole basis was diversity of citizenship. And they remained closed for 136 years until Congress enacted a statute in 1940 (reenacted in 1948 as 62 Stat. 869, 930) expressly conferring on Federal courts jurisdiction in cases between citizens of the District of Columbia and citizens of another state. This statute came before the Supreme Court in 1949 on a question of constitutionality. While the Court refused to overrule the *Hepburn* case, it held the 1940 statute valid on the ground that "Congress may exert its power to govern the District of Columbia by imposing the judicial function of adjudicating justiciable controversies on the regular federal courts." *National Mutual Insurance Co.* v. *Tidewater Transfer Co.*, 337 U.S. 582, 600 (1949).

19. *Downes* v. *Bidwell*, 182 U.S. 244, 262 (1900).

20. The only expressed limitation upon this power, as defined in the same section of the Constitution, is that no new state shall be formed within the jurisdiction of any other state, nor by the junction of two or more states, without the consent of such states, as well as of the Congress (*see* 342).

legal means exist for compelling action should it refuse to grant the privilege, although it is generally agreed that at the time of the adoption of the Constitution it was probably believed that all "territory held or to be held by the United States was to be regarded as material from which new States were to be created as soon as population and material development should warrant." [21]

The process of admitting new states to the Union is a comparatively simple one. The Constitution itself provides neither the method nor the conditions that must be met by a given territory. It is entirely discretionary with Congress. The usual process for obtaining statehood is for Congress to pass an "enabling act," upon petition from the people of a territory, authorizing the framing of a constitution and laying down certain requirements that must be met. When the conditions have been met, a resolution is passed by Congress reciting this fact, and the territory is declared a state and admitted as such into the Union.[22]

Vermont was the first state to be admitted to the Union. The area comprised within the present limits of the state was included in conflicting grants made by France and England and was simultaneously claimed by Massachusetts, New Hampshire, and New York. After the Revolution these states agreed to the independence of Vermont and by an act approved February 18, effective March 4, 1791 (1 Stat. 191), it joined the Thirteen Original States as a member of the Union.[23]

Ohio was the first of the states to be carved out of the original "Northwest Territory" which was ceded to the Federal Government by the Confederation of States and governed according to the provisions of the Northwest Ordinance of 1787. The provisions were reenacted on August 7, 1789 (1 Stat. 50), upon establishment of the new Government.[24] The date of its admission to statehood is generally regarded as November 29, 1802, when the constitutional convention of Ohio completed its work, although the congressional enabling act was approved April 30, 1802 (2 Stat. 173), and the territorial delegate in Con-

21. WILLOUGHBY (1929), *op. cit. supra* note 3, at 403. This is buttressed by the language used in the several treaties by which the United States acquired the Louisiana Territory, Florida, California, New Mexico, and Alaska. This was to the effect that the territories thus acquired were to be incorporated as integral elements of the United States and ultimately to be erected into states and admitted into the Union in full and equal fellowship with the Original States. *Id.* at 413, 414. Thus, the treaty which provided for the cession of Louisiana declared that "The inhabitants of the ceded territory shall be incorporated in the Union of the United States, and admitted as soon as possible according to the principles of the Federal constitution, to the enjoyment of all the rights, advantages and immunities of citizens of the United States." 8 Stat. 202 (1803).

22. WILLOUGHBY (1929), *op. cit. supra* note 3, at 404. In some cases the final step in the process is a proclamation issued by the President (*see* 3431).

23. DOUGLAS (1932), *op. cit. supra* note 7, at 85, 86.

24. WILLOUGHBY (1929), *op. cit. supra* note 3, at 408.

gress retained his seat until March 1, 1803, from which it would appear that Congress assumed the latter date to be the beginning of statehood.[25]

Texas holds a unique position among the states insofar as statehood is concerned. It is the only state that was an independent republic just prior to admission, and did not pass through the status of a territory but immediately became a state of the Union upon annexation.[26]

### 341. Equality of the States—The "Equal Footing" Clause

The Constitution does not directly mention that all the existing states are to be equal in stature or that new states are to be admitted on an equal footing with the other states. But it does define the political privileges which the states are to enjoy and declares that all powers not granted to the United States shall be reserved to the states. This has been held to establish an indestructible Union composed of indestructible states that are equal in power, dignity, and authority, each competent to exert that residuum of sovereignty not delegated to the United States by the Constitution itself.[27]

This principle of the equality of the states had its origin even before the adoption of the Constitution. In a resolution passed by Congress on October 10, 1780, it was provided that new states should be formed in such territories as might be ceded to the United States by the Original States and that they should have "the same rights of sovereignty, freedom and independence, as the other states" (18 Journs. of Cong. 915 (1780)). The Northwest Ordinance of 1787 (*see* text at note 24 *supra*) declared that the new states that were to be carved out of the territory should be admitted "on an equal footing with the original States in all respects whatever." And this has become a fixed principle in the

25. Douglas (1932), *op. cit. supra* note 7, at 186, 187. For dates of admission to the Union of the various states, *see* Table 1. This is based on information contained in *id.* at 86–242. The Thirteen Original States (*see* note 64 *infra*) are omitted from this tabulation since strictly speaking they were not *admitted* to the Union but *formed* the Union. They ratified the Constitution on various dates between 1787 and 1790. *Id.* at 246.

26. By a joint resolution, approved Mar. 1, 1845, Congress gave its consent for admitting the Republic of Texas as a state, provided certain conditions were accepted. 5 Stat. 797. On Dec. 29, 1845, Texas was formally admitted as a state of the Union. 9 Stat. 108. The only other state that was formerly an independent republic is the new State of Hawaii and was known as the Republic of Hawaii, but unlike Texas it acquired territorial status first (*see* 3432).

27. In laying down the rule that admiralty jurisdiction applied to navigable waters above the ebb and flow of the tide as it did to tidal waters, the Supreme Court of the United States said: "The Union is formed upon the basis of equal rights among all the states. . . . And it would be contrary to the first principles on which the Union was formed to confine these rights to the states bordering on the Atlantic, and to the tide-water rivers connected with it, and to deny them to the citizens who border on the lakes, and the great navigable streams which flow through the western states. Certainly such was not the intention of the framers of the Constitution. . . . That equality does not exist, if the commerce on the lakes and on the navigable waters of the West are denied the benefits of the same courts and the same jurisdiction for its protection which the Constitution secures to the states bordering on the Atlantic." *The Genesee Chief* v. *Fitzhugh*, 12 How. 443, 454 (53 U. S., 1851).

TABLE 1.—*Admission of States to Union*

[Numbers in parentheses indicate order of admission.]

| State | Organized as territory | Admitted to Union |
|---|---|---|
| Alabama (22) | Mar. 3, 1817 | Dec. 14, 1819 |
| Alaska (49) | Aug. 24, 1912 | Jan. 3, 1959 |
| Arizona (48) | Feb. 24, 1863 | Feb. 14, 1912 |
| Arkansas (25) | July 4, 1819 | June 15, 1836 |
| California (31) | | Sept. 9, 1850 |
| Colorado (38) | Feb. 28, 1861 | Aug. 1, 1876 |
| Florida (27) | Mar. 30, 1822 | Mar. 3, 1845 |
| Hawaii (50) | June 14, 1900 | Aug. 21, 1959 |
| Idaho (43) | Mar. 3, 1863 | July 3, 1890 |
| Illinois (21) | Mar. 1, 1809 | Dec. 3, 1818 |
| Indiana (19) | July 4, 1800 | Dec. 11, 1816 |
| Iowa (29) | July 3, 1838 | Dec. 28, 1846 |
| Kansas (34) | May 30, 1854 | Jan. 29, 1861 |
| Kentucky (15) | | June 1, 1792 |
| Louisiana (18) | Mar. 26, 1804 | Apr. 30, 1812 |
| Maine (23) | | Mar. 15, 1820 |
| Michigan (26) | June 30, 1805 | Jan. 26, 1837 |
| Minnesota (32) | Mar. 3, 1849 | May 11, 1858 |
| Mississippi (20) | Apr. 7, 1798 | Dec. 10, 1817 |
| Missouri (24) | June 4, 1812 | Aug. 10, 1821 |
| Montana (41) | May 26, 1864 | Nov. 8, 1889 |
| Nebraska (37) | May 30, 1854 | Mar. 1, 1867 |
| Nevada (36) | Mar. 2, 1861 | Oct. 31, 1864 |
| New Mexico (47) | Sept. 9, 1850 | Jan. 6, 1912 |
| North Dakota (39) | Mar. 2, 1861 | Nov. 2, 1889 |
| Ohio (17) | | Mar. 1, 1803 |
| Oklahoma (46) | May 2, 1890 | Nov. 16, 1907 |
| Oregon (33) | Aug. 14, 1848 | Feb. 14, 1859 |
| South Dakota (40) | Mar. 2, 1861 | Nov. 2, 1889 |
| Tennessee (16) | | June 1, 1796 |
| Texas (28) | | Dec. 29, 1845 |
| Utah (45) | Sept. 9, 1850 | Jan. 4, 1896 |
| Vermont (14) | | Mar. 4, 1791 |
| Washington (42) | Mar. 2, 1853 | Nov. 11, 1889 |
| West Virginia (35) | | June 19, 1863 |
| Wisconsin (30) | July 3, 1836 | May 29, 1848 |
| Wyoming (44) | July 25, 1868 | July 10, 1890 |

admission of new states. It was embodied in slightly different language ("a new and entire member of the United States of America") in the statute admitting the first state (Vermont) to the Union of States (*see* text at note 23 *supra*). Subsequent statutes of admission generally used the phrase "on an equal footing." For example, in admitting Hawaii, the fiftieth state, the statehood act reads "is declared admitted into the Union on an equal footing with the other States in all respects whatever" (73 Stat. 4 (1959)).

Although this policy has been rigidly followed by the Congress from the beginning, it had in many cases attached various types of conditions to the acts of admission that it considered binding upon the would-be states.[28] Although the practice of attaching restrictions on new states was followed for a long time, the question of their binding force was not fully dealt with judicially until 1911, when the question of the condition imposed by Congress upon Oklahoma restricting the moving of its capital (*see* note 28 *supra*) was raised in the Supreme Court. In sustaining the right of Oklahoma to move its capital at its discretion, regardless of the condition, the Court enunciated the important doctrine of the political equality of the states, to wit, that "when a new State is admitted into the Union, it is so admitted with all of the powers of sovereignty and jurisdiction which pertain to the original States, and that such powers may not be constitutionally diminished, impaired or shorn away by any conditions, compacts or stipulations embraced in the act under which the new State came into the Union, which would not be valid and effectual if the subject of congressional legislation after admission."[29]

But the equal-footing doctrine is considered not to be impaired when the condition of admission pertains purely to a matter of internal policy of the state, such, for example, in reference to property. This involves no question of equality of status, but only of the power of a state to deal with the Nation in reference to such property.[30] And neither is it impaired because of diversity

28. This stems from the discretionary power which Congress has over the admission of new states (*see* 34). Thus, when Ohio was admitted in 1802, a condition of admission was that it would not tax the public lands sold by the United States for 5 years (a similar requirement was demanded of many of the states subsequently admitted). When the enabling act for Utah was passed in 1894, it was provided that public schools must be maintained free from sectarian control; and in the case of Oklahoma, the enabling act of 1906 provided that the capital city of the state should be at Guthrie and should not be changed prior to 1913. WILLOUGHBY (1929), *op. cit. supra* note 3, at 311.

29. *Coyle* v. *Smith*, 221 U. S. 559, 573 (1911). The Court held that the restriction in the act of admission relative to moving the seat of government was invalid because if Oklahoma was admitted on an equal footing with the Original States, she, "by virtue of her jurisdictional sovereignty as such a State may determine for her own people the proper location of the local seat of government. She is not equal in power to them if she cannot." *Id.* at 579.

30. It was thus held by the Supreme Court, in *Stearns* v. *Minnesota*, 179 U. S. 223 (1900), that a provision in the act admitting Minnesota to the Union whereby the state received from the United States valuable public lands in return for which it agreed not to tax the land still owned in the state by the Federal Government, could be enforced in a subsequent effort of the state to violate it.

in the economic aspects of the several states resulting from differences in area, location, geology, and latitude. The requirement of equal footing is designed not to wipe out such diversities, but to create parity as respects political standing and sovereignty.[31]

### 3411. *Application to Tidelands and Submerged Lands*

The equal-footing principle has been held to have a direct effect on certain property rights and has been applied by the Supreme Court in connection with state ownership of tidelands (lands between high and low water) and lands under inland navigable waters, and federal paramount rights in the submerged lands along the open coast seaward of the low-water mark.

In an early case involving a controversy over a tideland area bordering on the Mobile River in Alabama (a subsequently admitted state), the Court held that when Alabama ceased to be a territory and was admitted into the Union as a state, she was thereby placed "on an equal footing with the original states." And since the shores of navigable waters and the soils under them were not granted by the Constitution to the United States they were reserved to the states as an attribute of sovereignty. Alabama, therefore, acquired the same rights in such lands by virtue of her admission on an equal footing with the Original States.[32] This rule has never been departed from.

Recently, the scope of the "equal footing" doctrine was considered by the Supreme Court and given a new interpretation in connection with ownership of the submerged lands off the coast of Texas. The rule set out in the *Pollard* case (*supra* note 32) is the normal application of the doctrine, that is, no state can be deprived of such property rights if others possess them; otherwise the states would not be equal in power, dignity, and authority. But in *United States* v. *Texas, supra* note 31, the Court held that the "equal footing" doctrine works also in the converse and prevents extension of the sovereignty of a state into the domain of national sovereignty from which other states have been excluded. *Id.* at 717. Since it had previously found that none of the Original States separately acquired ownership of the submerged lands off their coasts, and that the Federal Government, rather than the states, had paramount rights in these lands (*United States* v. *California, supra* note 32), it now held that whatever rights Texas may have had as an independent

31. *United States* v. *Texas,* 339 U.S. 707, 716 (1950) (*but see* 3411).

32. *Pollard's Lessee* v. *Hagan,* 3 How. 212, 229, 230 (44 U.S., 1845). This case was invoked by California in support of its contention of state ownership of submerged lands in the marginal belt, but the Supreme Court rejected this contention. *United States* v. *California,* 332 U.S. 19, 36 (1947). (*See* Volume One, Part 1, 112.)

republic were relinquished upon her admission into the Union on an "equal footing" with the other states (*see* Volume One, Part 1, 13).

## 342. Compacts Between States

Compacts or agreements between the states have been made ever since the formation of the United States. These are authorized by Article I, section 10, clause 3, of the Constitution which provides that "No State shall, without the Consent of Congress . . . enter into any Agreement or Compact with another State." [33] There has never been any doubt that when congressional assent is given, states may enter into such compacts. The provision is in effect a legal device for adjusting interstate relations, the requirement of congressional consent insuring that national interests will not suffer in the process.

It would be difficult to establish specific guide lines for determining what compacts require consent and what compacts do not. The circumstances in a given case would have considerable bearing on the decision. But the principle that the Supreme Court has enunciated is that congressional assent is required only if the interstate compact or agreement tends to increase the political power or influence of the states or which may encroach or interfere with the full and free exercise of federal authority.[34] As to the consent itself, the Constitution does not state when or how the consent shall be given, and it has been held that it may be given before or after the compact is made and may be expressed or implied.[35]

33. Compacts between the states were a practice that existed even prior to the adoption of the Constitution, one of the most noteworthy being the Compact of 1785 between Maryland and Virginia by which Virginia was allowed free fishing rights in the Potomac River in return for Maryland's right of free navigation through the Virginia capes (*see* 4211, particularly note 14 thereof).

34. *Virginia* v. *Tennessee*, 148 U.S. 503 (1893). This is a leading case on the subject of compacts. There is no difference between the terms "compacts" and "agreements" other than that the former is generally used with reference to more formal undertakings than is usually implied in the latter.

35. *Id.* at 520. As authority for an implied consent, the Court cited Justice Story to the effect that where a state is admitted into the Union, notoriously upon a compact made between it and the state of which it previously was a part, the act of Congress admitting such state is an implied consent to the terms of the compact. *Id.* at 521. Although the Court did not cite the case by name this was the situation in *Green* v. *Biddle*, 8 Wheat. 1 (21 U.S., 1823), which involved the admission of Kentucky into the Union pursuant to a compact between Virginia and the district of Kentucky (a part of Virginia) erecting the district into an independent state. Justice Story in his Commentaries on the Constitution of the United States (Vol. II, 4th ed. 265 (1873)) actually spells out the compact between Virginia and Kentucky and cites *Green* v. *Biddle*, *supra*, as authority for implied consent. The oblique boundary between California and Nevada was established by the Coast Survey in 1893–1899 and was accepted by both states as the true boundary, but has not yet been confirmed by Congress. Douglas (1932), *op. cit. supra* note 7, at 237. However, on the doctrine of *Virginia* v. *Tennessee*, *supra* note 34, and *Green* v. *Biddle*, *supra*, it would seem that confirmation would be implied from the fact that Congress did describe the boundary and appropriated funds for the partial cost of the survey. Annual Report, U.S. Coast and Geodetic Survey 287, 314 (1900), and 27 Stat. 357 (1892).

Recently, the question arose for the first time whether an interstate compact once consented to was subject to future investigation by Congress to discover if it is still in the interest of the United States and if the task for which the compact was permitted by Congress was being performed, or whether the con-

### 3421. *Interstate Boundaries*

A common area of compacts between states is in the adjustment of their boundaries. If the boundary established is to cut off an important and valuable portion of a state, the political power of the state enlarged would be affected by the settlement of the boundary. Hence, an agreement to adopt such a boundary, it has been said, would probably require the consent of Congress. However, where the running of a boundary simply serves to mark and define what actually existed before, but was undefined and unmarked, the agreement to run the boundary line, or its actual survey, would not require the consent of Congress.[36]

Acceptance of jurisdiction by the Supreme Court over boundary disputes between states had its origin in the case of *Rhode Island* v. *Massachusetts,* 12 Pet. 657 (37 U.S., 1838), where the Court overruled a motion by Massachusetts to dismiss the request of Rhode Island to ascertain and establish the disputed northern boundary between the states. The reasoning of the Court was that when the several states adopted the Constitution they made a grant to the United States of judicial power over controversies between two or more states (*see* 22 and 223), and that by the Constitution, it was ordained that this judicial power be exercised by the Supreme Court. Since there can be but two tribunals—the legislature or the judiciary—under the Constitution that can act on the boundaries of states, and since the former (Congress) is limited in express terms to assent or dissent where a compact or agreement is referred to

sent is eternal and unalterable. The case dealt with the Port of New York Authority established in 1921 under an interstate compact between New York and New Jersey and consented to by Congress. In an investigation of its operations by a congressional committee, an official of the Authority refused to yield certain internal working papers sought by the committee and was cited for contempt of Congress. At the trial, the citation was upheld. While not prepared to rule that in no situation can privilege attach to documents of a compact agency, the court believed it to be appropriate "in this situation to establish a test which balances congressional need for documents subpoenaed from compact agencies against the dangers to the particular compact involved and to the compact process in general which would result from the particular subpoena and investigation." On the facts of the case the court struck the balance in favor of disclosure. *United States* v. *Tobin,* 195 F. Supp. 588, 612 (1961). On appeal, however, the contempt conviction was reversed on the ground that the House of Representatives had not authorized the committee to subpoena such papers. *Tobin* v. *United States,* 306 F. 2d 270 (1962). On Nov. 13, 1962, the Supreme Court denied without comment a petition for review by the Government. *United States* v. *Tobin,* 371 U.S. 902.

36. *Virginia* v. *Tennessee, supra* note 34, at 520. A recent case of a compact between states, involving a boundary line, is the agreement entered into by Virginia and West Virginia with respect to a portion of their common boundary running through the Allegheny Mountains. The agreed-upon line was submitted to Congress for its consent and was approved Sept. 21, 1959 (73 Stat. 599). In the Maryland-Virginia boundary dispute, the Award of the Arbitrators of 1877 was ratified by both states (this, in effect, was a compact between them) and by Congress (*see* 4211). When the boundary line was run and marked by the Coast Survey in 1930, and ratified by both states, the question arose whether the ratification required the approval of Congress. It was decided administratively that the approval of the Award of 1877 was sufficient and that the actual delimitation of the boundary line merely carried out the award (*see* 4212 A).

it by the states (*see* 342), the power must reside in the Supreme Court or it cannot exist at all. It had been contended that the question of boundaries between states was political rather than judicial and therefore did not come within the purview of the Constitution for the settlement of controversies between states. But the Court said: "There is neither the authority of law or reason for the position, that boundary between nations or states, is, in its nature, any more a political question, than any other subject on which they may contend." *Id.* at 737.

### A. FINALITY OF BOUNDARIES—EFFECT OF ERRORS

Questions have arisen in connection with boundaries as to the effect of errors in the demarcation line on the validity of the boundary. An oft-cited case in this area is *Virginia* v. *Tennessee, supra* note 34. Virginia sought to have her boundary with Tennessee declared null and void and a new line established—85 years after it was approved by both states and was assented to by Congress—on the basis that the boundary line as marked did not follow a due east and west line along the parallel of 36°30′ North, but varied from it from 2 to 8 miles in width for a strip about 113 miles in length.[37] But the Supreme Court denied Virginia's request, stating: "The compact in this case having received the consent of Congress, though not in express terms, yet impliedly, and subsequently, which is equally effective, became obligatory and binding upon all the citizens of both Virginia and Tennessee. Nor is it any objection that there may have been errors in the demarcation of the line which the states thus by their compact sanctioned. After such compacts have been adhered to for years neither party can be absolved from them upon showing errors, mistakes or misapprehension of their terms, or in the line established; and this is a complete and perfect answer to the complainant's position in this case."[38]

37. The validity of the boundary was also challenged on the ground that it was not consented to by Congress (*see* note 35 *supra*).

38. *Id.* at 525. This case was cited by the Supreme Court in *Arkansas* v. *Tennessee*, 310 U. S. 563, 569 (1940), for the doctrine that as between the states of the Union, long acquiescence in the assertion of a particular boundary and the exercise of dominion and sovereignty over the territory within it, should be accepted as conclusive. The boundary between New Mexico and Colorado along the 37th parallel was approved by the Supreme Court on Oct. 24, 1960, pursuant to the report filed in 1960 by the commissioner designated to survey and mark the boundary under a decree of the Court of Apr. 13, 1925. *New Mexico* v. *Colorado*, 364 U. S. 296 (1960). The original case was decided Jan. 26, 1925, where the question was as to the alleged location of the line. Different surveys had been made—one in 1868 (by Darling) and the other in 1903 (by Carpenter), the two lines varying considerably in position. Both surveys were made under authority of the General Land Office, the later survey having been recognized from 1904 to 1908. The Court held the Darling line to control on the ground that for more than a half century this line was recognized successively as the boundary between the two territories, between the State of Colorado and the Territory of New Mexico, and between the two states. "The effect of this recognition of the Darling line

The situation is different, however, where markers on the boundary line have become indistinct or obliterated and it is desired to restore them in their original position. In such situations, an order may be issued for the restoration of such marks without any change of the line.[39]

(*a*) *County Boundaries.*—Similar questions have arisen in the case of county boundaries within a state. The law is well settled that the legislature of a state has the sole power to define and determine the boundary lines between counties and to provide the means or methods by which such boundaries, when in dispute, may be established and marked on the ground. If the legislature has declared the true line of a boundary, the courts cannot declare any other line to be the boundary, in the absence of legislative authority to so declare. But the court can declare and construe the law on the subject.[40]

## 343. Recent Admissions

The most recent admissions to the Union were Alaska and Hawaii—the last of the territories of the United States. The admission of Alaska to statehood was notable in at least one respect—it was the first time that a noncontiguous territory, although on the same continent and separated from the 48 states by foreign lands or international waters, was admitted to statehood. The admission of Hawaii was even more noteworthy because it was a noncontiguous territory completely detached from the American Continent. Thus, by 1959, the whole gamut of acquisition, incorporation, and admission was run, and all doubts as to the constitutionality of any of these acts completely resolved.[41]

by the United States," the Court said, "was not impaired by the temporary recognition of the Carpenter line." (The Carpenter line was accepted by Congress in 1908 as the proper location of the 37th parallel. This was vetoed by the President after which the General Land Office abandoned its recognition of the Carpenter line.) *New Mexico* v. *Colorado,* 267 U. S. 30, 37, 41 (1925)

39. *Virginia* v. *Tennessee, supra* note 34, at 528. Where there is evidence that a boundary marker had been moved it would be proper under the doctrine enunciated in this case to reestablish the marker from the original data.

40. *Trinity County* v. *Mendocino County,* 90 Pac. 685 (1907). In this case, the California legislature had declared that the boundary between the two counties should be the 40th parallel and that its location should be established by a surveyor and that the surveyor, when employed, should "accurately run" the line of the 40th parallel and mark it accordingly. The line so fixed and marked was to be the true boundary. It was contended that the quoted words were a limitation on his power and that if he ran the line inaccurately the survey would be void. But the Supreme Court of California held that the purpose and effect of the act was that, whether correct or not, the line surveyed and marked should thereupon be the true line. The construction contended for, the court said "would leave the county lines always subject to change and uncertainty; for if the line must be absolutely accurate in order to be valid, if the true line of that parallel and not any particular surveyed line thereof is to be the true county line, it would be subject to relocation and change whenever new discoveries, more accurate instruments, or more careful surveys should demonstrate that the previously surveyed line was incorrectly located on the ground." *Id.* at 688.

41. Alaska, although purchased in 1867, was not made a territory until Aug. 24, 1912. 37 Stat. (pt. 1) at 512. Hawaii was formally annexed to the United States July 7, 1898 (30 Stat. 750) (the transfer of sovereignty took place Aug. 12, 1898), and was constituted a territory by act of Apr. 30, 1900, effective June 14, 1900 (31 Stat. 141).

## 3431. *Admission of Alaska*

Alaska, which was an "incorporated" territory of the United States,[42] was admitted to statehood by Presidential Proclamation No. 3269, issued January 3, 1959 (73 Stat. C 16), the enabling act having been approved on July 7, 1958 (72 Stat. 339).[43] No specific boundary provisions are included other than the statement in Section 2 that "The State of Alaska shall consist of all the territory, together with the territorial waters appurtenant thereto, now included in the Territory of Alaska." The state is thus made coextensive with the territory without any exceptions.[44]

The Submerged Lands Act of 1953 (*see* Volume One, Part 2, 11), by which the several states were granted title to the submerged lands seaward of their coasts to their historic boundaries, is made specifically applicable to the State of Alaska.[45]

42. Although Alaska was granted territorial government in 1912, its legal status as an "incorporated" territory was considered settled by the Supreme Court in 1905 (*Rassmussen* v. *United States*, 197 U. S. 516). By that time, the possessions which had been acquired recently from Spain (Puerto Rico and the Philippines) were declared to be "unincorporated" territories, appurtenant to, and dependencies of, the United States, but not a part of the United States. H. Rept. 624, 85th Cong., 1st sess. (1957). The difference between an incorporated and an unincorporated territory is that in the first there is a general applicability of the Constitution with respect to the civil and private rights of the inhabitants, for example, the right to trial by jury, whereas in the second, Congress, in legislating for such territory, is bound by but few of the limitations which apply in the case of incorporated territories. WILLOUGHBY (1929), *op. cit. supra* note 3, at 476.

43. For information bearing on Alaska statehood, *see* H. Rept. 624, *supra* note 42. Alaska was the first territory to be admitted to the Union since Feb. 14, 1912, when, by Presidential proclamation (37 Stat. 1728), the admission of Arizona, the last of the 48 states, was declared in effect.

44. For a description of the boundary of the Territory of Alaska, *see* DOUGLAS (1932), *op. cit. supra* note 7, at 39–45.

45. One effect of the admission of Alaska into the Union was to shift the geographic center of the United States (if there be such a concept as a geographic center of two noncontiguous land areas) from its former position near Lebanon, Kans., in latitude 39°50′ North, longitude 98°35′ West, to its new position in Butte County, S. Dak., in latitude 44°59′ North, longitude 103°38′ West, or a distance of 439 miles in a northwesterly direction. This position, now unmarked, is about 11 miles west of Castle Rock, S. Dak., and 20 miles east of the tristate corner of South Dakota, Montana, and Wyoming. It is near a hill which bears the descriptive name of Two Top Peak. The method used to determine the new geographic center is a variation of the so-called "center-of-gravity" method. The geographic center of the 48 states being known, the geographic center of Alaska (including offlying islands, such as the Aleutians and those in the Bering Sea) was next determined by the center-of-gravity method and found to be at latitude 63°50′ North, longitude 152°00′ West, or about 60 miles northwest of Mt. McKinley. (In this computation, water areas were excluded except for inland waters and straits, passes, canals, etc., in the Alexander Archipelago in Southeast Alaska.) In the final determination of the geographic center of the 49 states, the 3,022,387 square miles of the 48 contiguous states were weighed against the 586,400 square miles of Alaska, and the new location considered to be at that point along a line of shortest distance between the two centers where the areas would balance. Due to the difficulty of determining the exact geographic center of two, large, irregular and separated areas on a spheroid, the uncertainty of the new location is considered to be about 10 miles in any direction. *Geographic Center of the United States*, Circular of July 30, 1958, U.S. Coast and Geodetic Survey. *See* also *New Geographic Center of the United States*, 18 SURVEYING AND MAPPING 430 (1958). For a discussion of the method of determining the geographic center of the United States, *see* Adams, *Geographical Centers*, 24 MILITARY ENGINEER 586 (1932). (*See* 3432 D for geographic center of the 50 states of the Union.)

### 3432. *Admission of Hawaii*

The Territory of Hawaii is the most recent to be admitted to statehood. It was proclaimed by the President on August 21, 1959 (73 Stat. C 74), under Presidential Proclamation No. 3309, the enabling act for its admission having been approved on March 18, 1959 (73 Stat. 4). As in the case of Alaska, the Submerged Lands Act of 1953 is made applicable to Hawaii, but the Outer Continental Shelf Lands Act of 1953 (*see* Volume One, Part 2, 21), by which jurisdiction of the United States over the submerged lands of the outer continental self was established, is also made applicable.[46]

#### A. ISLANDS AND REEFS OF HAWAII

Section 2 of the enabling act sets out the boundaries of the new state insofar as the inclusion or exclusion of certain islands is concerned. Specifically, it provides that "The State of Hawaii shall consist of all the islands, together with their appurtenant reefs and territorial waters, included in the Territory of Hawaii on the date of enactment of this Act, except the atoll known as Palmyra Island, together with its appurtenant reefs and territorial waters, but said State shall not be deemed to include the Midway Islands, Johnston Island, Sand Island (offshore from Johnston Island), or Kingman Reef [about 35 miles northwest of Palmyra Island], together with their appurtenant reefs and territorial waters." (*See* fig. 95.)

The statehood act is thus quite explicit as to the islands to be excluded from the new state, but it fails to specify the islands that are to be included except by the general reference to "all the islands . . . included in the Territory of Hawaii." The specific islands that constituted the territory must therefore be inferred from other documents. Questions have arisen regarding this and other matters pertaining to the new state and the results of these investigations are summarized and explained herein to eliminate duplication of effort in the future.[47]

The basic document for this purpose is the Report of the Commission on Annexation (S. Doc. 16, 55th Cong., 3d sess. (1898)) and is considered the foundation of the Organic Act of the Territory. In it are enumerated eight

46. The inclusion of the Outer Continental Shelf Lands Act was on recommendation of the Department of the Navy as a technical matter to show explicitly that it will apply to the State of Hawaii. S. Rept. 80, 86th Cong., 1st sess. 29 (1959).

47. The general purpose of the act is to include in the new state those islands that were formerly a part of the Territory of Hawaii. This accounts for the inclusion of two exclusionary provisions instead of grouping all the excluded islands together. It was for the purpose of differentiating between those that were part of the territory and those that were not.

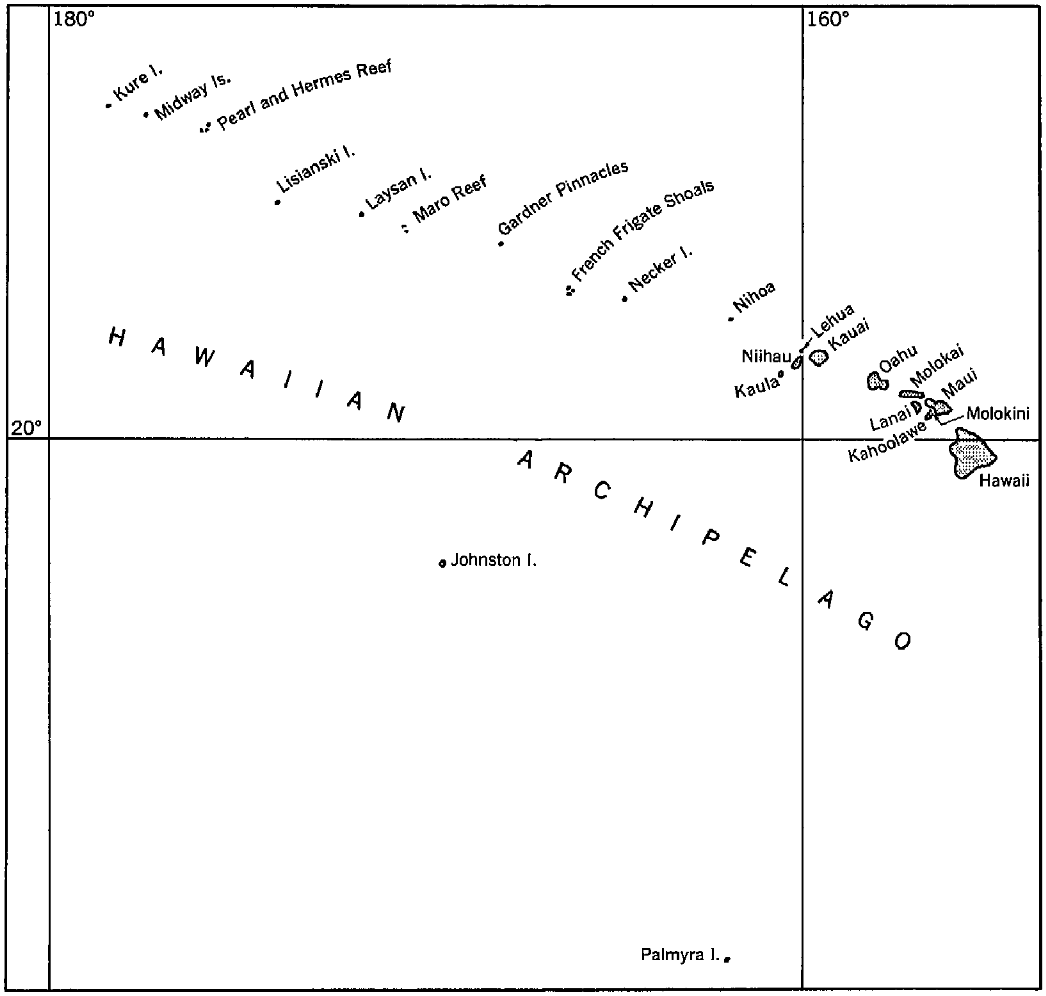


FIGURE 95.—The Hawaiian Archipelago and Johnston and Palmyra Islands.

principal islands (Hawaii, Maui, Molokai, Lanai, Kahoolawe, Oahu, Kauai, and Niihau); a group of small islands, atolls, and shoals (Molokini, Lehua, Kaula, Nihoa, Necker, French Frigate Shoal, Gardner Pinnacles, Laysan, Lisianski, and Ocean (now known as Kure)); and Palmyra Island. To these islands should be added Pearl and Hermes Reef, and Maro Reef, both of which have land exposed at high water.[48]

48. The inclusion of these reefs in the Territory of Hawaii has never been questioned and is supported by the material in the "Index to the Islands of the Territory of Hawaii," prepared by the Territorial Survey Department in 1931, and by a paper contained in the Forty-second Annual Report of the Hawaiian Historical Society (1933). From "Memorandum Re the Islands Now Included in the Territory of Hawaii" (Mar. 16, 1953), by the Deputy Attorney General of Hawaii.

Of the islands excluded from the new state, Palmyra is the only one that was formerly a part of the Territory. The island is small and is owned by one family. Because of its great distance from the main Hawaiian group of islands (about 1,200 miles to the southwestward), the Senate committee that considered the statehood bill did not believe it was an appropriate part of the new state even though it has been included within Honolulu County for census purposes.[49]

The other islands excluded from the State of Hawaii by the statehood act (Midway Islands, Johnston Island, Sand Island, and Kingman Reef), are generally placed in the doubtful category insofar as being a part of the Territory of Hawaii. Although the committee report states that these islands are not considered to be part of the territory (S. Rept. 80, *supra* note 46, at 2), this requires some clarification. To avoid repetitive statements in the following paragraphs, it should be stated here that the first three islands were definitely not included in the enumeration given in the Report of the Commission on Annexation, *supra,* but the fourth, Kingman Reef, could be inferred from the language used (*see* (*d*), below).

(*a*) The *Midway Islands* are commonly, but erroneously, assumed to be a part of the Territory of Hawaii because of their location at the western end of the Hawaiian Archipelago and because they lie between islands that are definitely a part of the territory. They were taken possession of in the name of the United States in 1867 and therefore were not part of the Kingdom of Hawaii that came under the Act of Annexation of 1898 (*see* note 41 *supra*) to become the Territory of Hawaii.[50]

(*b*) *Johnston Island* (formerly referred to as Cornwallis Island) has also sometimes been assumed to be part of the Territory of Hawaii because it is closer to the main Hawaiian Islands than Palmyra Island. The island was visited and taken possession of several times in the 1850's on behalf of the United States and the Kingdom of Hawaii, respectively, and was formally proclaimed by the King as part of Hawaii. However, in 1859, the Attorney General of the United States took the position that the King's proclamation was ineffective to give Hawaii jurisdiction and therefore fell in the same category as the Midway Islands (9 OPS. ATT'Y GEN. 364).[51]

49. S. Rept. 80, *supra* note 46, at 2. It has sometimes been questioned whether Palmyra Island belongs to the Hawaiian group because of its great separation from the main Hawaiian Islands. But this was settled by a 1947 decision of the Supreme Court of the United States (*United States* v. *Fullard-Leo,* 331 U.S. 256), which held that the island was annexed to the Kingdom of Hawaii on Feb. 26, 1862, and came within the territory annexed in 1898. A 1936 decision of the U.S. Geographic Board specifically includes the island as part of the Territory of Hawaii. Although Palmyra Island is not part of the new state and is not owned by the United States in a proprietary sense, it is still subject to the latter's sovereignty.

50. This view was supported by the United States Supreme Court in the case of *Downes* v. *Bidwell,* 182 U.S. 244 (1901) and by the Attorney General of Hawaii in 1905 and 1923 (from "Memorandum Re the Islands Now Included in the Territory of Hawaii," *supra* note 48). A decision of the U.S. Geographic Board in 1936 expressly excludes the islands from the Territory of Hawaii.

51. This position was upheld by the territorial Attorney General in 1923 and it was concluded that Johnston Island was not part of the Territory of Hawaii (from "Memorandum Re the Islands Now Included in the Territory of Hawaii," *supra* note 48). Also, the Supreme Court of the United States in 1947, by a dictum in *United States* v. *Fullard-Leo, supra* note 49, at 262, indicated that Johnston Island (there

(*c*) *Sand Island* (about 1 mile to the northeastward of Johnston Island) is a small island about 1,500 feet in diameter. Both Sand and Johnston Islands are part of the same atoll formation, and it is reasonable to assume that everything said in paragraph (*b*), above, also applies to Sand Island.

(*d*) *Kingman Reef* (about 35 miles northwestward of Palmyra Island) is bare at high water in only a very small part (approximately 2,000 square yards, or about one-half acre). It cannot be stated with certainty whether it was ever a part of the Territory of Hawaii. Although not enumerated as such in the Report of the Commission on Annexation, *supra,* it could be inferred to be included from the words "scattered reefs or shoals," with which the enumeration ends. However, the report on statehood (S. Rept. 80, *supra* note 46, at 2) indicates that only Palmyra Island was considered to be part of the territory, the other excluded islands and reefs being in a different category.[52]

### B. AREAS OF TERRITORY AND STATE

Various values have been given for the area of the Hawaiian Islands. While no great differences have been noted, the question has arisen as to what constitutes the official area of the new state and how it differs from the area of the territory. A study and an original computation for some of the islands and reefs yielded the following values:

(*a*) For the 8 major islands the total area is 6,435 square statute miles. By individual islands the areas are: Hawaii=4,030; Maui=728; Molokai=260; Lanai=141; Oahu=604; Kauai=555; Niihau=72; Kahoolawe=45.[53]

(*b*) For the remaining islands of the state (*see* text accompanying note 48 *supra*), the total area equals 2,401 acres, or 3.8 square statute miles.[54]

(*c*) The total area of the State of Hawaii thus equals 6,435+3.8, or 6,438.8 square statute miles.

(*d*) For the Island of Palmyra, excluded from the new state (*see* text at note 49 *supra*), the actual land area equals 592 acres, or 0.9 square statute mile.[55]

referred to as Cornwallis Island) was not part of Hawaii. A 1936 decision of the U.S. Geographic Board expressly excludes it from the territory.

52. With respect to the Hawaiian Archipelago, Palmyra Island, though part of the territory, was never a part of the archipelago; Midway Islands, while never a part of the territory, are part of the archipelago; and Johnston Island, Sand Island, and Kingman Reef were never a part of either the territory or the archipelago. U.S. Geographic Board (decision of 1936).

53. These figures are based on material prepared in 1959 by the Territorial Surveyor, the Commissioner of Public Lands, and the Deputy Attorney General of Hawaii for the Chairman of the House of Representatives Subcommittee on Territorial and Insular Affairs of the United States Congress. The 1940 Census of the United States gives a corresponding value of 6,419 square statute miles. The figures given in the text are the preferred values primarily because they are probably a later determination, although the overall difference between the two is no more than one-quarter percent, which could be accounted for by the margin of error inherent in the method of measurement, by the different personal equations of the cartographers making the measurements, and by the possible differences in the scale of the charts used by each.

54. These islands and reefs individually have the following areas in acres: Molokini=18; Lehua=278.7; Kaula=108.5; Nihoa=169.6; Necker=45; French Frigate Shoal=66.7; Gardner Pinnacles=5.4; Laysan=1,023.9; Lisianski=377.7; Kure=219.6; Pearl and Hermes Reef=87.5; Maro Reef=0.2.

55. A word of explanation is necessary regarding this value. Palmyra Island is an atoll consisting of many small islets on a barrier reef that encloses three lagoons. If the entire area within the high-water line is included (low-water reef and lagoons), then the area of the island is 3.8 square statute miles. Because of the peculiar situation of the land above high water with respect to the lagoons and the areal ratio of one to the other, only the land above high water is included in the area of the island.

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(*e*) The total area of the Territory of Hawaii was therefore 6,438.8+0.9, or 6,439.7 square statute miles.[56]

### C. SEAWARD BOUNDARIES

Apart from the land areas of Hawaii, as discussed above, the boundaries of the new state include the territorial waters (a 3-mile belt) that surround the various islands and reefs but do not include the waters separating them (*see* 384). Thus, where the channel between two islands is greater than 6 nautical miles, a strip of high seas remains. Vessels plying between two such islands are therefore for a part of the time on the high seas which are not under the jurisdiction of the State of Hawaii. This raises the question of the effect of the commerce clause of the Constitution on interisland commerce.[57] It has been held by the Supreme Court that transportation necessitating passage through waters not under the jurisdiction of a state, even though both termini of the voyage lie within the borders of that state, is not intrastate commerce, but rather foreign commerce for the purpose of the commerce clause of the Constitution.[58] The net effect of this is to vest in Congress full authority to regulate interisland traffic in Hawaii; however, under a well-established principle of constitutional law, the state could exercise such authority should Congress choose to refrain from exercising its own superior authority.[59]

56. The areas given in (*b*) and (*d*) are based on determinations made in the Coast Survey in Sept. 1959, using a polar planimeter and the largest-scale charts and surveys available. They have been computed for the actual land areas (above high water); they do not include shoals and reefs submerged at high water, nor are the appurtenant territorial waters of the various islands included. This is in conformity with the principles adopted by the U.S. Bureau of the Census in 1940 for computing the land area of the United States, where the areas of tidal flats (area between high and low water) were specifically excluded and the mean high-tide line adopted as the limiting line for measurement. The difference between this treatment and the inclusion of reef areas (areas mostly submerged at high water) would in the case of Palmyra Island amount to the difference between 0.9 and 7.3 square statute miles. In the case of Kure Island it would mean the difference between 0.34 and 21.4 square statute miles (a figure of 18 square miles has been frequently given). For a discussion of the principles followed in computing the area of the United States in connection with the 1940 Census, *see* 38. For the area of the territorial sea of Hawaii, *see* 384.

57. Art. I, sec. 8, cl. 3 provides that Congress shall have power "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes."

58. In *Lord* v. *Steamship Co.*, 12 Otto 541 (102 U.S., 1880), it was held that a ship transporting goods from San Francisco to San Diego was engaged in foreign commerce, even though both termini were in California, because the ship of necessity passed outside the 3-mile limit of California's jurisdiction. This interpretation of the meaning of "Commerce with foreign Nations, and among the several States" has been repeatedly reaffirmed, as, for example, in *Hanley* v. *Kansas City Southern Ry. Co.*, 187 U.S. 617 (1903).

59. In *Wilmington Transportation Co.* v. *California R.R. Com.*, 236 U.S. 151 (1915), it was held that sea transportation between the mainland of California and Santa Catalina Island (a part of California) was a matter over which the state could take jurisdiction, notwithstanding such transportation necessitated passage over waters outside California's boundaries, in the absence of congressional action in this area of regulation. The basis for the decision was that there is a distinction between those matters of interstate or foreign commerce where, if any legislation should be enacted at all, it ought to be of a national or general character, and those other matters of interstate or foreign commerce which are distinctly local in character and in which it would be proper for states to act in the absence of federal action. The instant case was held to fall within the second category. A similar doctrine was enunciated

D. NEW GEOGRAPHIC CENTER OF THE UNITED STATES

As in the case of Alaska, the addition of Hawaii to the Union has required a further revision of the geographic center of the United States, but in a much lesser degree. It has now been calculated by the Coast Survey to be in latitude 44°58′ North, longitude 103°46′ West, or about 6 miles in a west-southwest direction from its position determined when Alaska was admitted to statehood (*see* note 45 *supra*). It is still in Butte County, S. Dak., and is approximately 17 miles west of Castle Rock.[60]

## 35. FEDERAL OWNERSHIP—THE PUBLIC DOMAIN

The "public domain" or the "public lands" is the term applied to those areas of land that were turned over to the General Government by the Original States and to such other lands as were later acquired by treaty, purchase, or cession, and are disposed of under authority of Congress.[61] But the meaning of the words "public lands" may vary somewhat in different statutes passed for different purposes, and they are given such meaning in each as comports with the intention of Congress in their use.

The fundamental necessity of federal ownership of lands not included within the boundaries of the several states was early recognized and took form under a resolution of the Congress of the Confederation passed October 10, 1780, which provided for the reception and care of such unappropriated lands as might be ceded by the states to the United States, and for the disposition of such lands for the common good. In pursuance of this policy, cessions were

by the Supreme Court in the early case of *Cooley* v. *The Board of Wardens of the Port of Philadelphia*, 12 How. 299 (53 U.S., 1852), upholding the regulation of pilots by the State of Pennsylvania.

Material in this section is based on a memorandum prepared by the Department of the Interior, Mar. 27, 1953, for the Senate Committee on Interior and Insular Affairs, and published in S. Rept. 80, *supra* note 46, at 73.

60. In computing the new position, the same method was used as in determining the geographic center of the 49 states. The geographic center of Hawaii was determined and the area of the 49 states weighed against the area and location of Hawaii. The new location was considered to be at a point along a line of shortest distance between the two centers where the areas would balance. The uncertainty of the new location is estimated at about 10 miles in any direction. *Geographic Center of the United States*, Circular of Mar. 1959, U.S. Coast and Geodetic Survey. *See* also *Geographic Center of the United States Moves Again*, 19 SURVEYING AND MAPPING 295 (1959).

61. In 1776, when the Thirteen Colonies declared their independence from England, many of them possessed unoccupied territory, much of which was entirely detached and lay west of the Appalachian Mountains. A number of states, including Pennsylvania, New York, Massachusetts, Connecticut, and Virginia, laid claims to areas in what was afterward known as the Territory Northwest of the Ohio River or the Northwest Territory, a region comprising an area of approximately 278,000 square miles and now contained mainly in the States of Ohio, Indiana, Illinois, Michigan, and Wisconsin. These claims were to a greater or lesser extent conflicting, and most of the boundary lines were ill defined. DOUGLAS (1932), *op. cit, supra* note 7, at 63, 68.

made between 1781 and 1802 by seven states—New York, Virginia, Massachusetts, Connecticut, South Carolina, North Carolina, and Georgia—of an area amounting to 259,171,787 acres of land.[62] These transfers were the origin of the public domain. A foundation was thus laid for a common ownership to be exercised on behalf of the entire Nation.

The total land surface of the public domain, including Alaska, aggregated, at its greatest extent, 2.8 million square miles, or approximately the area of conterminous United States.[63] This does not include lands lying within our insular possessions, which have their own laws for the administration of the public lands independent of the national public-land system.

The Thirteen Original States[64] and the States of Kentucky, Maine, Vermont, West Virginia, Tennessee, and Texas were never part of the national public domain and their public lands and records remained with them.[65]

New states took no title to the vacant and unappropriated lands within their borders except as such lands were granted to them by the United States. This, however, did not apply to the tidelands and the lands under inland navigable waters (*see* Volume One, Part 1, 111).[66]

### 351. Principal Accessions to the Territory of the United States

The following are the principal accessions to the territory of the United States (*see* fig. 96):

1. *Louisiana Purchase.* This was the first of several land acquisitions that paved the way for the great western migrations (*see* 321). It was ceded by

62. Proudfit, Public Land System of the United States 1, U.S. Department of Interior (1923).

63. Gumm, *The Foundation of Land Records*, Our Public Lands 4, Bureau of Land Management (Oct. 1957). With the admission of Alaska and Hawaii to statehood, a new nomenclature has been proposed for designating the various geographic groupings of the United States, to wit: *conterminous* United States—the 48 states and the District of Columbia; *continental* United States—conterminous United States plus Alaska; *United States*—continental United States plus Hawaii. *Minutes*, U.S. Board on Geographic Names (July 21, 1959).

64. These comprised New Hampshire, Massachusetts, Rhode Island, Connecticut, New York, Pennsylvania, New Jersey, Delaware, Maryland, Virginia, North Carolina, South Carolina, and Georgia.

65. Gumm, *supra* note 63, at 4. When Hawaii was annexed in 1898, the crown lands of the former monarchy and the government lands became federal lands. The territory had administered the public lands, except federal reservations, for the United States since annexation. S. Rept. 80, *supra* note 46, at 2–3.

66. The enabling act, admitting Alaska to statehood, provides that within 25 years after statehood the state is granted and is entitled to select from lands within national forests in Alaska which are vacant and unappropriated at the time of selection an amount not to exceed 400,000 acres, and from other public lands in Alaska which are vacant, unappropriated, and unreserved at the time of selection another 400,000 acres. An additional 102,550,000 acres are granted during the same period from the public lands in Alaska that are vacant, unappropriated, and unreserved at the time of their selection, bringing the total available to the State of Alaska during the next 25 years to 103,350,000 acres, or 161,484 square miles. 72 Stat. 340 (1958). These grants are in lieu of the grant of land for internal improvements and in lieu of the swamp land grants usually made to new states. *Id.* at 343. (*See* 36.)

France on April 30, 1803. France's title had its origin and was based upon the discovery and proclamation of La Salle on April 9, 1682. The territory purchased was bounded generally by the Mississippi River on the east, and on the west by a line which ran, approximately, along the present eastern boundary of Idaho, and through the center of what are now Colorado and New Mexico. This territory extended north to Canada, and south to the Arkansas River and the present northern boundary of Texas.[67]

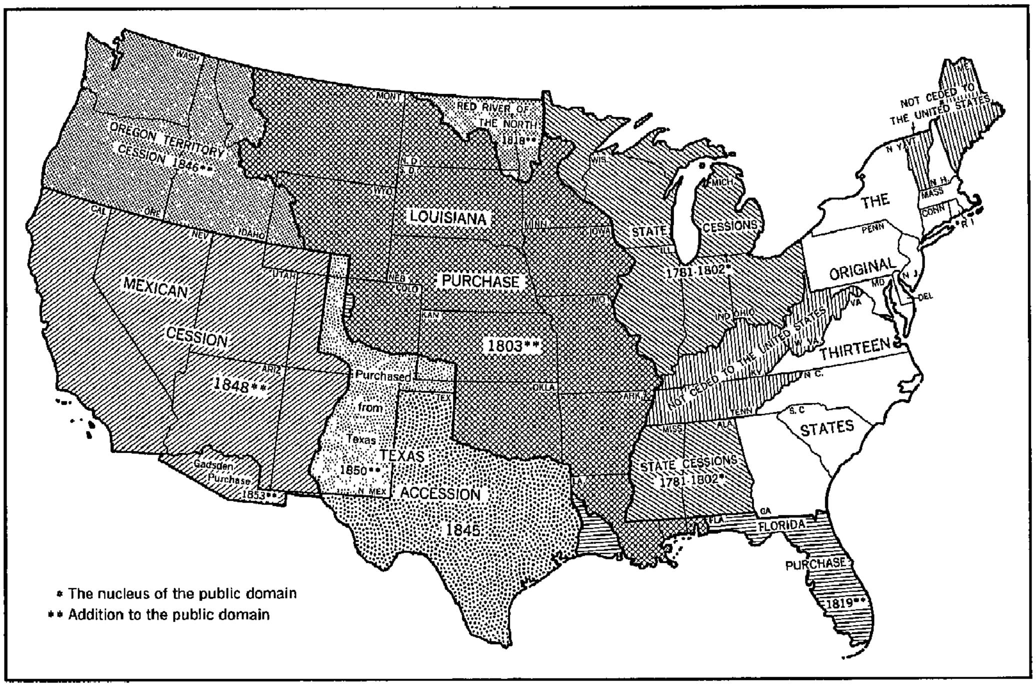


FIGURE 96.—Acquisition of the territory of the United States (exclusive of Alaska and island possessions) and origin of the public domain.

2. *Florida Purchase.* This was the second addition to the territory of the United States. It was ceded by Spain under a treaty dated February 22, 1819. From the date of the Louisiana Purchase, the territory known as West Florida was in dispute between the United States and Spain. The treaty of 1819 settled this and other conflicts and defined the boundary between the United States and the Spanish possessions in the Southwest.[68]

67. TIFFANY (1912), *op. cit. supra* note 2, at 831. For a historical sketch of the original Louisiana and the changes in its boundary during the 137 years between 1682 and 1819, when Florida was purchased from Spain, *see* BOND, THE LOUISIANA PURCHASE SESQUICENTENNIAL (1803–1953), U.S. DEPARTMENT OF INTERIOR (1952).

68. DOUGLAS (1932), *op. cit. supra* note 7, at 35. This treaty was not ratified by Spain until Oct. 20, 1820, after which it was proclaimed by the President on Feb. 22, 1821. *Id.* at 36.

3. *Texas Accession.* The next acquisition of territory was the Republic of Texas, which was admitted as a state by joint resolution of December 29, 1845.[69] The resolution incorporated, by reference, the joint resolution of March 1, 1845 (5 Stat. 797), approving the annexation of Texas. This resolution provided for the retention by Texas of "all the vacant and unappropriated lands within its limits, to be applied to the payment of the debts and liabilities of said Republic of Texas." On September 9, 1850, by act of Congress (9 Stat. 446), the United States purchased from the State of Texas certain lands now included in the States of Kansas, Colorado, New Mexico, Oklahoma, and Wyoming.

4. *Oregon Territory Cession.* In 1846, by treaty with Great Britain, the territory that is now occupied by the States of Washington, Oregon, and Idaho, and parts of Montana and Wyoming, which had been in dispute between the two countries for many years, was ceded by Great Britain, this country ceding in return all claim to the territory to the north thereof.[70]

5. *Mexican Cessions.* On February 2, 1848, by the Treaty of Guadalupe Hidalgo (proclaimed July 4, 1848), which marked the close of the war with Mexico, that nation ceded to the United States, for a modest consideration, territory included approximately within the present limits of California, Nevada, Utah, and within parts of Colorado, Arizona, and New Mexico, extending in effect from the Pacific Ocean to the western limit of the Louisiana Purchase. Subsequently, on December 30, 1853, a second purchase was made from Mexico, adjoining the present Mexican boundary in order to settle a question as to the limits of the cession of 1848. This is known as the "Gadsden Purchase" and lies in the States of Arizona and New Mexico.[71]

6. *Alaska Purchase.* The last of the major acquisitions to the territory of the United States was the purchase of Alaska from Russia. The convention between the two countries was signed March 30, 1867, and proclaimed June 20, 1867.[72]

## 352. Territory Under United States Sovereignty, Jurisdiction, etc.

The territory under the sovereignty, jurisdiction, etc., of the United States comprises, in addition to the 50 states and the District of Columbia, the following: Palmyra Island (*see* note 49 *supra*); Kingman Reef (*see* 3432 A(*d*)); Johnston Island (*see* 3432 A(*b*)); Sand Island (*see* 3432 A(*c*)); Midway Islands (*see*

69. 9 Stat. 108 (1845). Texas was an independent republic from 1836 to 1845.

70. Proudfit (1923), *op. cit. supra* note 62, at 2; Douglas (1932), *op. cit. supra* note 7, at 21.

71. *Id.* at 37–39.

72. *Id.* at 39. For an account of other acquisitions by the United States, including territory leased from foreign governments, *see id.* at 45–59.

3432 A(*a*)); Wake Island; Guam; Howland, Baker, and Jarvis Islands; American Samoa (including the Island of Tutuila, the Manua Islands, and all others of the Samoan group east of longitude 171° west of Greenwich, together with Swains Island); the Commonwealth of Puerto Rico (*see* note 15 *supra*); the Virgin Islands of the United States; Navassa Island; and the Swan Islands.[73]

### 3521. *The Trust Territory*

As a result of World War II, certain islands in the Western Pacific (specifically, the Caroline, Marshall, and Mariana Islands (except Guam)), which were formerly under Japanese mandate, have been placed under the administration of the United States through an agreement with the United Nations (61 Stat. 397 (1947)). They are known as "The Trust Territory."

### 3522. *Rights in Antarctica—The Antarctic Treaty*

On August 10, 1960, the Senate ratified a treaty (known as the Antarctic Treaty) with Russia and 10 other nations, including all 7 which have advanced territorial claims to Antarctica, to maintain the Antarctic as a peaceful international preserve.[74] These countries are those that participated in the Antarctic program of the International Geophysical Year (IGY) of 1957–1958. Through the treaty, the countries accept the following objectives: the Antarctic Continent and surrounding areas shall be used exclusively for peaceful purposes; nuclear explosions and radioactive waste disposal shall be banned in the treaty area; no territorial claims or rights shall either be recognized or affected; freedom of scientific investigation shall be maintained and international cooperation to that end promoted; and complete rights of unilateral inspection shall insure fulfillment of these objectives. Geographically, the treaty applies to the area south of latitude 60° South, including all ice shelves, but does not affect the rights of any nation under international law with regard to the high seas within that area. It is of indefinite duration but may be amended at any time

73. *United States and Outlying Areas,* Geographic Report No. 4 (June 23, 1961), Office of the Geographer, U.S. Department of State. The Canal Zone is under the jurisdiction of the United States in accordance with Art. III of the 1903 Convention between the United States and Panama, and is governed by the Canal Zone Government. In addition to the islands enumerated above, there are some 25 islands in the Pacific Ocean over which the United States claim to sovereignty is disputed by other governments. Chief among these are Canton, Enderbury, Christmas, and Funafuti. Three islets in the Caribbean Sea fall into the same category. There are also certain islands in the Western Pacific to the south of the main Japanese islands, which, as a result of Art. 3 of the peace treaty with Japan, are under United States authority. *Ibid.*

74. 106 CONG. REC. 16090 (1960). For background and text of the treaty, *see* 41 DEPT. STATE BULLETIN 650, 911–917 (1959).

by the unanimous agreement of the consultative parties. After 30 years, amendments may be proposed by majority agreement. The treaty entered into force on June 23, 1961.[75]

### 353. Disposition of the Public Domain

Originally, and for many years thereafter, it was the primary conception of Congress that the public lands would be sold as the main source of revenue for the country. Later, this concept was broadened and the disposition geared to aid in the settlement and industrial development of the country. The preemption law, the homestead act, the townsite acts, the railroad grants, the reclamation acts, and the mineral lands acts were all exemplifications of the new concept.

Grants were also made to states under various enactment statutes (*see* 36). Of the total area of the public domain, about 775 million acres still remain under federal ownership.[76]

It has been the policy of the Government to make no disposition of its public lands until after they have been surveyed and a plat of the survey has been filed with and approved by the Bureau of Land Management (formerly the General Land Office) of the Department of the Interior.[77] When lands are thereafter granted, the plat is a part of the patent or deed (*see* 3532) and binds all parties as to the boundaries of the land conveyed, to the same extent as would be the case if the descriptive features of the plat were set forth in the patent.[78]

#### 3531. *Rectangular System of Surveys*

The rectangular system of surveys was inaugurated by the Continental Congress on May 20, 1785, with "An ordinance for ascertaining the mode of locating and disposing of lands in the western territory, and for other purposes therein mentioned." This is commonly called the "Land Ordinance of 1785." [79]

75. 47 Dept. State Bulletin 40 (1962).

76. Gumm, *supra* note 63, at 4. *See also* note 66 *supra*. Authority for congressional disposition of the public domain is derived from Art. IV, sec. 3, cl. 2 of the Constitution, which provides that Congress shall have power "to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States." This power of Congress to dispose of such property has been held to be without limitation. *Alabama* v. *Texas*, 347 U.S. 272 (1954).

77. *Buxton* v. *Traver*, 130 U.S. 232 (1889).

78. *Cragin* v. *Powell*, 128 U.S. 691 (1888).

79. 28 Journs. of Cong. 375–381 (1785). Thomas Jefferson was chairman of the committee appointed by the Continental Congress to prepare the plan for the survey and disposition of the public lands. Because of this, he has sometimes been mentioned as the originator of the Rectangular System of Surveys. The prevailing opinion, however, seems to be that the system was not the result of any single individual's thinking. Patton, 1 Land Titles (2d ed.) 289 (1957).

The first public land surveys were made under this ordinance. This required the surveys to begin "on the river Ohio, at a point that shall be found to be due north from the western termination of a line which has been run as the southern boundary of the state of Pennsylvania." This southern boundary had been completed in 1784, but the western boundary (common with Virginia) had not been surveyed. It therefore became necessary for the line between Pennsylvania and Virginia (later West Virginia) to be surveyed before the surveys of the public lands could be started. The survey of the west boundary of Pennsylvania was completed in the summer of 1785, and a point on the west boundary at the north bank of the Ohio River marked by a stake on August 20, 1785. Thus was set the mark for the "point of beginning" of the survey of the public lands at a place now known as East Liverpool, Ohio. Actual work on the survey was begun on September 30, 1785, under the personal supervision of Thomas Hutchins—then Geographer of the United States—by running a line west from the point of beginning, as required by the statute. This was intended as a base line to govern the township subdivisional surveys.[80]

That part of the Northwest Territory (*see* note 61 *supra*) which became the State of Ohio was the experimental area for the development of the system. The original intent was to establish townships exactly 6 miles square, these to be divided into 36 sections, each of which was to be exactly 1 mile square (640 acres). No allowance was made for the curvature of the earth and numerous complexities resulted. Successive amendments to the rules were made by acts of Congress as the surveys progressed westward. The culmination of these successive changes is the present system.[81]

Early public land surveys were made under changing systems and until 1910 were generally made by contractors who used crude instruments and often worked under unfavorable field conditions. Consequently, the lines and corners are sometimes in other than their theoretical positions. To eliminate litigation and to avoid costly resurveys, the original corners as established on the ground stand as the legally true corners, regardless of any irregularities in the original surveys (*see* note 129 *infra*).

80. *"Point of Beginning" Commemoration*, 20 SURVEYING AND MAPPING 475 *passim* (1960). For an account of the early surveys of the public lands, *see* PATTISON, BEGINNINGS OF THE AMERICAN RECTANGULAR LAND SURVEY SYSTEM, 1784–1800 (1957). The early acts of the United States Congress that dealt with the sale and survey of the public lands are embodied in the Act of May 18, 1796 (1 Stat. 464), entitled "An Act providing for the Sale of the Lands of the United States, in the territory northwest of the river Ohio, and above the mouth of Kentucky river," and the Act of Feb. 11, 1805 (2 Stat. 313), entitled "An Act concerning the mode of Surveying the Public Lands of the United States."

81. The adoption of the rectangular system marked an important transition from the surveying practices that prevailed in most of the Original Colonies where land grants were made without reference to any system and generally by "metes and bounds" (*see* 3741 C). CLARK (1959), *op. cit. supra* note 13, at 110.

The unit of the system is the *township,* a tract of land approximately 6 miles square; its distinguishing characteristic is that in the main, and in all cases where practicable, its units are in rectangular form. The township layouts are based on two primary lines—a *principal meridian* and a *base line* passing through an *initial point* (*see* fig. 97). The principal meridian is a true north-south line (a meridian) extending both north and south of the initial point, and the base line is a true east-west line (a parallel of latitude) extending both east and west of the initial point. These two lines constitute the axes of a system and the initial point constitutes the origin of that system.

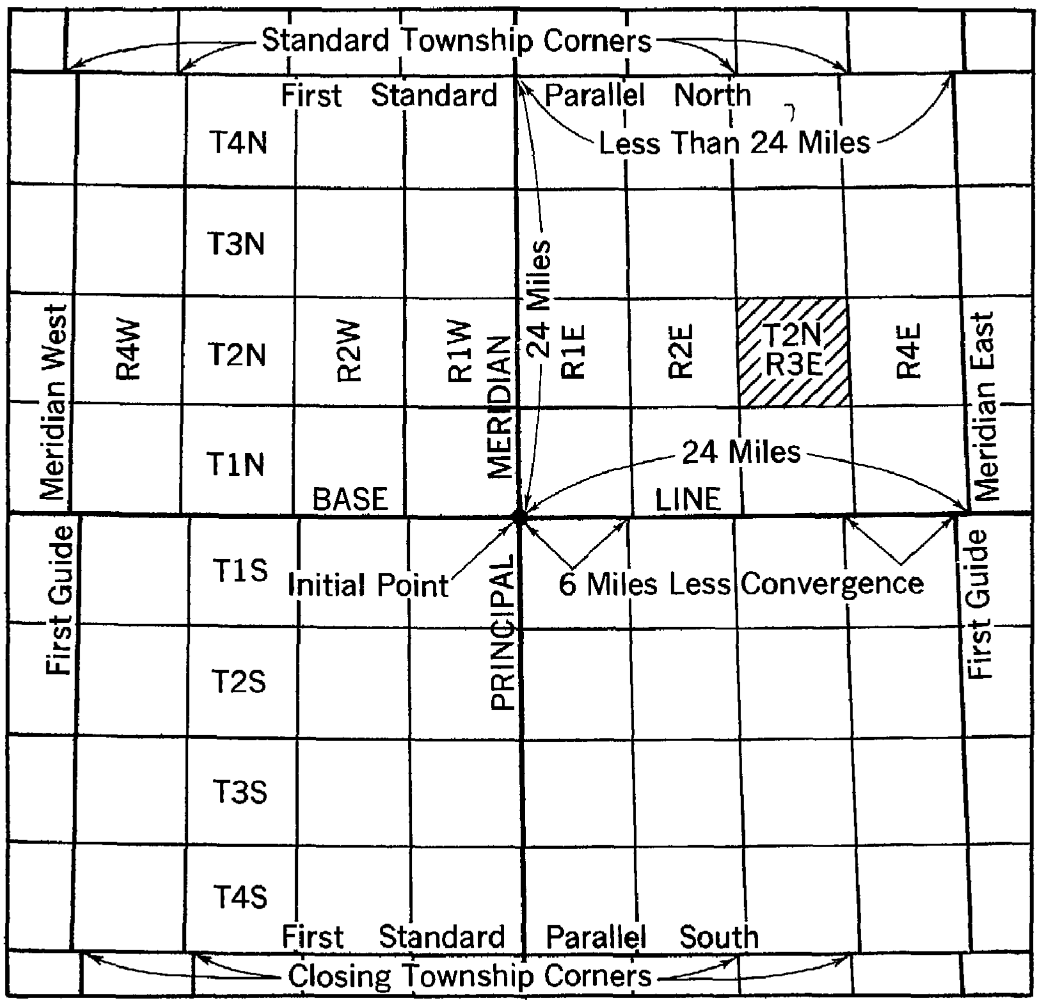


FIGURE 97.—Subdivision of the public lands into 24-mile tracts and townships under the rectangular system of surveys.

Since public land surveys have been in progress simultaneously in widely separated areas of the country, a large number of initial points with corresponding principal meridians and base lines have been established and from these the public land surveys are extended. Subdivisions of the public lands are referenced to their appropriate principal meridian which is designated by name or number.[82]

Surveys of the public lands are under the jurisdiction of the Bureau of Land Management. The law prescribes the chain as the unit of linear measure for the survey of the public lands and all measurements are made in miles, chains, and links. A chain equals 100 links, or 66 feet, and 80 chains equals 1 statute mile, or 5,280 feet. Steel ribbon tapes from 2 to 8 chains in length are used.[83]

Public land surveys are incomplete in the following states: Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.[84]

### A. SURVEY OF 24-MILE TRACTS

Each system to be surveyed is divided into tracts by means of standard parallels or correction lines (true parallels of latitude) located at intervals of 24 miles to the north and south of the base line and by means of guide meridians (true meridians) spaced at intervals of 24 miles east and west of the principal meridian. These meridians start at points on the base line or standard parallels and extend north to the next standard parallel. These two systems of lines form tracts approximately 24 miles square, the largest unit in the public lands system today. (*See* fig. 97.)[85]

82. There are 32 initial points in the United States and no more are contemplated. As of 1947 there were 3 such points established in Alaska. MANUAL OF INSTRUCTIONS FOR THE SURVEY OF THE PUBLIC LANDS OF THE UNITED STATES 166–168, U.S. BUREAU OF LAND MANAGEMENT (1947). (The table on page 168 of that publication gives the latitudes and longitudes for all the initial points and the states they control.) Since 1947 (as of June 1960), two additional principal meridians have been established in Alaska—the Kateel River meridian with initial point at longitude 158°45′31″.014 W., latitude 65°26′16″.374 N. (21 Fed. Reg. 8123 (1956)), and the Umiat meridian with initial point at longitude 152°00′04″.551 W., latitude 69°23′29″.654 N. (22 Fed. Reg. 152 (1957)).

83. MANUAL OF INSTRUCTIONS, etc. (1947), *op. cit. supra* note 82, at 24, 25. Township plats (*see* 3531 B) are generally drawn to a scale of 1:31,680, but scales of 1:15,840, or larger, may be used when necessary for showing portions of townships in detail. The sheet size is always 19 by 24 inches, regardless of the scale. Plats are reproduced by photolithography. *Id.* at 401, 420.

84. *A Program to Strengthen the Scientific Foundation in Natural Resources*, H. Doc. 706, 81st Cong., 2d sess. 51 (1950). For a treatise on the Rectangular System and a history of the development of the public land surveys, *see* STEWART, PUBLIC LAND SURVEY (1935).

85. Because of the convergence of the meridians, the distance between the guide meridians is 24 miles only at the starting points; at all other points the distance is less by the amount of the convergence. There are thus two sets of corners along each standard parallel—one set (standard corners) referring to the guide meridian north of the parallel and the other set (closing corners) less than 24 miles apart established by the guide meridians from the south closing on that parallel.

### B. SURVEY OF TOWNSHIPS

The next subdivision in the system is the *township*. In each 24-mile tract there are 16 townships, each approximately 6 miles square. This is accomplished by means of *range lines* (true meridians) laid out along the base line and each standard parallel in the same way as the guide meridians are laid out (*see* note 85 *supra*), and by township or *tier lines* (true parallels) which join corners on the principal meridian, guide meridians, and range lines. (*See* fig. 97.)[86]

### C. SURVEY OF SECTIONS

The final subdivision in the system under the original ordinance is the *section* (*see* fig. 98). Each township contains 36 sections, each 1 mile square, or 640 acres. Succeeding amendments to the original ordinance provided for further subdivisions into quarter sections, and quarter-quarter sections, the last containing 40 acres each (*see* fig. 99).[87] The sections are formed by straight lines, 1 mile apart, run parallel to the eastern range lines of the townships and by straight east-west lines, 1 mile apart, run parallel to the south township line.

The 36 sections in a township are numbered consecutively from 1 to 36, commencing with No. 1 in the northeast corner of the township, proceeding west to section 6, south to section 7, east to section 12, and so on, alternately, to No. 36 in the southeast corner.[88]

### D. MEANDER LINES

When land which would otherwise be comprised within a section is in part covered by navigable water, "meander lines" are run. These lines are

86. Townships are numbered consecutively as Township 1 North (T1N), Township 1 South (T1S), etc., north and south of the base line to the limit of the system, and east and west of the principal meridian as Range 1 West (R1W), Range 1 East (R1E), etc., to the limit of the system, a complete designation of a township being T1N, R1W. When associated with the principal meridian the description absolutely fixes its location geographically.

87. Sections are not subdivided in the field by the government engineers, but monuments are placed halfway between the section corner monuments and imaginary lines are drawn on the official plats dividing the section into four quarter sections of approximately 160 acres each. Surveys of subdivisions smaller than the section are the work of the local engineer. The government engineer is required so to establish the official section boundary monuments that a proper foundation is laid for the subdivision of the section, whereby the officially surveyed lines may be identified and the subdivision of the section controlled as contemplated by law. MANUAL OF INSTRUCTIONS, etc. (1947), *op. cit. supra* note 82, at 205.

88. A section is defined with reference to the township in which it is located, thus: Section Three, Township One North, Range One West. A subdivision of the same section, for example, a quarter-quarter section, would be defined thus: The northeast quarter of the southeast quarter of Section Three, Township One North, Range One West, or as the case may be for any other quarter-quarter section. In each case, the principal meridian would be designated to fix the parcel geographically. (*See* 3741 A.)

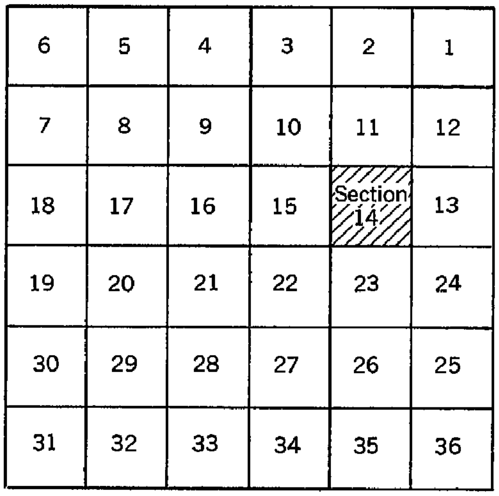


FIGURE 98.—Subdivision of townships into sections. There are 36 sections in each township always numbered as shown in the figure.

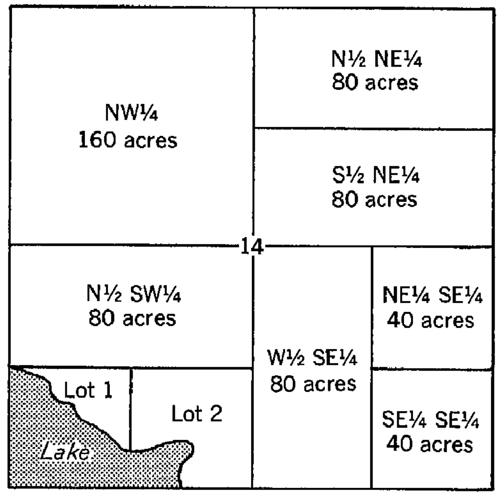


FIGURE 99.—Subdivision of section into quarter sections, half-quarter sections, quarter-quarter sections, and lots.

usually a short distance back from the water's edge. They disregard the minor sinuosities of the shore, and are used as a means of determining the quantity of land in the "fractional" section, as it is called. The meander line is not, however, a boundary line. Whenever a government plat shows a subdivision to be bounded by meandered water, unless there is a clear indication to the contrary, it is the water itself, and not the meander line, which forms the boundary.[89] But there is an exception to this where there is fraud or mistake in running the meander line. If either of these elements is present, the courts have generally held that the meander line is the actual boundary.[90]

89. *Mitchell* v. *Smale,* 140 U.S. 406 (1891). In Nebraska, however, the meander line is presumptively the boundary (*Harrison* v. *Stipes,* 51 N. W. 976 (1892)), and in Michigan, private ownership of land along Lake Michigan is held not to extend beyond the meander line (*Ainsworth* v. *Munoskong Hunting Club,* 123 N. W. 802 (1909)), but the state's ownership of the land between the meander line and the water is subject to a right of access to the water by the riparian owner (*Staub* v. *Tripp,* 226 N .W. 667 (1929)). The State of Washington has adopted a rule that where the federal meander line is below the actual high-water line, a federal patent issued before statehood, or the right to which vested before statehood, carries title as far as the meander line. *Mercer Island Beach Club* v. *Pugh,* 334 P. 2d 534, 536 (1959). This notwithstanding the fact that the federal rule is perfectly clear that the water line and not the meander line is the true boundary. *Hardin* v. *Jordan,* 140 U.S. 371, 380–381 (1891); *City of Los Angeles* v. *Borax Consolidated, Ltd.,* 74 F. 2d 901, 902 (1935), and cases there cited. The Supreme Court of Washington explained the Washington rule as an exercise of the state's power to dispose of lands below the high-water line, pointing out that the state has no corresponding power to deal with lands above the high-water line, as that line marks the limit of the title which is acquired upon statehood. *Washougal Transp. Co.* v. *Dalles, etc., Nav. Co.,* 68 Pac 74, 77 (1902).

90. The judicial statement of the rule regarding meander lines can be summarized as follows: If the body of water is located substantially as shown upon the government plat, it is this natural monument which forms the boundary. But if there never was a body of water in front of a given parcel of land, or if one did not exist there at the time of the survey, then there was no natural object or monument marking the

Another qualification of the general rule is that the meander line will be treated as a boundary line if the meander line is actually or by necessary implication made a boundary of the land sold. So, if a meander line is established at an excessive distance from the actual shore as to leave between its course and the shore an excess of unsurveyed land, as where impassable marsh is encountered but later surveyed and patented by the Government, the meander line will be considered the boundary line of the first tract surveyed and not the shoreline.[91]

### 3532. *Method of Transfer—Federal Patents*

When the Government transfers to an individual a part of the public lands it does so by means of a "patent." A patent is a document that vests in the transferee the complete legal title to the land transferred, or furnishes evidence of the transfer. A patent is necessary to pass a perfect legal title to public lands.[92]

The patent is, in form, a conveyance of the land, and corresponds to a "deed" when the parties to the conveyance are private individuals. When issued, the patent must be signed in the name of the President, either by himself or by his duly appointed secretary, sealed with the seal of the General Land Office (now the Bureau of Land Management), and countersigned by the recorder.[93]

When Congress has made a grant taking effect *in praesenti* (at the present time), a patent is not necessary to transfer the title but its purpose is merely to furnish evidence of the transfer, or to show compliance with the conditions thereof, thus obviating the necessity of other proof of title in any legal controversy that may arise.[94] The Swamp Lands Act of 1850 (*see* 361) is an example of a grant taking effect at the date of the act and not at the time of issue of the patent.[95]

boundary of the parcel; therefore, resort must be had to the secondary evidence, that is, the courses and distances which are ascertainable from the plats and surveys, and they must prevail. *French-Glenn Live-Stock Co.* v. *Springer*, 58 Pac. 102 (1899) (Oreg.) and affirmed by the Supreme Court of the United States in 185 U.S. 47 (1902). This statement of the rule was also approved by the Minnesota court in *Security Land & Exploration Co.* v. *Burns*, 91 N. W. 304 (1902) and affirmed by the Supreme Court in 193 U.S. 167 (1904).

91. *Niles* v. *Cedar Point Club*, 175 U.S. 300 (1899). This case involved fast land lying a considerable distance south of Lake Erie, and was bounded on the north by a boggy, wet marsh adjoining the lake. The patent of the fast land was held to be limited by the original meander line and not to include the marsh land.

92. Patents are also issued by the state governments to transfer title to state lands.

93. *McGarrahan* v. *Mining Co.*, 6 Otto 316 (96 U.S., 1878). Until all these have been done, the United States has not executed a patent for a grant of lands. *Id.* at 320.

94. *Wright* v. *Roseberry*, 121 U.S. 488 (1887).

95. *Id.* at 507. In this case, the lower court had held that inasmuch as the Commissioner of the General Land Office had not certified the lands in controversy as swamp lands there was no title in the state (Calif.) which it could convey. The Supreme Court held this to be an erroneous interpretation of the act on the ground that title passed as of the date of the act and all that was necessary was to show that the lands in question were swamp and overflowed lands on that date and no certificate of the Commissioner was necessary to pass the title. *Id.* at 520–521.

The extent of a federal patent, that is, the limit of the land conveyed is necessarily a federal question. It is a question which concerns the validity and effect of an act done by the United States—a right asserted under federal law. But rights and interests of riparian owners in the tidelands—lands between the high- and low-water marks—which are subject to the sovereignty of the state, are matters governed by local law.[96]

## 36. STATE OWNERSHIP

It has already been noted that the Thirteen Original States and seven other states were never a part of the public domain (*see* notes 64 and 65 *supra* and accompanying text). Their lands remained with them to be disposed of by them under their own laws.

In the remaining states, land ownership included grants by the Federal Government of portions of the public domain under various enactment statutes. Among the more important of these were those for educational purposes. Usually, section 16 in every township, and sometimes also section 32, has been granted to the state or territory for the support of schools. In addition, grants have been made for state universities, agricultural colleges, and for other similar purposes. To each state, also, in which there were public lands, 500,000 acres were granted for internal improvements (Act of Sept. 4, 1841 (5 Stat. 453)).[97]

### 361. Swamp and Overflowed Lands—The Swamp Lands Act

State ownership is also derived from the grant by the Federal Government of swamp and overflowed lands. This had its origin in the Act of March 2, 1849 (9 Stat. 352), when Congress granted to Louisiana all the swamp and overflowed lands within the state for the purpose of aiding in reclamation. The Act of September 28, 1850 (9 Stat. 519), known as the "Swamp Lands Act," extended the grant to other public-land states then in the Union, but states subsequently admitted acquired no rights under it. Similar grants, however, have been made by special acts of Congress to some of the later states.[98]

Under the Swamp Lands Act, all swamp and overflowed lands, within the respective boundaries of the states, which were part of the public domain and were unfit for cultivation were granted to them, if the same were unsold at the

96. *Borax Consolidated, Ltd.* v. *Los Angeles*, 296 U.S. 10, 22 (1935).

97. Tiffany (1912), *op cit. supra* note 2, at 835–836.

98. *Pengra* v. *Munz*, 29 Fed. 830 (1887) (Oreg.). This case construes the Act of Mar. 12, 1860 (12 Stat. 3), extending the swamp lands grant to Oregon and Minnesota.

time of passage of the act and if their character *at that time* brought them within the provisions of the grant. The effect of the act was thus to invest the states *in praesenti* with an inchoate or equitable title to those lands falling within the description of the act, to be perfected into a legal title when the lands were identified as swamp lands (by the Secretary of the Interior) and a patent issued. The legal title, when acquired, related back to the date of the passage of the act. But it did not include swamp lands which the Government had not acquired nor did it free any of them of obligations to which they were subject when the act was passed.[99] On the other hand, if the lands claimed by a state were in fact swamp and overflowed lands on the day the act took effect, then they were not afterwards public lands at the disposal of the United States.[100] And it was held in *State* v. *Gerbing,* 47 So. 353, 357 (1908) (Fla.), that the act did not apply to the lands between ordinary high- and low-water marks (the tidelands) because the title to such lands was not in the United States when the 1850 act was passed, but was in the State of Florida by virtue of its sovereignty on admission into the Union (citing *Mann* v. *Tacoma,* 153 U.S. 273 (1894)).

Questions regarding the nature of the land may arise many years after the passage of the act—witness the cases cited in notes 99 and 100 *supra*—when the land in controversy has been subjected to filling or other man-made improvements. Early surveys of the Bureau, if available, could play a decisive role.[101]

As to what constitutes swamp and overflowed lands under the statute, no uniformity of opinion exists because of the inherent difficulty of laying down a hard-and-fast rule. But certain general tests have been applied by the courts. Thus, for example, it has been held that the proper test is the capacity of the land to produce a staple crop as the result of cultivation. The fact that land is subject to periodic overflow does not of itself constitute it as swamp and overflowed land. But land which is subject to overflow and requires artificial means to subject it to beneficial use is within the statute.

99. *United States* v. *O'Donnell,* 303 U.S. 501, 509–510 (1938). In determining the nature of the land at the time of passage of the act, early Bureau surveys played an important part in the final adjudication of this case (*see* 414).

100. *Wright* v. *Roseberry,* 121 U.S. 488, 521 (1887). In this case, the Supreme Court held that, under the Swamp Lands Act, the action of the Secretary of the Interior in identifying the lands as swamp and overflowed lands is conclusive against collateral attack, but when he has neglected or failed to make the identification, it is competent for the grantees of the state to identify the lands in any other appropriate mode which will effect that object. *Id.* at 509.

101. A case in point is the request of Sept. 17, 1958, from the Interior Department for copies of surveys along a section of the delta area of the Louisiana coast between 1839 and 1851. These surveys were necessary for determining whether or not there were lands in existence on Mar. 2, 1849, or Sept. 28, 1850 (*see* text at note 98 *supra*), and if there were it was essential to know the character of the land. On investigation, it developed that the earliest survey made by the Bureau in this area was dated 1884, but the incident emphasizes the collateral value of these early surveys.

While the terms "swamp lands" and "overflowed lands" have been distinguished, they have also been regarded as synonymous.[102]

### 362. Offshore Submerged Lands—The Submerged Lands Act

The most recent grant of lands by the Federal Government to the states is embodied in Public Law 31, which was approved May 22, 1953 (67 Stat. 29), and is identified as the Submerged Lands Act. Under it Congress confirmed and established the titles of the states to submerged lands under navigable waters within state boundaries. The act confers rights in three categories of cases: lands under inland navigable waters, tidelands (lands between high- and low-water marks), and lands under the open sea. Insofar as the first two categories are concerned, the act is merely declaratory of existing law and gives legislative expression to the doctrines enunciated by the Supreme Court in a long line of decisions beginning with *Martin* v. *Waddell,* 16 Pet. 367 (41 U.S., 1842), and *Pollard's Lessee* v. *Hagan,* 3 How. 212 (44 U.S., 1845) (*see* Volume One, Part 1, 111). The new aspect of Public Law 31 is the granting to the coastal states the submerged lands seaward of ordinary low-water mark and outside the inland waters, which the Supreme Court had held under the paramount rights doctrine to belong to the Federal Government (*see* Volume One, Part 1, 112).[103]

## 37. PRIVATE OWNERSHIP

Private land ownership in the United States comprises those lands that formerly belonged to the Federal Government, to an individual state, or to a

102. *Miller* v. *Tobin,* 18 Fed. 609, 614 (1883) (Oreg.). In this case, it was said that the phrase "swamp and overflowed" as used in the statute is merely the equivalent of the phrase "wet and unfit for cultivation" and therefore land which is too wet for cultivation is swamp and overflowed, whether the water flows over it or stands upon it. On the other hand, it has been held that the word "swamp" without the addition of the word "overflowed" would have conveyed all lands so lacking in drainage as to be temporarily covered by water in the rainy seasons, and therefore the word "overflowed" was added for the purpose of bringing within the statute permanently submerged areas. *McDade* v. *Bossier Levee Board,* 33 S. 628, 631 (1902) (La.). The "permanently submerged areas" referred to in this case were the overflowed swamps and the shallow lakes of Louisiana. It does not apply to the beds of the Great Lakes, or even the smaller lakes, for the reason that such bodies of water are not susceptible of private ownership and because the purpose would not be to reclaim them, as contemplated by the statute. *Ibid.* It has also been held that the term swamp lands refers to lands that require drainage to fit them for cultivation (*Irwin* v. *San Francisco Savings Union,* 136 U.S. 578 (1890)), while the word overflowed refers to a permanent condition of the land and will remain so without reclamation or drainage. *Heath* v. *Wallace,* 138 U.S. 573, 584 (1891). For an enumeration of situations (with citations to cases) where the lands have been held to be within the Swamp Lands Act, *see* 50 *Corpus Juris,* at 999 n. 34, and 73 *Corpus Juris Secundum,* at 764–766.

103. For a comprehensive treatment of the various aspects of the Submerged Lands Act, *see* Volume One, Part 2, chap. 1.

foreign government. Grants made by the Federal Government which form the present basis of private ownership have already been noted in 353. It remains therefore to consider those lands derived from a state or from a foreign government.[104]

### 371. Grants by States

Of the lands within the Thirteen Original Colonies, the larger part had, at the time of the American Revolution, been granted to individuals or to associations, to hold in private ownership, and their rights, except insofar as the lands were confiscated for disloyalty, were not affected by the transfer of the sovereignty to the state. The lands not so encumbered vested in the Original States to be disposed of by them in accordance with a statutory system providing for their survey and sale to persons making formal application to the state authorities.

Grants made to individuals by states which ceded certain lands to the General Government were recognized by the United States in accordance with the agreement of cession.

Within the states formed from territory ceded to the United States by foreign governments (*see* 351) and in which grants have been made by the United States to the states (*see* 353), the latter have disposed of some of the lands so granted to individuals and corporations.

### 372. Grants by Foreign Governments

Within the territory ceded to the United States by France, Spain, and Mexico, there existed, at the time of the cession, private rights based upon grants previously made. These were recognized by the United States after examination of their validity by commissioners named for the purpose, or by the Federal courts.[105]

Lands comprised within the limits of the present State of Texas have been, in succession, the subject of private grants by the Spanish Government, the Mexican Government, the Mexican States of Coahuila and Texas, the Republic of Texas, and the present State of Texas.[106]

104. There is a distinction between ownership and possession. The former signifies the right of possession or use and control of the land owned, whereas the latter signifies a use of the land, whether supported by ownership or not. An owner may not have possession, but he has the right of possession.

105. Tiffany (1912), *op. cit. supra* note 2, at 841; *United States* v. *O'Donnell, supra* note 99, at 511.

106. Tiffany (1912), *op. cit. supra* note 2, at 842. For a comprehensive statement on the main sources of private title in the separate states with reference to original grants to the states, the laws in force, and judicial decisions, *see* Patton, 2 Land Titles (2d ed.) 73–111 (1957).

## 373. Extent of Ownership

According to 16th century English law, *cujus est solum, ejus est usque ad coelum et ad inferos* (to whomsoever the soil belongs, he owns also to the sky and to the depths) was an accepted maxim and rule. That is, the owner of realty, unless there has been a division of the estate, is entitled to the free and unfettered control of his own land above, upon, and beneath the surface.[107] This is a sweeping rule which, with respect to private ownership above the surface, would appear to be completely out of focus with the needs of the modern air age. How 20th century courts have dealt with this maxim and the principles that have been developed are discussed in the following paragraphs.[108]

### 3731. *Above the Surface*

The *ad coelum* doctrine, as it is called, has not been accepted universally with respect to ownership of the airspace. It has been challenged as never having been the law—at least was never taken literally—but rather as a mere figurative phrase to express the full and complete ownership of land and the right to whatever superjacent airspace was necessary or convenient to the enjoyment of the land. Thus, it was said by the Ninth Circuit Court of Appeals

107. Blackstone, 2 Commentaries (Lewis ed., 1902) 18 (1769). For a legal history of the maxim from its earliest conception to its recent consideration, *see* Klein, *Cujus Est Solum Ejus Est . . . Quousque Tandem?* 26 The Journal of Air Law and Commerce 237 (Summer 1959).

108. The upward extent of private ownership is to be distinguished from national sovereignty over the airspace. In the Convention on International Civil Aviation, signed at Chicago in 1944, it is proclaimed that "the contracting States recognize that every State has complete and exclusive sovereignty over the air space above its territory," thus recognizing the old English maxim. But the full scope of this basic international rule has never been established. Nor was it of particular importance that it be more specifically defined. The advent of satellites, missiles, and rockets has, however, emphasized the need for reexamining this rule in terms of the upward extent of a nation's sovereignty—does it end where there is no longer sufficient air to support aircraft, does it stop at the outer limit of the atmosphere, or does it extend into outer space? *See* Hogan, *Legal Terminology for the Upper Regions of the Atmosphere and for the Space Beyond the Atmosphere,* 51 American Journal of International Law 362 (1957); and Bookout, *Conflicting Sovereignty Interests in Outer Space: Proposed Solutions Remain in Orbit!* 7 Military Law Review 23 (Department of the Army Pamphlet No. 27-100-7, Jan. 1960).

Cognizance is being taken on an international level of the possible legal questions that these technological developments raise. On Dec. 13, 1958, the General Assembly of the United Nations adopted a resolution establishing an *ad hoc* committee to report, among other things, on "the nature of legal problems which may arise in carrying out programs to explore outer space." This committee reported to the General Assembly on June 25, 1959 (U.N. Doc. A/4141), but made no determination of precise limits between airspace and outer space. Jessup and Taubenfeld, *The United Nations Ad Hoc Committee on the Peaceful Uses of Outer Space,* 53 American Journal of International Law 877 (1959). Although the problem is new and no agreements have been reached, judicially or otherwise, a considerable literature is developing in this field. *See,* for example, Fenwick, *How High Is the Sky?* 52 American Journal of International Law 96 (1958); Potter, *International Law of Outer Space, id.* at 304; Latchford, *The Bearing of International Air Navigation Conventions on the Use of Outer Space,* 53 American Journal of International Law 405 (1959); Kloman, *The Law and Outer Space,* 87 U.S. Naval Institute Proceedings 44 (1961); *Survey of Space Law,* H. Doc. 89, 86th Cong., 1st sess. (1959); and *Legal Problems of Space Exploration* (A Symposium), S. Doc. 26, 87th Cong., 1st sess. (1961). The last is a compilation of 94 articles written between 1951 and 1958.

that this "formula 'from the center of the earth to the sky' was invented at some remote time in the past when the use of space above land actual or conceivable was confined to narrow limits, and simply meant that the owner of the land could use the overlying space to such an extent as he was able, and that no one could ever interfere with that use."[109]

It has also been challenged on the ground that the maxim is no more than dictum, insofar as laying down a principle of ownership of the airspace beyond the range of actual occupation, since in every case in which it was found it was used in connection with occurrences common to the era, such as overhanging branches or eaves (*see* 3733).[110]

This limitation on the *ad coelum* doctrine became more crystallized with the passage of the Air Commerce Act of 1926 (44 Stat. 568, 572) and the Civil Aeronautics Act of 1938 (52 Stat. 973, 980). These have given the United States "complete sovereignty of the airspace" over the country and have granted "any citizen of the United States a public right of freedom of transit in air commerce through the navigable air space of the United States."[111]

The question reached the Supreme Court of the United States in 1946 in a case involving the right of military aircraft of the United States to fly so low with respect to private property as to destroy the use of the property as a poultry farm.[112] In reviewing the finding of the Court of Claims against the Govern-

109. *Hinman* v. *Pacific Air Transport,* 84 F. 2d 755, 757 (1936). An injunction and money damages were sought against the airline on the ground of alleged ownership of a stratum of airspace overlying real property which the airline invaded by gliding planes within 100 feet of the surface. Without defining the upward extent of such stratum of airspace, it was alleged that the space to an altitude of not less than 150 feet may reasonably be expected to be used. The court denied the injunction on the ground that no injury was shown other than the use of airspace which is lawful unless it causes injury to the landowner's possession. The principle of this case was cited with approval by the Supreme Court in *United States.* v. *Causby,* note 112 *infra* (*see* text following note 113 *infra*), and by the United States Court of Appeals in the later case of *Allegheny Airlines* v. *Village of Cedarhurst,* 238 F. 2d 812 (1956) (*see* note 116 *infra*).

110. *Thrasher* v. *City of Atlanta,* 173 S. E. 817 (1934); *Swetland* v. *Curtiss Airports Corp.,* 55 F. 2d 201 (1932).

111. "Air commerce" is defined in the 1938 act as including "any operation or navigation of aircraft which directly affects, or which may endanger safety in, interstate, overseas, or foreign air commerce"; and "navigable air space" is defined as "air space above the minimum altitudes of flight prescribed by regulations issued under the Act." These definitions are essentially the same as appear in the "Federal Aviation Act of 1958" (72 Stat. 731, 739), except that navigable airspace also includes "airspace needed to insure safety in take-off and landing of aircraft." Intrastate air commerce, at least in the lower airspace over a private owner's property, is subject to regulation by the states and the federal regulations do not apply. *Strother* v. *Pacific Gas & Electric Co.,* 211 P. 2d 624 (1949). The Uniform State Law for Aeronautics provides that "sovereignty in the space above the lands and waters of this State is declared to rest in the State, except where granted to and assumed by the United States." 2 *Corpus Juris Secundum,* at 903.

112. *United States* v. *Causby,* 328 U.S. 256 (1946). The dwelling and farm was located about ⅓ mile from a municipal airport near Greensboro, N.C., which the Government had leased in 1942 for a term of 1 month with the right to renew until 1967. The 30 to 1 safe glide angle, approved by the Civil Aeronautics Authority, caused the path to one of the runways to pass directly over the property at a height of 83 feet, which was 67 feet above the house, 63 feet above the barn, and 18 feet above the highest tree. The Court of Claims, where the suit originated, awarded damages against the Government for the value of the property destroyed and the easement imposed. But it made no finding as to the

ment, the Supreme Court considered the old doctrine of ownership of the airspace in the light of the modern air age. It rejected the doctrine in no uncertain terms as not being one of general applicability, and said: ". . . that doctrine has no place in the modern world. The air is a public highway, as Congress has declared. Were that not true, every transcontinental flight would subject the operator to countless trespass suits. Common sense revolts at the idea. To recognize such private claims to the airspace would clog these highways, seriously interfere with their control and development in the public interest, and transfer into private ownership that to which only the public has a just claim."[113]

But the principle enunciated, the Court held, did not apply to the instant case for the reason that, while the airspace is a public highway, and normally flights over private land do not constitute a "taking of property" (*see* note 113 *supra*), they are a taking if so low and so frequent as to be a direct and immediate interference with the enjoyment and use of the land. If the landowner is to have full enjoyment of his land, he must have exclusive control of the immediate reaches of the enveloping atmosphere. "Otherwise," the Court said, "buildings could not be erected, trees could not be planted, and even fences could not be run. . . . The landowner owns at least as much of the space above the ground as he can occupy or use in connection with the land" (citing *Hinman* v. *Pacific Air Transport, supra* note 109).[114]

The vigorous dissent of two justices, from the holding of the majority, emphasized even more strongly the public nature of the airspace and indicated an even greater limitation, or virtual abandonment, of the *ad coelum* doctrine. They held it "inconceivable . . . that the Constitution guarantees that the airspace of this Nation needed for air navigation is owned by the particular persons who happen to own the land beneath to the same degree as they own the surface below. No rigid constitutional rule . . . commands that the air must be con-

precise nature or duration of the easement. (An easement is a right, in one person, created by grant, or its equivalent, to do certain acts on or over another person's land.) From this judgment, the Government appealed to the Supreme Court.

113. *Id.* at 261. It was the Government's contention that since the navigable airspace, under the Air Commerce Act of 1926, is subject to a public right of freedom of interstate and foreign air navigation, the flights are therefore an exercise of the declared right of travel through the airspace, and when flights are made within the navigable airspace without any physical invasion of the property of the landowners, there is no taking of property within the 5th amendment to the Constitution, which provides that the United States shall take no private property for public use without just compensation. *Id.* at 260.

114. *Id.* at 264, 266. The Court did not undertake to determine what the precise limits are since the Court of Claims had already established by evidence that there was a diminution in the value of the property brought about by the frequent, low-level flights. It agreed with the lower court that a servitude had been imposed upon the land, but it was uncertain from the record whether it was permanent or temporary, which would affect the amount of damages. The judgment of the Court of Claims was therefore reversed and the case remanded to it for determination whether the easement established was permanent or temporary from which it would be possible to make a more realistic assessment of the damages sustained.

sidered as marked off into separate compartments by imaginary metes and bounds in order to synchronize air ownership with land ownership." [115]

In summary, it can be stated that, based on the two cases heretofore discussed, the old maxim that ownership of land extends to the sky has no general applicability in the modern world. At most, it is restricted to as much of the airspace above the ground as the landowner can reasonably occupy or use in connection with the land; the fact that he does not occupy it in a physical sense by erection of buildings and the like is not material. Flights by airplanes of the Federal Government over private lands are not a "taking" under the 5th amendment, so as to entitle the owner to just compensation, unless they are so low and so frequent as to be a direct and immediate interference with the enjoyment and use of the land.[116]

The doctrine of *United States* v. *Causby, supra,* was extended in March 1962 to commercial aircraft operating from municipal airports. *Griggs* v. *County of Allegheny,* 369 U.S. 84 (1962). The county as the owner of the airport was held liable for damages caused to a homeowner as a result of planes flying so low as to make occupancy of the home undesirable and unbearable. The Supreme Court found that the noise, vibration, and fear caused by constant and extremely low overflights had so interfered with the use and enjoyment of the property as to amount to taking of an air easement over it for which

115. *Id.* at 271. As for the case in question, they held the facts insufficient to support a taking of property under the 5th amendment. At most it constituted a nuisance, or the result of negligence, for which the Government had not consented to be sued. These justices would have completely reversed the decision of the Court of Claims. *Id.* at 275. In their view, the Air Commerce Act of 1926, which gave the United States complete and exclusive national sovereignty in the airspace, was passed on the assumption that the commerce clause of the Constitution gave Congress the same plenary power to control navigable airspace as its plenary power over navigable waters. And Congress gave the Civil Aeronautics Authority power to prescribe air traffic rules and these rules, they held, included those prescribing safe altitudes during take-off and landing operations, as well as safe altitudes while on the level of cross-country flight, and that the distinction drawn in the majority opinion between the two is not supported by the legislative history of the act. *Id.* at 272, 273. (The majority opinion considered the rules of safe altitude while on the level of cross-country flight as rules prescribing the safe altitude proper and rules governing take-off and landing as rules of operation. The minimum prescribed for cross-country flight was 500 feet during the day and 1,000 feet at night. This was held to be the navigable airspace which Congress placed within the public domain, and therefore, the flights in question were not within the navigable airspace and not within the public domain.) *Id.* at 263, 264. In the Federal Aviation Act of 1958, take-off and landing operations are specifically included within the definition of navigable airspace (*see* note 111 *supra*), which manifests an intention on the part of Congress to further circumscribe the *ad coelum* doctrine. The *Causby* decision was brought to the attention of Congress during the hearings on the 1958 act and presumably the spelling out of navigable airspace as including that needed for take-off and landing of aircraft was made with that in mind. *Hearings before Subcommittee on Aviation of the Committee on Interstate and Foreign Commerce on S. 3880,* 85th Cong., 2d sess. 137 (1958).

116. In 1956, a Federal appellate court passed on the extent of ownership of the airspace. The case involved the constitutionality of a village ordinance prohibiting air flights over the village at less than 1,000 feet above the ground. Approved take-off and landing procedures at the nearby airport, under the federal regulations, brought the planes over the village as low as 450 feet. It was held that the federal regulatory system had preempted the field below as well as above 1,000 feet from the ground and therefore the village ordinance was invalid; and that flights over private land are not a "taking" within the 5th amendment unless they are so low and so frequent as to be a direct and immediate interference with enjoyment and use of the land. *Allegheny Airlines* v. *Village of Cedarhurst, supra* note 109, at 816.

the county must pay just compensation, as required by the 14th amendment to the Constitution. (The slope gradient of the approach area left a clearance of 11.36 feet between the bottom of the glide angle and the chimney.) [117]

### 3732. *Below the Surface*

The owner of the surface of land is prima facie the owner of the soil or mineral deposits to the center of the earth, and this ownership cannot ordinarily be interfered with. Any underground encroachment by an adjoining owner is a violation of the surface owner's rights.[118] There are, however, certain limitations on the right of enjoyment of possession of all property, one of which is its use to the detriment of or interference with a neighbor. And this has been held to give a court an inherent power to direct a survey to be made of the cave of one owner in order to determine whether the cave extends under the ground of an adjoining owner so as to constitute a violation of his right of ownership of the soil beneath his land.[119]

The soil beneath the surface may be divided horizontally for purposes of ownership, the surface belonging to one person, and a stratum below the surface to another, this frequently occurring in the case of a conveyance of the minerals separate from the surface.[120] But it has also been held that the owner's title does not extend beyond a depth which he can reasonably use.[121]

117. Two justices dissented from the majority opinion, not on the substantive holding of the right of a landowner to the use of some of the airspace above it, but on the ground that the United States, in its comprehensive plan for national and international air commerce—regulating in minute detail every aspect of air transit—has complete and exclusive sovereignty in the airspace above the United States, and therefore, it, rather than the county, had taken an air easement over the property. On this point the majority believed that the county as the promoter, owner, and lessor of the airport—with power to decide where the airport should be built, what runways it would need, their direction and length, and what land and navigation easements would be needed—took the air easement in the constitutional sense. But in *Batten* v. *United States*, 306 F. 2d 580 (1962), a Federal Court of Appeals held that property owners whose use and enjoyment of their properties were interfered with by noise, vibration, and smoke from adjacent military jet airport cannot recover for claimed governmental taking of their property without compensation. On appeal, the Supreme Court refused to review the lower court finding. *Batten* v. *United States*, 371 U.S. 955 (1963).

118. *Langhorne* v. *Turman*, 133 S.W. 1008 (1911) (Ky.). It is well known that oil has been extracted from wells extending thousands of feet below the surface and dug either by the landowner or by others under lease from him.

119. *Edwards* v. *Sims*, 24 S.W. 2d 619 (1929) (Ky.). This case involved the Great Onyx Cave of Kentucky. The same principle was applied by the Supreme Court of the United States in upholding a Montana statute authorizing the survey of the mining property of another when necessary to protect or enforce the right of any person owning a mining claim. *Montana Co.* v. *St. Louis Mining and Milling Co.*, 152 U.S. 160 (1894).

120. *Lee* v. *Bumgardner*, 10 S.E. 3 (1889) (Va.). Such right of ownership in minerals in place is to be distinguished from rights under a grant merely to take minerals from the land. Such right is not exclusive of the owner of the land also to take them, unless it is so expressed. *Johnstown Iron Co.* v. *Cambria Iron Co.*, 32 Pa. 241 (1859); 72 Am. Dec. 783.

121. *Boehringer* v. *Montalto*, 254 N.Y. Supp. 276 (1931).

### 3733. *Laterally*

A variation of the doctrine of private ownership above the surface of land (*see* 3731) is the case of the extent of lateral ownership. It can be stated as a general rule that the owner of a parcel of land has the right to occupy and use it to the full extent of his boundaries and of this right he cannot be deprived. Any infringement by another person of such right, as by allowing the branches of a tree or the eaves or wall of a building to project over adjoining land, constitutes a violation of his right for which the law would afford a remedy.[122]

A variant of the "eaves doctrine" arises where land is conveyed and the deed describes one of the boundaries as 4 feet from the "northerly side" of a building. The question here posed is whether the conveyance carries with it the land to the edge of the eaves or only to the side of the building at ground level. In Massachusetts, the court held that the boundary was 4 feet from the extremest part of the building which in that case was the edge of the eaves.[123] But the decisions on this point are not uniform, and in a Maine case the court held that a boundary line, which was described as "parallel with and at the distance of eight feet four inches from the south side of the meetinghouse" had to be measured from the corner board of the meetinghouse and not from the edge of the eaves.[124]

### 374. Transfer of Land

The usual mode of transferring land from one owner to another is by deed, which is an instrument in writing and under seal.[125] An essential requirement

122. *Hoffman* v. *Armstrong*, 48 N.Y. 201 (1872) (overhanging branches). But the court held in this case that the fruit on the overhanging branches belonged to the owner of the land on which the tree stood and not to the adjoining owner, and if the latter interfered with the removal of the fruit (as long as there was no trespass on his land) an action would lie against him. *See also Meyer* v. *Metzler*, 51 Cal. 142 (1875) (wall of building).

123. *Millett* v. *Fowle*, 22 Mass. 150 (1851).

124. *Center Street Church* v. *Machias Hotel Co.*, 51 Me. 413 (1864). However, in a later Maine case involving the lateral extent of a right of way adjacent to a building, the court pointed out the conflict between the *Millet* case, *supra*, and the *Center Street Church* case. Without expressing an opinion as to which rule should be preferred, the court distinguished between a right of way and that of land bounded by a building, as in the *Millet* case. It said: "When land is bounded by a building, it would be unreasonable to assume that the parties to the conveyance intended that the main portion of the building should be on one side of the line, and the cornices, and other projecting finish, on the other. Hence the rule that, in such a case, the line shall be regarded as wholly on one side of every portion of the building. Not so a right of way. There is nothing unreasonable in the assumption that a mere right of way, even if created by an express grant, was intended to extend under the projecting finish of a building." The court held the right of way to extend to the side of the building and not merely to the cornice on the gable, which projected about 8 inches from the building. It therefore reached the same conclusion as in the *Center Street Church* case, but for a different reason. *Farnsworth* v. *Rockland*, 22 Atl. 394 (1891) (Me.).

125. At common law (*see* 251) a conveyance of land was required to be under seal. This was accomplished by impressing some device upon wax which was made to adhere to the paper. By statute in many states, a mere scroll or any other device marked on the paper on which the conveyance is written, is sufficient, and the writing of the word "Seal" in connection with the signature is regarded as a sufficient sealing. *Cochran* v. *Stewart*, 59 N.W. 543 (1894) (Minn.).

of a deed is that the subject of the conveyance, the land itself, be fully described in order that it may be properly identified. The importance of the description has been recognized by the courts who have established that a deed to be valid requires, among other things, a thing granted, which must be described with sufficient clearness to set it apart from other things of the same kind.[126] If the deed does not refer to the land with such particularity as to render this possible then the conveyance is nugatory.[127]

In many of the states there are statutory provisions authorizing an owner of land to have it surveyed and laid off in lots and blocks, and to file in the public records a plat or map of the land as thus laid off, authenticated and certified as may be required. Thereafter, any one of the lots or blocks may be conveyed by reference to the lot or block number. Even without statutory authority, a reference in the conveyance to a particular plat or map for purposes of description makes the plat in effect a part of the conveyance, and it may be utilized to identify the land conveyed.[128]

### 3741. *Description of Land*

There are various methods of describing real property for transfer purposes. Among the more usual are: (*a*) by reference to the government survey in the public land states, (*b*) by reference to a map or plat which indicates the location of the land, (*c*) by metes and bounds, (*d*) by natural or artificial monuments, and (*e*) by course and distance. The pertinent aspects of these different methods will be briefly considered.

#### A. BY GOVERNMENT SURVEY

It has been previously noted that one of the early acts passed by the Congress was to provide for a system of rectangular surveys as a preliminary to the disposition of the public domain (*see* 3531). This furnishes one of the simplest methods of land description for all purposes of transfer in those parts of the country in which title to land is derived from the United States. In this method, the description is by reference to township, range, section, and principal meridian, and can apply to only one particular parcel of land. Thus, "the Northeast Quarter of the Southeast Quarter (NE¼SE¼) of Section

126. *Los Angeles County* v. *Hannon*, 112 Pac. 878 (1910).

127. *Howard* v. *North*, 51 Am. Dec. 769, 783 (1849) (Tex.). And even where a description clearly delineates the land to be conveyed, but does not locate it because of its uncertain starting point has been held to be invalid. *Barker* v. *Southern Ry. Co.*, 34 S.E. 701 (1899) (N.C.).

128. *King* v. *Sears*, 18 S.E. 830 (1893) (Ga.).

Ten (10), Township Two South (T2S), Range Six East (R6E) of the Meridian of New Mexico" would be a complete description for title purposes (*supra* note 88).[129]

### B. BY REFERENCE TO MAP OR PLAT

Where a tract of land has been surveyed and laid off in blocks and lots, any one of the lots or blocks may be conveyed by reference to the map or plat, that is, by the number which it bears on the plat, thus avoiding the necessity of a detailed description of the land conveyed. As a general rule, when maps or plats are referred to in conveyances they are regarded as incorporated into the instrument and are usually held in effect as a part of the conveyance and may be utilized to identify the boundaries of the land conveyed.[130] This also applies to field notes. If the plat is in conflict with the field notes in an original government survey of the public lands, the plat prevails because it shows the lines that were approved by the Surveyor General and by which the land was sold.[131]

### C. BY METES AND BOUNDS

Instead of describing land by reference to the township and section as in conveyances of the public lands (*see* 3741 A), or by reference to a map or plat (*see* 3741 B), it is common to describe it by placing all the data in the description. This is usually termed as a description by "metes and bounds."

129. A unique feature of government public land surveys is their conclusive nature. They cannot be attacked in a suit between private parties. The location of corners and lines established, when identified, are conclusive, and the true corner of a government survey is where the United States surveyors established it, whether such location is right or wrong. *Vaught* v. *McClymond,* 155 P. 2d 612 (1945) (Mont.). Although not part of the rectangular system, surveys of the Coast and Geodetic Survey have been accorded, at least in the Federal courts, a similar dignity, to the extent of taking judicial notice of the accuracy of such surveys (*see* 412).

130. *Deery* v. *Cray,* 10 Wall. 263 (77 U.S., 1870). A map or plat is the usual and proper method of making a record of a survey. *Karter* v. *East,* 125 So. 655 (1929) (Ala.). It is important to note that the Supreme Court of the United States, in the boundary dispute between Arkansas and Tennessee along the Mississippi River, where it was necessary to locate the middle of the main navigable channel as it existed before the avulsion of 1876, accepted the line of the boundary commissioners based on a reconnaissance map of the area prepared by a government engineer in 1874 pursuant to an act of Congress (courses of channel were taken by compass, distances were determined by the speed of the boat, and widths of river were estimated and to some extent checked by triangulation). The use of the map was objected to on the ground that it was not based upon a survey accurately made by measurement and instrumental observations, and therefore valueless to fix the old channel. But the Court held that the standard demanded was not applicable in the circumstances. It said: "The thing to be done must be regarded. It is to locate the boundary along that portion of the bed of the river that was left dry as a result of the avulsion, according to the middle of the main navigable channel at the time the current ceased to flow therein as a result of the avulsion. Absolute accuracy is not attainable. A degree of certainty that is reasonable as a practical matter, having regard to the circumstances, is all that is required." *Arkansas* v. *Tennessee,* 269 U.S. 152, 157 (1925).

131. *Bilbo Livestock & Land Co.* v. *Henson,* 71 So. 2d 874 (1954) (Ala.). However, under some authorities the field notes control. *Swarzwald* v. *Cooley,* 103 P. 2d 580, 589 (1940) (Calif.).

A survey of a tract by metes and bounds is one of the oldest methods of describing land and is the outgrowth of the art of surveying as practiced in olden times and was the method used to transfer lands in the Thirteen Original Colonies.[132] Metes and bounds mean the boundary lines or limits of a tract. On this there is general agreement, but as to the exact meaning of the term there is variation among text writers and courts.[133]

Separately, the word "metes" has been defined as the exact length of each line of a tract; whereas "bounds" has been defined as the limiting lines or boundary lines, either real or imaginary, which enclose or mark off a tract of land, or the natural or artificial marks which indicate the beginning and ending.

When used together, it would appear that "metes and bounds" is no more than a contraction for "measurements and boundaries." But the term has been defined variously in the law dictionaries as: the boundary lines of land, with their terminal points and angles (Bouvier); the boundary lines and corners of a piece of land (Ballentine); and the boundary lines of lands with their terminating points or angles (Black).

In an early Maine case, where a statute required metes as well as bounds to be used in describing real property, it was said: "By metes, in strictness, may be understood the exact length of each line, and the exact quantity of land in square feet, rods, or acres. . . . Metes result from bounds; and where the latter are definitely fixed, there can be no question about the former." [134]

In the oft-cited case of *People* v. *Guthrie,* 46 Ill. App. 124 (1892), it was said: "We understand the phrase 'Metes and bounds,' to mean the boundary line or limit of the tract. This boundary line may be pointed out and ascertained by reference to objects either natural or artificial which are permanent in character and location, and so situated with reference to the tract to be described that they may be conveniently used for the purpose of indicating its extent. . . . The metes and bounds of the tract are definitely fixed by locating its centerline and naming the width of the tract as if the lines of its outer boundary had been given by courses and distances, and a description thus given would in a case of a discrepancy prevail over a description by courses and distances." [135]

132. BOUCHARD AND MOFFITT, SURVEYING (4th ed.) 536 (1959).

133. It has even been suggested that it is one of those linguistic couplets, similar to "will and testament," "give and devise," that crept into the English language after the Norman Conquest, one part of the couplet reflecting Anglo-Saxon influence and the other Norman French, but essentially both have or originally had the same meaning. Adams, *Metes and Bounds,* 11 SURVEYING AND MAPPING 305 (1951).

134. *Buck* v. *Hardy,* 6 Me. 137 (1829). This would seem to indicate that "metes" being a function of the bounds may be omitted, but never the "bounds" which when set forth with certainty fix the former. *See,* for example, *Lefler* v. *City of Dallas,* 177 S.W. 2d 231, 234 (1943) (Tex.), where the court said: "We do not think it necessary to a metes and bounds description that length of line be given when, as here, all boundaries of the involved area are fully set forth by calls for course and adjoiner."

135. This definition and the one in *Buck* v. *Hardy,* note 134 *supra,* are cited in the more recent case of *United States* v. *5.324 Acres of Land,* 79 F. Supp. 748 (1948).

In some states, it commonly means a description by reference to adjoining lands;[136] in others, it is by reference to natural or artificial monuments.[137] It has also been stated that a description by metes and bounds consists of running out tracts of land by courses and distances and planting monuments at the several corners or angles.[138]

It thus appears from the cases and texts that whatever may have been encompassed originally by the term "metes and bounds," it has been given a construction rather general in scope, and any description that is definite and locatable will be considered as falling within the purview of the term. Therefore, in reconciling conflicting elements in a description (*see* 3742), metes and bounds need not be considered as a distinctive class of calls.[139]

### D. BY MONUMENTS—NATURAL AND ARTIFICIAL

Boundaries of land are often described by reference to monuments. A monument, for the purpose of description, may consist of any object or mark on the land which may serve to identify the location of a line constituting a part of the boundary. The monument may be either a permanent natural object found on the land, such as a river, stream, lake, pond, ledge of rocks, or tree; or it may be an artificial object, such as a highway, wall, ditch, or post.[140]

Objects, to be ranked as monuments, must have certain physical properties such as visibility, permanence and stability, and definite location, independent

136. *Moore* v. *Walsh,* 93 Atl. 355 (1915) (R.I.).

137. *Whitridge* v. *Baltimore,* 63 Atl. 808 (1906) (Md.).

138. Clark (1959), *op. cit. supra* note 13, at 52. But in *Wood* v. *Ramsey,* 17 Atl. 563 (1889) (Md.), it was held that metes and bounds always control course and distance, the inference being that the latter is not synonymous with the former.

139. Patton (1957), *op. cit. supra* note 79, at 314. In the survey of the public lands, metes and bounds surveys are required to define the boundaries of irregular tracts which are noncomformable to legal subdivisions, such as the boundaries of mineral and other claims, grants, and reservations. The fixation of the official survey upon the ground is ascertained by connecting it by course and distance to a corner of the public survey or to a location monument. Manual of Instructions, etc. (1947), *op. cit. supra* note 82, at 349, 450. In the adjudication of water boundaries that are determined by tidal definition, the boundary is often described as following the mean low-water line or the mean high-water line, as the case may be, and "the several courses and distances thereof," instead of resorting to specific courses and distances, which would be awkward for a curving shoreline. This was the method used by the Supreme Court in its decree establishing the boundary between New Jersey and Delaware within the 12-mile circle. *New Jersey* v. *Delaware,* 295 U.S. 694 (1935). A similar method was used by the Department of Justice in describing the federal-state boundary along the Louisiana coast under the decree of the Supreme Court in the case of *United States* v. *Louisiana,* 340 U.S. 899 (1950) (*see* Volume One, Part 1, 731). Following the interpretation by the courts of the term "metes and bounds," such description would qualify under that category.

140. Frequently, the corners or lines of a tract of land are defined by reference to adjoining land, or to some adjoining structure, which, in its legal significance, includes the land under it, such as a house or mill. In such a case, the land conveyed extends merely to the side of the land or structure referred to as a monument, while in the ordinary case of a monument, the name of which does not include the ownership of land, such as a wall, a post, or a survey marker, the land conveyed extends to the center thereof. *City of Boston* v. *Richardson,* 95 Mass. 146, 154 (1866).

of measurements;[141] and if the ravages of time destroy these essential elements, the object may lose its dignity as a monument and the boundary would be controlled by an inferior call, such as course and distance, because of its superior certainty.[142]

### E. BY COURSE AND DISTANCE

Courses and distances are mathematical descriptions of boundary lines indicating their direction and length. A course is the direction or bearing of a line with reference to the true or magnetic meridian.[143] Courses determined with a transit or theodolite are related to the true meridian and result in true bearings, whereas those determined with a magnetic compass are related to the magnetic meridian and result in magnetic bearings.

In descriptions by courses and distances, one without the other is meaningless. Only in the case of a triangular tract are distances alone (measured along the boundaries) sufficient to limit its shape and area; in all other figures, both are necessary. Each is an observed quantity and each liable to error in field determination and in recording. Where a conflict exists between the two, and where no superior calls exist, the order of precedence cannot be stated categorically in favor of one over the other. It does not fall in the same category as the rule that gives precedence to physical monuments on the ground over courses and distances, which is a reasonable rule (*see* 3742(*b*)).

While the reasons sometimes advanced for supporting the rule that courses take precedence over distances—to wit, the greater probability of a chain carrier losing count or reporting distances incorrectly, or the greater the distance the greater the probability of error[144]—are valid under certain circumstances, the more technically sound rule would be to prefer neither one over the other, but

141. *Parran* v. *Wilson*, 154 Atl. 449 (1931) (Md.).

142. Thus, where it was impossible to ascertain even approximately where a fence marking the boundary of a tract of land was, it had lost its location and was therefore of no avail to the court in making its decision. Under these circumstances course and distance established the line. *McNichol* v. *Flynn*, 153 N.Y. Supp. 308 (1915). (*See also* note 157 *infra* and text pertaining thereto.)

143. The true meridian at a given place is a line that passes through that place and the geographical poles; in other words, it is the observer's plane that passes through the earth's axis of rotation. The magnetic meridian at a given place is defined as a line having the direction of the magnetic needle; that is, a vertical plane fixed by the direction taken by a perfect compass needle. It is sometimes thought that the compass points toward the magnetic pole. This is incorrect. The compass does point in the rather general direction of the magnetic pole over most of the earth—but usually not exactly toward the pole. For example, along the 100th meridian in the United States the north magnetic pole bears due north, but the compass points 10° or more to the east of true north. HOWE AND HURWITZ, MAGNETIC SURVEYS 3, SERIAL No. 718, U.S. COAST AND GEODETIC SURVEY (1956).

144. *Matador Land & Cattle Co.* v. *Cassidy-Southwestern Commission Co.*, 207 S.W. 430, 432 (1918) (Tex.). Other reasons sometimes mentioned are failure to observe the correct position of the zero-point of the tape, reading the wrong footmark, tape not stretched straight, careless plumbing, and difficulty of the terrain over which the distances are measured, whereas bearings or angles are observed by one man—usually the best trained and most responsible person on the survey party, working under easier conditions and usually keeping the notes.

rather to be guided by the circumstances surrounding each particular case, including methods of survey, character of the terrain, etc. This, in essence, is what the Supreme Court held in an early case, when it said: "It may be laid down as an universal rule, that course and distance yield to natural and ascertained objects. But where these are wanting, and the course and distance cannot be reconciled, there is no universal rule that obliges us to prefer the one or the other. Cases may exist, in which the one or the other may be preferred, upon a minute examination of all the circumstances."[145]

Course references in deeds or other instruments sometimes require interpretation. When a boundary line is described as running toward one of the cardinal points (north, east, south, or west), there is no ambiguity. Where either of these words is used without qualification, the meaning is "due north," "due east," "due south," or "due west," as the case may be. Even the words "easterly," "northerly," etc., have been held to mean "due east," "due north," etc., if there is nothing in the description to indicate an intent to limit the exact direction.[146] The same is true of variants of these words, to wit, "eastward," "southward," etc.[147] And by analogy, this general rule would apply to the intercardinal points. For example, northwesterly would mean the exact direction of northwest unless there was language in the instrument that indicated an intent to consider this a general rather than an exact direction.

A common form of limitation is where a water boundary is defined by reference to the tide—for example, the line of mean high water or the line of mean low water. It is customary in these cases to use phraseology such as, "thence along the mean low-water line in a southerly direction," or by a similar reference to the mean high-water line. Such general references to the cardinal

145. *Preston's Heirs* v. *Bowmar*, 6 Wheat. 580 (19 U.S., 1821). A point of such consideration, although not conclusive, would be that the accepted rule for balancing a survey made with the compass—that is, adjusting for the error of closure—is to assume that the error of closure is as much due to erroneous bearings as to erroneous chaining. On the other hand, if a transit is used for measuring the angles, then the assumption is that the error of closure is due wholly to chaining. JOHNSON AND SMITH, THE THEORY AND PRACTICE OF SURVEYING 235 (1913).

146. *Livingston Oil & Gas Co.* v. *Shasta Oil Co.*, 114 S.W. 2d 378, 381 (1938) (Tex.). But in *Fosburgh* v. *Sando*, 166 P. 2d 850, 851 (1946) (Wash.), it was held that "northerly" implies only in a general direction and the description of the land was insufficient without recourse to oral testimony which would be violative of the Statute of Frauds. In this case, it was shown that even if "northerly" were assumed to mean "due north," then the next course would not have been sufficiently clear without the introduction of parol testimony. *Ibid.*

147. *Higgins* v. *Round Bottom Coal & Coke Co.*, 59 S.E. 1064, 1068 (1907) (W. Va.). In determining what was intended by a clause which gave a right to undermine "southward beyond the lines of said tract," the court held the use of the word "lines" instead of "line," and the fact that the residue of the land lay south and west of two lines of the granted tract, clearly indicated an intention not to limit the grant to land immediately and directly south of the granted tract, but rather a grant to undermine southwestward, as well as southward, from the tract granted.

or intercardinal points are controlled by the directions taken by the line of low water or the line of high water.[148]

A word of caution is necessary regarding the term "due north." By modern surveying practices, when surveys with the compass are becoming more and more infrequent, this would be interpreted to mean the same as "true north," that is, as referring to the true meridian. But many of the early property boundary surveys in the United States were made with the magnetic compass, such surveys being referenced to the magnetic meridian rather than the true meridian (*see* note 143 *supra*). Due north and true north must therefore be distinguished. The first (due north) may be magnetic or true, whereas the latter (true north) can only mean geographic or astronomic north and would coincide with the true meridian. The interpretation of the term "due north," or the like, thus depends upon how the surveys in a particular state were referenced. Where the deed or patent does not indicate what meridian is intended, it has been held that courses relate to the magnetic meridian.[149]

The value of the magnetic declination on different dates is held to be a matter of proof and not subject to judicial notice (*see* 412 note 1).[150]

## 3742. *Conflicting Elements in Descriptions*

Descriptions in deeds are not always free of ambiguity as to meaning and there may be conflicts between the various provisions which make it difficult to locate the boundaries of the land on the ground. Courts have therefore developed rules of construction for such situations which should be understood in any consideration of shore boundaries. The more common of these will be dealt with.

The cardinal rule for the resolution of ambiguities in conveyances is to determine the intent of the parties as effectively expressed and as inferred from

148. In the New Jersey-Delaware boundary dispute, one of the sections along the eastern bank of the Delaware River was described in the Supreme Court's decree as "Thence (6) along the mean low water line of the eastern bank of the Delaware River, the several courses and distances thereof, the general direction being first, southwestward, second, southeastward and lastly, southward." *New Jersey* v. *Delaware, supra* note 139, at 696.

149. *McKinney* v. *McKinney,* 8 Ohio St. 423, 427 (1858). It was said in this case that in respect to surveys in Ohio, where two meridians had been adopted for the survey of the public lands, " 'west' or 'due west,' in one class of original surveys, means a line at a right angle to the true meridian; and in another class 'west' or 'due west' is west according to the bearings of the surveyor's compass at the time of the original survey." But in *Richfield Oil Corp.* v. *Crawford,* 249 P. 2d 600, 608 (1952) (Calif.), it was held that "due north" must be surveyed on an astronomical basis, unless other terms of a deed or admissible extrinsic evidence show that a different method was intended. For citations to cases defining or construing various compass directions, *see* 11 *Corpus Juris Secundum,* at 543–545.

150. *Vance* v. *Marshall,* 6 Ky. 148, 150 (1813). It was considered the universal custom among surveyors at that time to orient surveys with the magnetic meridian, and resurveys had to be executed according to the magnetic meridian at the date of entry and not at the date of resurvey. *Ibid.*

all parts of the instrument, giving each word its due force, and read in the light of conditions and circumstances existing at the time the conveyance was executed.[151] Any rules which courts have formulated as to the precedence to be given the elements in the description that may be in conflict are merely intended as aids in arriving at this intention. These same rules of construction, applied to deeds and grants, are applicable in the case of boundaries, a fundamental principle being that the most material, certain, and least liable to error will prevail.[152]

The object of all rules for the establishment of boundaries is to ascertain the actual location of the boundary as made at the time. In resolving conflicts in descriptions, courts have generally agreed upon the following order of precedence: (1) natural monuments or objects, such as mountains, lakes, and streams; (2) artificial marks, stakes, or other objects, made or placed by the hand of man; (3) maps and plats; (4) courses and distances; and (5) recitals of quantity. While these rules of comparative dignity have been said to be not artificial rules, built on mere theory, but rather the result of human experience, they are not conclusive and are merely helpful in determining to which of conflicting locative calls controlling effect should be given.[153] Preference is given to monuments because they are least liable to error, and the degree of importance given to other calls is in proportion to the liability of the parties to err in reference to them. But the rules are not inflexible, and a call which would defeat the parties' intention will usually be rejected, regardless of the comparative dignity of the conflicting calls.[154]

The above stated order which, other things being equal, gives precedence to natural monuments over all other calls, does not obtain where lines and corners of a survey have been run and marked, and can be found. Such lines constitute the true boundaries and prevail over all other calls including those of monuments, provided such lines were intended by the parties as lines of the land

151. *Carlisle* v. *Graves*, 64 So. 2d 456 (1953) (La.). Ambiguities are either latent or patent. Where the language used is clear and suggests only a single meaning, but some extrinsic fact creates a need for interpretation or a choice between two or more possible meanings, it is termed a *latent*, or hidden, ambiguity. But a *patent* ambiguity is one which appears on the face of the instrument and arises from the use of defective or obscure language. *Petrie* v. *Hamilton College*, 53 N. E. 216 (1899) (N.Y.). Patent ambiguities cannot generally be cured by outside evidence, and it is in the field of latent ambiguities for which the rules of construction have been established.

152. *Newsom* v. *Pryor*, 7 Wheat. 7 (20 U.S., 1822).

153. *United States* v. *Redondo Development Co.*, 254 Fed. 656 (1918) (N. Mex.). Calls are of two kinds—locative and descriptive. Locative calls are specific or particular calls, exactly locating a point or line. Descriptive calls are general or directory calls and merely direct attention to the neighborhood where the specific calls may be found. *Cates* v. *Reynolds*, 228 S. W. 695 (1921) (Tenn.).

154. *State* v. *Sulflow*, 128 S. W. 652 (1910) (Tex.). In case of a clear mistake, a call of a lower order will control one of a higher order, as most clearly indicating the intention of the grant.

to be conveyed and reference is made in the conveyance to such lines. This is sometimes referred to as "following the footsteps of the surveyor." [155]

(*a*) *Control of Monuments.*—Monuments are regarded as natural or artificial, these terms referring broadly to the works of nature and the works of man, respectively. The objects that are ranked as monuments and the physical properties they should possess have been described in 3741 D. Except as stated previously that lines actually surveyed and marked take precedence over monuments, calls for monuments ordinarily control other and conflicting calls in a conveyance, natural monuments outranking artificial ones in the order of precedence.[156] So that calls for monuments control courses and distances, maps and plats, and quantity. (Watercourses, such as streams, rivers, and lakes, or the banks and shores thereof, are in the category of natural monuments.) But, as is the case with rules of construction in general, the rule of priority of monuments is not absolute or inflexible. It is still a rule of construction, and as such is adaptable to circumstances, or it is a rule of evidence. Thus, a call for a natural monument will yield to other and conflicting calls when application of the general rule would be contrary to the intention of the parties, or when the call for the natural monument is clearly erroneous.[157]

Within these qualifications, monuments, whether natural or artificial, control a conflicting description by course and distance.[158] And the same applies to conflicting calls for quantity. It is immaterial that the boundary of the land as ascertained from the monuments embraces a much larger area than that called for.[159]

Monuments of equal dignity stand as equals before the law and one natural monument is entitled to no more respect than another natural monument. However, where there is a conflict between monuments, that which is most certain, least likely to mistake, or better serves to carry out the intention of the

155. *Millerman* v. *Megaritty*, 242 S. W. 757 (1922) (Tex.). In connection with the control of marked lines over courses and distances, it has been said that the reason for the rule is that the marks on the ground constitute the survey while the courses and distances given in the conveyance are only evidence of the survey. *Andrews* v. *Wheeler*, 103 Pac. 144 (1909) (Calif.).

156. For a list of objects that have been held to be monuments generally or with respect to particular situations, *see* 11 *Corpus Juris Secundum*, at 545.

157. *Kelekolia* v. *Onomea Sugar Co.*, 29 Hawaii 130, 134 (1926). It was said in this case that "All of these ordinary rules [that natural monuments control], however, relating to conflicts between areas, courses and distances and natural monuments and between two or more natural monuments, are susceptible of exceptions and need not be followed or may be reversed when under the circumstances and the evidence the contrary rule better serves to carry out the intention of the parties as to the location or extent of the land described in the instrument under consideration."

158. *White* v. *Spahr*, 59 S. E. 2d 916 (1950) (Ga.). The reason for the rule has been stated to be that monuments or objects afford greater certainty than calls for courses and distances and are less subject to error. *Barker* v. *Houssiere-Latreille Oil Co.*, 106 So. 672 (1925) (La.).

159. *Daughtrey* v. *McCoy*, 135 S. W. 1060 (1911) (Tex.). Monuments erected by mutual consent control all statements in the deed including such definite descriptions as containing "exactly one acre and a half." *Emery* v. *Fowler*, 38 Me. 99 (1854).

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parties will be given preference. And one which corresponds with the courses and distances or with quantity will be accepted.[160] The same is true of artificial monuments.

(*b*) *Control of Maps and Plats.*—Maps or plats referred to in a conveyance of land are generally regarded as furnishing the true descriptions of the boundaries of the land conveyed. And a map or plat so referred, particularly if it is a public record, stands upon the same footing as a monument.[161] A map as a monument controls calls for course and distance, in case there is a conflict between them. And it has been said that maps and notes of a survey "are products of technical engineering skill, and practical knowledge gained by laying out the many separate parcels and defining their relations to each other and to the whole section. Therefore, departure from their terms is tolerable only in instances where boundary line and measurements are so inconsistent that one or the other must yield something to perfect or to approximate the identity of the grant." [162] Maps, plats, and field notes also take precedence over descriptions by area or quantity, the latter being considered the weakest of all descriptions.[163]

(*c*) *Control of Course and Distance.*—In the absence of any superior calls in a boundary description, calls for course and distance will ordinarily govern. This follows the legal principle that the best evidence of which a case is susceptible must be produced. Thus, where the calls for courses and distances were manifestly erroneous because a survey based upon them failed to close, they were nevertheless accepted because they furnished the only location of the boundary, since the site of the north bank of an old slough as it existed in 1893 could not be determined with certainty.[164] But this does not mean that courses and distances cannot be overcome by other forms of evidence that establish the intent of the parties more certainly, or if the exclusive use of courses and distances would frustrate the grant.

Calls for courses and distances will in cases of conflict control calls for quantity, especially if the latter is qualified by the words "more or less," unless an unconscionable result would ensue.

The internal conflict between course and distance and its resolution has been previously discussed (*see* 3741 E).

(*d*) *Control of Quantity.*—It has already been noted that a description of land by naming the area it is supposed to comprise is considered in terms of other

160. *Gilbert* v. *Parrott*, 182 S. W. 859 (1916) (Ky.).

161. *Wilson* v. *Chicago Lumber & Timber Co.*, 143 Fed. 705 (1906).

162. *In re Tremont Housing Corp.*, 242 N.Y. Supp. 128, 129 (1930).

163. *Wagers* v. *Wagers*, 238 S. W. 2d 125 (1951) (Ky.).

164. *Armstrong* v. *Batterton*, 260 S. W. 80 (1924) (Mo.). The course and distance in this case was not only the best but the only evidence available as to the location of the boundary corners.

conflicting descriptions to be the weakest in the determination of boundaries and therefore the last element to be resorted to. But where there is doubt as to the true description, a recital for quantity may be resorted to for the purpose of making that certain which would otherwise be uncertain.[165] And quantity will control where it is made the essence of the contract, or there is a covenant to convey a definite quantity.[166]

## 38. AREA OF THE UNITED STATES (1940)

There have been many determinations of the area of the United States beginning with 1850 when, in the annual report of the General Land Office, total areas were given for the 17 states and 3 territories being surveyed by that agency.[167] For decades, the U.S. Bureau of the Census has given increased attention to the measurement of the areas of the states and counties, in connection with the various censuses of the United States.[168] But, as elsewhere, an accurate measurement had to await the construction of accurate maps.

By 1937, the cartographic picture had improved sufficiently to justify the undertaking by the Bureau of the Census of the remeasurement of the United States, in connection with the Sixteenth Census in 1940.[169]

### 381. Definitions for Measurement

Determining the area of the United States is not a simple matter. Many problems are involved that must be resolved in advance, one of the knottiest

165. *Korneman* v. *Davis,* 219 S. W. 904 (1920) (Mo.).

166. *Doyle* v. *Mellen,* 8 Atl. 709 (1887) (R.I.). The use of the words "more or less" in connection with quantity is to show that all the land embraced within the description is intended to pass, and in that sense are often important in the construction of the instrument of conveyance. And it has been held that " a deed which describes the land and states the number of acres, although with the words 'more or less,' clearly imports that there is not a great deficiency or excess." *Belknap* v. *Sealey,* 67 Am. Dec. 120 (1856) (N.Y.). And when used in connection with quantity or distance they are considered words of safety or precaution, intended to cover some slight or unimportant inaccuracy. The same applies to the use of the word "about." *Russo* v. *Corideo,* 129 Atl. 849 (1925) (Conn.).

167. Proudfoot, Measurement of Geographic Area 27, U.S. Bureau of the Census (1946).

168. *Id.* at 65–113. The 1881 measurement was the most comprehensive to that time and gave the land and water areas for the states and territories, with a breakdown for counties, coast waters (bays, gulfs, sounds, etc.), rivers and smaller streams, and lakes and ponds. In addition, it included a table of the principal inland lakes and their areas, and gave, for the first time, an account of the methods and maps employed, the water bodies included, and the outer limits of the United States used as a basis for measurement. *Id.* at 88–95. The 1906 measurement included the areas of the land and water surface of the states and territories of continental United States, and the total areas of the outlying possessions. In addition, the areas of those portions of the Great Lakes allocable to the bordering states were also given. *Id.* at 112–113.

169. Complete coverage of the United States on one single projection had just become available with the completion by the Coast and Geodetic Survey of the sectional aeronautical charts covering the United States. *Id.* at 31.

being that of setting the outer limits of the United States, which in turn involves the adoption of definitions for land and water; establishment of criteria for the inclusion or exclusion of bays, sounds, estuaries, and the Great Lakes; and for the treatment of tidal flats and other surfaces temporarily covered with water.

In resolving these problems, fundamental definitions were established for the first time for *state waters* (waters other than inland) (*see* 3811), *inland waters* (*see* 3812), and *land areas* (*see* 3813).

### 3811. *State Waters*

For establishing the outer limits of the United States, that is, to determine which waters (coastal and Great Lakes) adjacent to the states should be included or excluded, the following three rules were adopted:

(1) Where the coastline was regular, it was followed directly unless there were offshore islands within 10 nautical miles.

(2) Where embayments occurred having headlands of less than 10 and more than 1 nautical mile in width, straight lines connecting the headlands set the limits; however, the coastline was followed if the indentation of the embayment was so shallow that its water area was less than the area of a semicircle using the said straight line as a diameter.

(3) In cases where there were two or more islands less than 10 and more than 1 nautical mile from shore, they were connected by a straight-line or lines and other straight lines drawn to the shore from the nearest point on each end island.[170]

### 3812. *Inland Waters*

Definitions, in harmony with those established for coastal and Great Lakes water (*see* 3811) and for land (*see* 3813), were established for the treatment of inland waters. The rules for state waters were adopted, but a limit of 1 nautical mile was substituted for the 10 nautical miles; that is, in the case of tributary waterways, to either state waters (*see* 3811) or to the open sea, having headlands of 1 nautical mile or less in width, straight lines connecting the headlands set the

170. BATSCHELET, AREAS OF THE UNITED STATES 2 (Sixteenth Census of the United States: 1940), U.S. BUREAU OF THE CENSUS (1942). These rules are adaptations of the principles urged by the United States, at the 1930 Hague Conference on the Codification of International Law, for determining the status of an indentation *vis-a-vis* inland waters and high seas (*see* Volume One, Part 1, 42, 421, 43, 54). These water areas are not included in the table of areas for the United States (*see* Table 2), but are given in a separate table entitled "Water area, other than inland water, for conterminous United States by primary bodies of water" (*see* Table 3). PROUDFOOT (1946), *op. cit. supra* note 167, at pages 37 to 51, contains a multisectional strip map which traces the outer limits of the United States. It shows in symbolized form the areas of state waters along the entire coast of conterminous United States, including the Great Lakes.

limits of inland waters. In addition, inland water was defined to include the following: permanent inland water surface, such as lakes, reservoirs, and ponds having an area of 40 acres or more; streams, sloughs, estuaries, and canals having a width of one-eighth statute mile or more; and islands having less than 40 acres of area.[171]

### 3813. *Land Areas*

Land was defined to include the following categories: land permanently dry, and land temporarily or partially covered by water, such as marshland, swamps, and river flood plains; streams, sloughs, estuaries, and canals less than one-eighth of a statute mile in width; and lakes, reservoirs, and ponds having less than 40 acres in area. Tidal flats, that is, land between high and low water, were omitted from a consideration of land areas and the mean high-tide line used as the limiting line.[172]

## 382. TECHNIQUE OF MEASUREMENT

For the actual measurement of the areas, the technique adopted was as follows: The total area of the United States was computed by using the sectional series of aeronautical charts of the Coast and Geodetic Survey on a scale of 1: 500,000 in conjunction with the Smithsonian Geographical Tables. Areas of 30 minutes on a side were taken directly from the tables.[173] Those parts of the United States which did not cover a 30-minute area were measured by polar planimeter.

For the individual states, the same method was used as for the United States and the state areas were then adjusted to the established United States total.

The counties were measured by planimeter, using U.S. Geological Survey state maps on a scale of 1:500,000. The county values were then adjusted to the adjusted state areas.[174]

171. *Id.* at 33. These definitions and those for land area (*see* 3813) are in terms of practical limits for planimeter measurement when working on maps with scales varying from 1: 62,500 to 1: 125,000.

172. *Ibid.* and n. 100.

173. WOODWARD, SMITHSONIAN GEOGRAPHICAL TABLES 146–148 (1918). The values in the tables were adjusted to conform to the legal ratio of 39.37 inches to the meter. BATSCHELET (1942), *op. cit. supra* note 170, at 2.

174. *Ibid.* With the polar planimeter, errors of 0.15 to 1.0 percent result in ordinary hand operations, depending on the size of the area to be measured, the character of the map paper, the skill of the operator, and a number of other possible variables. Under controlled conditions, results are accurate to even less than 10.15 percent. A maximum variation of 0.6 percent was allowed between original and independent duplicate readings. PROUDFOOT (1946), *op. cit. supra* note 167, at 20, 34.

## 383. Derived Values

As measured, in accordance with the adopted definitions and techniques, the derived totals in the various categories are as follows (the categories follow the definitions outlined in note 63 *supra*):

### INLAND WATER

Conterminous United States = 45,259 square statute miles
Continental United States = 60,594 square statute miles
United States = 60,607 square statute miles

### LAND AREA

Conterminous United States = 2,977,128 square statute miles
Continental United States = 3,548,193 square statute miles
United States = 3,554,619 square statute miles

### LAND AND WATER AREA

Conterminous United States = 3,022,387 square statute miles
Continental United States = 3,608,787 square statute miles
United States = 3,615,226 square statute miles

### STATE WATER

Conterminous United States = 74,364 square statute miles

Table 2 shows the land and inland water area by states for the United States. Table 3 shows the state waters by states for conterminous United States only—figures for the then territories of Alaska and Hawaii were not computed in the 1940 Census.[175]

175. The Census tables include a breakdown of the land and water area of the United States by counties and by minor civil divisions. *See* Tables 2 and 3 of Batschelet (1942) *op. cit. supra* note 170. Also included are land and water areas of the United States possessions and the Philippine Islands. *Id.* at 3 (Table I).

*World Areas.*—A value of 135,262,000 square kilometers (52,225,000 square statute miles) has been given for the land area of the world, exclusive of the polar regions and some uninhabited islands, but inclusive of the areas of inland waters. United Nations Demographic Yearbook 124 (1962). Since neither the exact method of determining each area nor the precise definition of its composition and time reference is known for all areas, the value may not necessarily be on a comparable basis for all countries. Some area figures are based on recent surveys while others are no more than conjectures based on random items of information. Furthermore, the concept of inland waters varies from country to country, some including the area of coastal bays, inlets, and gulfs, in addition to major rivers and lakes. Apparent inconsistency with previously published figures (for example, 135,369,000 square kilometers in the 1958 Yearbook) may be due to the introduction of improved estimates, to increases in actual land surface by reclamation, or to a change in the unit of measurement used. *Id.* at 14. Based on information furnished by the Hydrographic Office of the Department of the Navy, the area of Antarctica is reckoned as comprising 5,300,000 square statute miles. The World Almanac 594 (1963).

TABLE 2.—*Land and Inland Water Area of the United States*

| State | Areas in square statute miles | | |
|---|---|---|---|
| | Total | Land | Inland water |
| Alabama | 51, 609 | 51, 078 | 531 |
| Alaska | 586, 400 | 571, 065 | 15, 335 |
| Arizona | 113, 909 | 113, 580 | 329 |
| Arkansas | 53, 102 | 52, 725 | 377 |
| California | 158, 693 | 156, 803 | 1, 890 |
| Colorado | 104, 247 | 103, 967 | 280 |
| Connecticut | 5, 009 | 4, 899 | 110 |
| Delaware | 2, 057 | 1, 978 | 79 |
| District of Columbia | 69 | 61 | 8 |
| Florida | 58, 560 | 54, 262 | 4, 298 |
| Georgia | 58, 876 | 58, 518 | 358 |
| Hawaii | 6, 439 | 6, 426 | 13 |
| Idaho | 83, 557 | 82, 808 | 749 |
| Illinois | 56, 400 | 55, 947 | 453 |
| Indiana | 36, 291 | 36, 205 | 86 |
| Iowa | 56, 280 | 55, 986 | 294 |
| Kansas | 82, 276 | 82, 113 | 163 |
| Kentucky | 40, 395 | 40, 109 | 286 |
| Louisiana | 48, 523 | 45, 177 | 3, 346 |
| Maine | 33, 215 | 31, 040 | 2, 175 |
| Maryland | 10, 577 | 9, 887 | 690 |
| Massachusetts | 8, 257 | 7, 907 | 350 |
| Michigan | 58, 216 | 57, 022 | 1, 194 |
| Minnesota | 84, 068 | 80, 009 | 4, 059 |
| Mississippi | 47, 716 | 47, 420 | 296 |
| Missouri | 69, 674 | 69, 270 | 404 |
| Montana | 147, 138 | 146, 316 | 822 |
| Nebraska | 77, 237 | 76, 653 | 584 |
| Nevada | 110, 540 | 109, 802 | 738 |
| New Hampshire | 9, 304 | 9, 024 | 280 |
| New Jersey | 7, 836 | 7, 522 | 314 |
| New Mexico | 121, 666 | 121, 511 | 155 |
| New York | 49, 576 | 47, 929 | 1, 647 |
| North Carolina | 52, 712 | 49, 142 | 3, 570 |
| North Dakota | 70, 665 | 70, 054 | 611 |
| Ohio | 41, 222 | 41, 122 | 100 |
| Oklahoma | 69, 919 | 69, 283 | 636 |
| Oregon | 96, 981 | 96, 350 | 631 |
| Pennsylvania | 45, 333 | 45, 045 | 288 |
| Rhode Island | 1, 214 | 1, 058 | 156 |
| South Carolina | 31, 055 | 30, 594 | 461 |
| South Dakota | 77, 047 | 76, 536 | 511 |

TABLE 2.—*Land and Inland Water Area of the United States*—Continued

| State | Areas in square statute miles | | |
|---|---|---|---|
| | Total | Land | Inland water |
| Tennessee | 42, 246 | 41, 961 | 285 |
| Texas | 267, 339 | 263, 644 | 3, 695 |
| Utah | 84, 916 | 82, 346 | 2, 570 |
| Vermont | 9, 609 | 9, 278 | 331 |
| Virginia | 40, 815 | 39, 899 | 916 |
| Washington | 68, 192 | 66, 977 | 1, 215 |
| West Virginia | 24, 181 | 24, 090 | 91 |
| Wisconsin | 56, 154 | 54, 715 | 1, 439 |
| Wyoming | 97, 914 | 97, 506 | 408 |
| Total | 3, 615, 226 | 3, 554, 619 | 60, 607 |

### 384. Area of the Territorial Sea of the United States

Associated with the outer limits of the United States, as defined in 3811 for area purposes, is the territorial sea of the United States over which this country exercises full sovereignty. As such, it is part of the national territory, subject only to the right of innocent passage of foreign vessels (*see* Volume One, Part 1, 312).

The territorial sea of any nation is an offshore zone measured from the low-water mark along the coast, or from the seaward limits of inland waters where there are embayments that qualify as such. This line, from which the territorial sea is measured, is known as the baseline and its delineation along a coast is dependent upon the application of certain principles that have been accepted in international law (*see* Volume One, Part 1, 33).

The United States has traditionally recognized a zone of 3 nautical miles as the breadth of the territorial sea. Based on this distance, and using principles of delimitation adopted at Geneva on April 27, 1958, at the United Nations' Conference on the Law of the Sea (*see* Volume One, Part 3, 2211), the Department of State has computed the area of the territorial sea for conterminous United

States (*see* note 63 *supra*) to be 17,321 square nautical miles.[176] Since the limiting line for measuring the land and water area of the United States (*see* 3812 and 3813) is not identical with the baseline for measuring the territorial sea, this area cannot be superposed on the area of the United States to obtain a single value which will represent the full areal extent to the outer limit of the territorial sea.[177]

The Department of State has also computed the area of the territorial sea of Hawaii—that is, for those islands constituting the State of Hawaii—using the same principles and criteria as used for conterminous United States. This yielded a value of 3,069 square nautical miles.[178]

## 39. SHORELINE OF THE UNITED STATES

In the measurement of any shoreline, an important consideration is the method and unit used. Unless these are known, and the scale of the maps used are given, the significance of the values derived will be lost. Thus, a 1-mile unit stepped off with dividers will give a different result from a 3-mile unit—the larger the unit, the lower will be the value. The result obtained by this method will differ from the result obtained by using an opisometer (recording measure), following all the indentations and sinuosities of the shore. The latter would obviously give the highest value. By contrast, a measurement based on straight lines joining principal headlands only would give the lowest value.

There have been several published tabulations by the Coast and Geodetic Survey beginning with the 1915 tabulation. These will be briefly discussed and significant differences explained.

(*a*) *The 1915 Tabulation.*—This tabulation included the shoreline of the United States and outlying territories. Unit measures of 30 minutes of latitude, 3 statute miles, and 1 statute mile were used to compute the general coastline, the tidal shoreline (general), and the tidal shoreline (detailed), respectively. Alaska, the Philippine Islands, and the United States Samoan Islands were not measured with a unit measure of 1 statute mile because

176. Pearcy, *Measurement of the U.S. Territorial Sea,* 40 DEPT. STATE BULLETIN 963 (1959). Separate computations were made for each coastal state, the delineation of the territorial sea being first drawn on the nautical charts of the Coast and Geodetic Survey, using the 1200 series charts (scale 1:80,000) for the Atlantic and Gulf coasts and the 5000 series charts (scale approximately 1:180,000) for the Pacific coast. A total of 89 charts was used.

177. In measuring the land and water area of the United States, the high-water line along the coast is taken as the limiting line, whereas for the territorial sea it is the low-water line. Also, the limit of inland water in the first case is defined by an opening in the coast 1 nautical mile or less across headlands, whereas in the second case it is 10 nautical miles (24 miles according to the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone) (*see* Volume One, Part 3, 2211 C(*c*)). Therefore, under certain configurations a hiatus would exist between the two limiting lines.

178. Pearcy, *Hawaii's Territorial Sea,* 11 THE PROFESSIONAL GEOGRAPHER 2 (Nov. 1959).

TABLE 3.—*Water Area, Other Than Inland Water, for Conterminous United States by Primary Bodies of Water*

[Areas in square statute miles]

| State | Total water area other than inland water | Atlantic coastal water | Chesapeake Bay | Delaware Bay | Lake Erie | Straits of Georgia and Juan de Fuca | Lake Huron | Long Island Sound |
|---|---|---|---|---|---|---|---|---|
| Alabama | 560 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| California | 69 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Connecticut | 573 | ...... | ...... | ...... | ...... | ...... | ...... | 573 |
| Delaware | 350 | ...... | ...... | 350 | ...... | ...... | ...... | ...... |
| Florida | 1,735 | 37 | ...... | ...... | ...... | ...... | ...... | ...... |
| Georgia | 48 | 48 | ...... | ...... | ...... | ...... | ...... | ...... |
| Illinois | 1,526 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Indiana | 228 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Louisiana | 1,016 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Maine | 1,102 | 1,102 | ...... | ...... | ...... | ...... | ...... | ...... |
| Maryland | 1,726 | ...... | 1,726 | ...... | ...... | ...... | ...... | ...... |
| Massachusetts | 959 | 959 | ...... | ...... | ...... | ...... | ...... | ...... |
| Michigan | 38,575 | ...... | ...... | ...... | 216 | ...... | 8,975 | ...... |
| Minnesota | 2,212 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Mississippi | 556 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| New Jersey | 384 | ...... | ...... | 315 | ...... | ...... | ...... | ...... |
| New York | 4,376 | ...... | ...... | ...... | 594 | ...... | ...... | 726 |
| Ohio | 3,457 | ...... | ...... | ...... | 3,457 | ...... | ...... | ...... |
| Oregon | 48 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Pennsylvania | 735 | ...... | ...... | ...... | 735 | ...... | ...... | ...... |
| Rhode Island | 14 | 14 | ...... | ...... | ...... | ...... | ...... | ...... |
| South Carolina | 138 | 138 | ...... | ...... | ...... | ...... | ...... | ...... |
| Texas | 7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Virginia | 1,511 | ...... | 1,511 | ...... | ...... | ...... | ...... | ...... |
| Washington | 2,397 | ...... | ...... | ...... | ...... | 1,610 | ...... | ...... |
| Wisconsin | 10,062 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Total | 74,364 | 2,298 | 3,237 | 665 | 5,022 | 1,610 | 8,975 | 1,299 |

TABLE 3.—*Water Area, Other Than Inland Water, for Conterminous United States by Primary Bodies of Water*—Continued

| State | Gulf of Mexico coastal water | Lake Michigan | New York Harbor | Lake Ontario | Pacific coastal water | Puget Sound | Lake St. Clair | Lake Superior |
|---|---|---|---|---|---|---|---|---|
| Alabama | 560 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| California | ...... | ...... | ...... | ...... | 69 | ...... | ...... | ...... |
| Connecticut | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Delaware | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Florida | 1, 698 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Georgia | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Illinois | ...... | 1, 526 | ...... | ...... | ...... | ...... | ...... | ...... |
| Indiana | ...... | 228 | ...... | ...... | ...... | ...... | ...... | ...... |
| Louisiana | 1, 016 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Maine | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Maryland | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Massachusetts | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Michigan | ...... | 13, 037 | ...... | ...... | ...... | ...... | 116 | 16, 231 |
| Minnesota | ...... | ...... | ...... | ...... | ...... | ...... | ...... | 2, 212 |
| Mississippi | 556 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| New Jersey | ...... | ...... | 69 | ...... | ...... | ...... | ...... | ...... |
| New York | ...... | ...... | 23 | 3, 033 | ...... | ...... | ...... | ...... |
| Ohio | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Oregon | ...... | ...... | ...... | ...... | 48 | ...... | ...... | ...... |
| Pennsylvania | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Rhode Island | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| South Carolina | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Texas | 7 | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Virginia | ...... | ...... | ...... | ...... | ...... | ...... | ...... | ...... |
| Washington | ...... | ...... | ...... | ...... | 226 | 561 | .... | ...... |
| Wisconsin | ...... | 7, 387 | ...... | ...... | ...... | ...... | ...... | 2, 675 |
| Total | 3, 837 | 22, 178 | 92 | 3, 033 | 343 | 561 | 116 | 21, 118 |

large sections of these areas were unsurveyed and any detailed measurement would have been very approximate, if not misleading.[179]

(*b*) *The 1948 Tabulation.*—In 1939–1940, a comprehensive remeasurement of the tidal shoreline (detailed) was undertaken using a recording measure. The results of this

179. *Lengths, in Statute Miles, of the General Coast Line and Tidal Shore Line of the United States and Outlying Territories,* Serial No. 22, U.S. Coast and Geodetic Survey (1915). There were two printings of this serial, both dated Nov. 1915, but only one was priced and was for sale by the Superintendent of Documents. The only other difference between the two was that one gave 71 miles for the general coastline of Mississippi, while the other gave 14. However, the total for the Gulf coast was the same in both printings, and since the total agreed with the summation using the value of 14, the 71 must be presumed to be a typographical error.

measurement were combined (with a few differences) with the previously issued 1915 figures for general coastline and for tidal shoreline (general) and published as a leaflet in July 1948.[180]

(*c*) *The 1959 Tabulation.*—In January 1959, another tabulation was issued. This was practically a reissue of the 1948 tabulation except that the shoreline of Alaska was included in the tabulation for the United States, and three island areas added to the listing over which the United States exercises sovereignty—Johnston Island, Navassa Island, and the Swan Islands (*see* 352).

(*d*) *The 1961 Tabulation.*—The most recent tabulation of shoreline by the Bureau is dated April 1, 1961. Only two categories are included—general coastline and tidal shoreline. In every previous tabulation, except the interim tabulation in 1946 (*see* note 180 *supra*), a category of tidal shoreline (general) was also included. Apart from the difference in the arrangement of totals along the various coasts, the principal change from the 1959 tabulation is the increase in the general coastline of Florida from 1,197 to 1,350 statute miles. This reflects a new approach to the measurement of the Florida Keys. The same approach is reflected in the changes in the lengths of the Atlantic and Gulf tidal shoreline of the state, although the total for both coasts remains the same.[181]

Table 4 gives the present (1963) values recognized by the Bureau for three categories for the 50 states, based on the 1961 tabulation for the general coastline and the tidal shoreline (detailed), and on the 1959 tabulation for the tidal shoreline (general). The criteria for measurement are as follows:

*General Coastline.*—The measurements under this heading were made with a unit measure of 30 minutes of latitude (approximately 34.5 statute miles) on charts as near the scale of 1:1,200,000 as possible. The coastline of bays and sounds was included to a point where the waters narrowed to the width of the unit measure, the distance across at such points being included.

*Tidal Shoreline* (*general*).—Measurements under this heading (including islands) were made with a unit measure of 3 statute miles on charts of 1:200,000 and 1:400,000 scale when available. The shoreline of bays, sounds, and other bodies of water was included to a point where the waters narrowed to a width of 3 statute miles, the distance across at such points being included.[182]

180. There were differences in the general coastline for Mississippi and California and in the tidal shoreline (general) for the Hawaiian Islands and the Panama Canal Zone. An interim tabulation made in 1946 also embodied the 1939–1940 remeasurement for tidal shoreline (detailed), but this tabulation was superseded shortly thereafter by the 1948 tabulation. The value of 44 miles for the general coastline of Mississippi given in the 1948 tabulation in place of the 14 in the 1915 tabulation (*see* note 179 *supra*) was based on a different approach to the method of measuring an island coastline such as Mississippi's. The value of 840 miles for the general coastline of California, instead of 913 miles given in the 1915 tabulation, resulted from a remeasurement.

181. The general coastline of Alaska was remeasured in 1961 yielding the same 6,640 statute miles carried in all previous tabulations. Christmas Island was omitted from the 1961 tabulation because its sovereignty is in dispute with the United Kingdom. Small differences are noted in the case of Hawaii, due to the separate listing of the Midway Islands, the latter not being a part of the State of Hawaii (*see* 3432 A(*a*)); and in the case of the Swan Islands and Johnston Island. The change in the shoreline of the Swan Islands is the result of Coast Survey observations in 1960. STEWART, OCEANOGRAPHIC CRUISE REPORT, USC&GS SHIP EXPLORER 127, U.S. COAST AND GEODETIC SURVEY (1960).

182. The figures for Louisiana in this category do not include the shoreline of Lake Maurepas and Lake Ponchartrain. The value for the State of Hawaii was derived by deducing 20 miles (the tidal shoreline (general) of the Midway Islands) (*see* Table 5) from the value of 900 miles given in the 1959 tabulation for the Hawaiian Islands, resulting in a value of 880 miles.

TABLE 4.—*Lengths of the General Coastline and Tidal Shoreline of the United States*

| State | Lengths in statute miles | | |
|---|---|---|---|
| | General coastline | Tidal shoreline, general | Tidal shoreline, detailed |
| Alabama | 53 | 199 | 607 |
| Alaska | 6, 640 | 15, 132 | 33, 904 |
| California | 840 | 1, 190 | 3, 427 |
| Connecticut | .............. | 96 | 618 |
| Delaware | 28 | 79 | 381 |
| Florida | 1, 350 | 2, 276 | 8, 426 |
| Georgia | 100 | 603 | 2, 344 |
| Hawaii | 750 | 880 | 1, 052 |
| Louisiana | 397 | 985 | 7, 721 |
| Maine | 228 | 676 | 3, 478 |
| Maryland and D.C. | 31 | 452 | 3, 190 |
| Massachusetts | 192 | 453 | 1, 519 |
| Mississippi | 44 | 155 | 359 |
| New Hampshire | 13 | 14 | 131 |
| New Jersey | 130 | 398 | 1, 792 |
| New York | 127 | 470 | 1, 850 |
| North Carolina | 301 | 1, 030 | 3, 375 |
| Oregon | 296 | 312 | 1, 410 |
| Pennsylvania | .............. | .............. | 89 |
| Rhode Island | 40 | 156 | 384 |
| South Carolina | 187 | 758 | 2, 876 |
| Texas | 367 | 1, 100 | 3, 359 |
| Virginia | 112 | 567 | 3, 315 |
| Washington | 157 | 908 | 3, 026 |
| Total | 12, 383 | 28, 889 | 88, 633 |

*Tidal Shoreline* (*detailed*).—The figures under this heading (including islands) reflect the remeasurement of 1939–1940 (*see* text at note 180 *supra*) using a recording measure and the largest-scale charts and maps then available. Shoreline of bays, sounds, and other bodies of water was included to the head of tidewater, or to a point where such waters narrowed to a width of 100 feet, but with the following qualifications: Both shores of a stream were measured if over 200 yards wide, but streams between 30 yards (100 feet) and 200 yards in width were measured as a single line through the middle of the stream.[183]

Table 5 gives the shoreline of island areas under sovereignty of the United States for the three categories used for Table 4 and following the same criteria for measurement.[184]

TABLE 5.—*Lengths of the General Coastline and Tidal Shoreline of Areas Over Which the United States Exercises Sovereignty*

| Locality | Lengths in statute miles | | |
|---|---|---|---|
| | General coastline | Tidal shoreline, general | Tidal shoreline, detailed |
| Baker Island | 3 | 3 | 3 |
| Guam Island | 78 | 84 | 110 |
| Howland Island | 4 | 4 | 4 |
| Jarvis Island | 5 | 5 | 5 |
| Johnston Island | 5 | 5 | 5 |
| Midway Islands | 20 | 20 | 33 |
| Navassa Island | 5 | 5 | 5 |
| Palmyra Island | 9 | 9 | 16 |
| Panama Canal Zone | 20 | 20 | 126 |
| Puerto Rico | 311 | 362 | 700 |
| Samoa Islands | 76 | 91 | 126 |
| Swan Islands | 8 | ... | 10 |
| Virgin Islands | 117 | 126 | 175 |
| Wake Island | 12 | 12 | 20 |

## 391. Shoreline Along the Great Lakes

The values given in Table 4 do not include the shoreline of the states bordering the Great Lakes. The Bureau has never measured these shorelines. The following values in statute miles are from a recent measurement by the U.S. Lake Survey and include the main shoreline of the lakes, their outflow rivers, and the islands, but do not include marshy areas, landlocked bays and harbors, and islands of less than 1 mile in perimeter: Illinois=63; Indiana=45;

183. In the 1915 tabulation, the corresponding tidal shoreline was measured with a unit measure of 1 statute mile, rather than with a recording instrument (*see* text at note 179 *supra*). Also, the measurement was stopped when the waters narrowed to the width of the unit measure. These differences in procedure account for the marked increase in length of shoreline for this category in the later tabulation.

184. Kingman Reef (off Palmyra Island) and Sand Island (off Johnston Island) were not included in the tabulation because the shoreline in each case was less than 1 mile.

Michigan = 2,790; Minnesota = 189; New York = 408; Ohio = 312; Pennsylvania = 51; and Wisconsin = 820. The total shoreline = 4,678 statute miles, of which 1,092 miles comprise islands.[185] This brings the total tidal shoreline of the 50 states of the United States including the shoreline along the Great Lakes to 93,311 statute miles.[186]

185. *Shoreline Measurements—The Great Lakes*, News Letter, American Shore and Beach Preservation Association, Sept. 30, 1960.

186. *World Coastline.*—A measurement made by the Coast Survey in 1955 yielded a value of approximately 280,000 statute miles for the *general coastline* of the world. No other categories were determined. The method of measurement differed somewhat from the method used for measuring the general coastline of the United States (*see* 39). A unit of 50 statute miles was used for the mainland coasts, and units of either 10 or 20 miles for islands of less than 100 miles in circumference. The shoreline of small islands was estimated. Coastal indentations, such as bays, rivers, and inlets, with openings less than 10 statute miles were disregarded; for openings of 10 miles or more the shores of the indentation were measured, the measurements extending inland until the water distance across measured no more than 10 miles. For a breakdown of the coastlines for the various countries of the world and for observations on the method and accuracy of the measurements, *see* Karo, *World Coastline Measurements*, 33 INTERNATIONAL HYDROGRAPHIC REVIEW 131 (May 1956).

CHAPTER 4

# Some Legal Aspects of the Bureau's Work

A plane crashes on the west shore of the Potomac River. Does jurisdiction over the accident fall to the District of Columbia or to Virginia? An award of arbitrators defines the boundary between two jurisdictions as "following the meanderings of the said river." How is this to be interpreted with respect to indentations of the shore? The recreation room of a seaside home is damaged during a storm. Did the flooding result from the stage of the tide or from the storm? A Supreme Court decision describes the area of federal jurisdiction as seaward of the "ordinary" low-water mark. How is such boundary to be interpreted for the coasts of the United States? The seaward limit of riparian property is defined by the high-water line. How is such line to be established on the ground?

These are but a few examples of the types of information the Bureau is called upon to furnish, and constitute the legal aspects of its work. They are not exactly new developments in the work of the Bureau, but greater attention has been focused on them in recent years resulting from an increased awareness of the usefulness of precise surveys and of the carefully accumulated observational data in the settlement of boundary and other problems associated with lands bordering the seacoast.

The legal aspects of the Bureau's work may thus be said to flow from the nature of its work, from the precise survey methods used, and from its area of operation. They take the form of cases in which Bureau records are used or personnel appear as expert witnesses, cases in which the Bureau's advice is sought or its services solicited, and legal-technical inquiries covering almost every field of its operations. In dealing with these legal aspects, any phase of the law that has an impact on the field surveys (geodetic, topographic, hydrographic, or tidal) or nautical charts of the Bureau is considered an appropriate subject of discussion in this publication.

## 41. COAST SURVEY RECORDS AS EVIDENCE

The grants of waterfront property contain frequent references to the boundaries as the high-water line or the low-water line. Such lands are often in litigation and it becomes necessary to establish where the present boundary line is, or where it was at some time in the past. Our hydrographic and topographic surveys, as well as our tidal data, constitute an authentic record of conditions along our coasts extending back for more than a hundred years. The Bureau is called upon many times each year for tabulations of tidal data, for copies of original surveys, or for copies of aerial photographs. There are many instances of the use of Bureau records as evidence in legal controversies, a few of which will be described following the discussion of documentary evidence and judicial notice.

### 411. Documentary Evidence

Documentary evidence is evidence supplied by written instruments. In the law of evidence, documents are either public or private. A public document, it has been held, is one that records facts which may have been inquired into or taken notice of for the benefit of the public by an agent authorized for the purpose (*Woltin* v. *Metropolitan Life Ins. Co.*, 4 N.Y.S. 2d 296, 300 (1938)). Relevant public records are always admissible in evidence, although not accompanied by the usual tests of truth—the swearing and cross-examination of the persons who prepared them. They are entitled to this confidence because made as part of an official duty by agents appointed for that purpose, and because the facts stated in them are entries of a public nature and it would often be difficult to prove them by means of sworn witnesses. The document produced must be from the proper custody, and its identity, authenticity, and genuineness established. The rule admitting official documents has been applied to official letters, official maps, reports and records generally of official surveyors, and naval charts.

In view of the impropriety of allowing public records to be removed from their usual place of deposit, it is an established rule that whenever they are needed as evidence the contents may be proved by a properly authenticated copy (*New Mexico* v. *Texas*, 275 U.S. 279 (1927)).

The admission of government documents in evidence in the Federal courts, is governed by Title 28, chapter 115, section 1733(b) of the United States Code (1958 ed.), which provides that "Properly authenticated copies or transcripts of any books, records, papers, or documents of any department or agency of the United States shall be admitted in evidence equally with the originals thereof." 62 Stat. 946 (1948). It appears from this that only *copies* need be authenticated and not the *originals.* For example, a photostatic copy of a survey sheet or of a tidal record would require authentication, but a published chart or a printed publication would not, since all are *originals* and no particular one can be considered the master copy. It should be remembered, however, that this provision of the U.S. Code applies to procedures in the Federal courts. It may be different in some of the state courts. This interpretation as to our publications and charts is borne out by the method of authentication provided for in Rule 44(a) of the Rules of Civil Procedure for the District Courts of the United States (U.S. Code, page 5165). The rule states: "An official record or an entry therein, when admissible for any purpose, may be evidenced *by an official publication* thereof or by a copy attested by an officer having the legal custody of the record, or by his deputy, and accompanied with a certificate that such officer has the custody." (Emphasis added.) The rule further provides that the certificate may be made by a judge of a court of record, authenticated by the seal of the court, "or may be made by any public officer having a seal of office and having official duties in the district or political subdivision in which the record is kept, authenticated by the seal of his office."

In connection with authentication, it should be noted that both the 1940 and 1946 editions of the Code (Title 28, sec. 661(b)) provided that authentication be under the seal of the department. This was omitted in the 1952 and 1958 editions (sec. 1733(b)). However, this does not obviate the need for a seal because the language of Rule 44, quoted above, is actually broader than was provided in former editions of the Code. The former provisions that courts should take judicial notice of executive department seals was purposely omitted in the 1952 edition as being unnecessary, since state and Federal courts do take judicial notice of such seals without statutory mandate.

### 412. Judicial Notice of Coast Survey Records

It is a tribute to the foresight and wisdom of the pioneering founders of the Coast Survey that the precision standards which they established early in the 19th century have stood well the test of time. This accuracy is reflected in the credence which judicial tribunals attach to the surveys of the Bureau, by way of taking judicial notice of their accuracy.[1] This was significantly brought out in

1. Judicial notice is the act by which a court, in conducting a trial, or framing its decision, will, of its own motion, take cognizance of certain facts without proof which are regarded as established by common knowledge, *e.g.,* the laws of the state, international law, historical events, main geographical features, etc.

the case of *United States* v. *Romaine,* 255 Fed. 253 (1919), where the United States Court of Appeals for the Ninth Circuit said:

> We are unable to agree with the trial court as to the effect which should be given to the hydrographic maps of the United States Coast and Geodetic Survey as evidence in this case. We think the maps should be given full credence, and should be taken as absolutely establishing the truth of all that they purport to show . . . . Capt. George R. Campbell, United States engineer and hydrographic surveyor, testified to the accuracy of official hydrographic maps, stating that all the features connecting the shores with the water are accurately outlined and surveyed and tied to permanent landmarks, that these surveys are made with extreme accuracy, and that all are worked on an astronomical basis and are chained and taped a number of times, and that the government is always careful to do as accurate work as is possible on a coast line and in its marine coast survey work. Such testimony was hardly necessary, we think, for the court might properly take judicial notice of the accuracy of the official plats of the United States Coast and Geodetic Survey.[2]

The importance of this pronouncement by so high a court is emphasized by the nature of the doctrine of judicial notice and its evidentiary value. It was stated by the Supreme Court of California that "The judicial notice which courts take of matters of fact embraces those facts which are within the common knowledge of all, or are of such general notoriety as to need no evidence in their support, and also those matters which do not depend upon the weight of conflicting evidence, but are in their nature fixed and uniform, and may be determined by mere inspection, as of a public document, or by demonstration, as in the calculations of an exact science. . . . As this knowledge of the court does not depend upon the weight of evidence, and is not to be determined upon a consideration of the credibility of witnesses, it is evident that, when the court has stated to the jury a fact of which it takes judicial knowledge, the correctness of such statement is not to be controverted or set aside on an appeal by affidavits which are merely contradictory of the correctness of such statement."[3]

*North Hempstead* v. *Gregory,* 65 N.Y. Supp. 867 (1900). The limits of judicial notice cannot be prescribed with exactness, but notoriety is, generally speaking, the ultimate test of facts sought to be brought within the realm of such notice. *Gottstein* v. *Lister,* 153 Pac. 595, 602 (1915) (Wash.).

2. The controversy involved the question of the true location of the mouth of the Nooksack River, Wash., in 1855. (It had later changed its position.) The hydrographic surveys of 1855 and 1888 were introduced in evidence to show where the mouth of the river was. The lower court disregarded these surveys and relied upon the testimony of certain witnesses. The Circuit Court of Appeals reversed this and found for the United States. To the same effect is *Boone* v. *Kingsbury,* 273 Pac. 797, 813 (1928), where the Supreme Court of California, in passing on the question of the power of the state to alienate tide and submerged lands that are unfit for navigation and fishing, said: "The court is invited to and will take judicial notice of the coast lines within the state and will also resort to publications issued by the department of commerce describing and delineating the United States coast and geodetic surveys."

3. *People* v. *Mayes,* 45 Pac. 860 (1896) (Calif.). In this case, the trial court instructed the jury, as a matter of judicial knowledge, that the moon on a certain night rose at 10:57 p.m. No evidence on that point had been offered. The appellant contended that the instruction to the jury was erroneous, and in support of his contention presented an affidavit by one Swift that the moon rose at 10:35 p.m. The court said that while the affidavit stated that the statement is "made from accurate, correct, and reliable astronomical observations, calculations, and data," it does not state that the calculations were made by Swift, or the person by whom they were made, "so that the affidavit is of no higher grade than hearsay, and is insufficient to overcome the presumption of the correctness of the court's statement to the jury."

But it is important to emphasize that before a record is introduced in evidence, the primary purpose of the record should first be established. For example, an index map of charts in an area, as is contained in a chart catalog or in a *Coast Pilot,* is prepared for the purpose of showing primarily the layout of charts and should be used for that purpose only. The inclusion of geographic names is only secondary to the main purpose and should have no probative value for establishing the historical use of a particular name. The same applies to sketches in annual reports of the Bureau that show the work progress. That is the primary purpose of the sketch and any additional information shown must be evaluated with that in mind. On the other hand, a geographic name on a nautical chart is an integral part of the chart because it aids the navigator in identifying his whereabouts and would be given full credence.[4]

## 413. The Westward Growth of Rockaway Point

An interesting example of the value of the surveys and resurveys of the Bureau involved the westward growth of Rockaway Point, Long Island. Specifically, the question concerned the ownership of the point, which had built up considerably to the westward since the date of the original grant in 1685. By various conveyances through this grant the Rockaway Pacific Corporation claimed title to the land now forming the point.

The controversy centered about the manner in which the point grew—whether as a result of true accretion, or whether by annexation of islands or bars. Figure 100 is a section of the Coast Survey chart of 1844 and shows the middle ground shoal, including an area bare at high water known as Duck Bar Island, to the westward of Rockaway Point. (In the figure, the point is to the right of the feature marked "Negro Bar.") The State of New York had maintained that the growth of the point since 1887, the date it released its interest in the land area, was the result of the annexation of islands or bars; that the island had remained fixed in position, and that the water area in

4. In *Colby* v. *Todd Packing Co.,* 80 F. Supp. 761 (1948), the Federal District Court of Alaska took judicial notice of the time of flood tide as given in the *Tide Tables;* in *Borax Consolidated, Ltd.,* v. *Los Angeles,* 296 U.S. 10 (1935), the Supreme Court of the United States took notice of the definition of mean high water as given in Marmer, Tidal Datum Planes 76, Special Publication No. 135, U.S. Coast and Geodetic Survey (1927); in *Atkocus* v. *Terker,* 30 N.Y.S. 2d 628 (1941), the court took judicial notice of the geographical features and navigability of Jamaica Bay, N.Y.; and in *People of the State of New York* v. *Kraemer, Foley, Scannella,* and *Emig,* 164 N.Y.S. 2d 423 (1957), the court, in passing on the question of the public right of navigation in a man-made harbor which opened on navigable waters, took judicial notice of the statement in the Atlantic Coast Pilot (Section B) 344, U.S. Coast and Geodetic Survey (1950), that the harbor in question "is used considerably by local boats as an anchorage and as a harbor of refuge." But it has been held that variations in the location of the magnetic meridian on different dates is a matter of proof and not subject to judicial notice (*see* 3741 E).

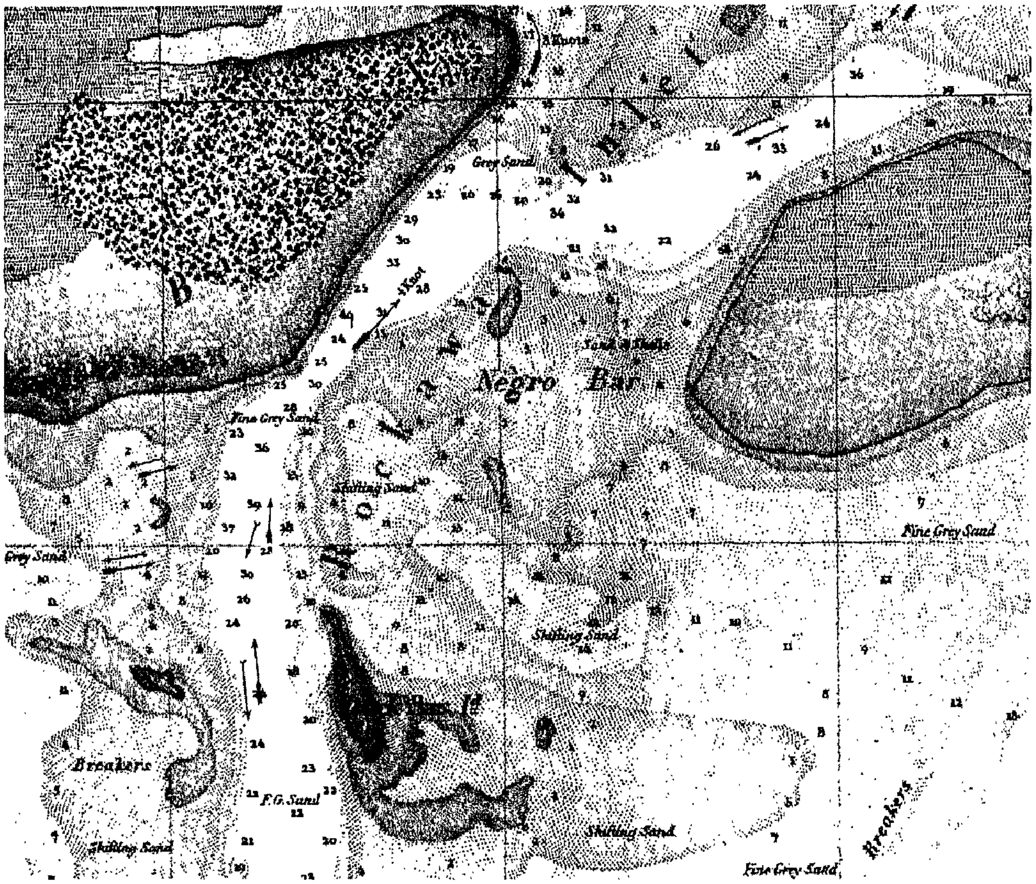


FIGURE 100.—Section of Coast Survey chart of 1844 used in the controversy over the westward growth of Rockaway Point, Long Island.

between filled up and connected the point with the island; and that the state, never having relinquished title to the island, retained ownership when the island became attached to the point, thus coming into possession of the point itself.

The Coast and Geodetic Survey had made frequent topographic and hydrographic surveys of the locality, the records dating back to 1835. While the experts for the litigants differed as to the method of growth of the point, both made use of Bureau surveys to uphold their respective theories.

The New York Court of Claims found against the State of New York, saying: "We are firmly impressed . . . by the vast amount of documentary evidence introduced, including maps and charts of all kinds, that for a considerable period of time before the state released its claim the growth of Rock-

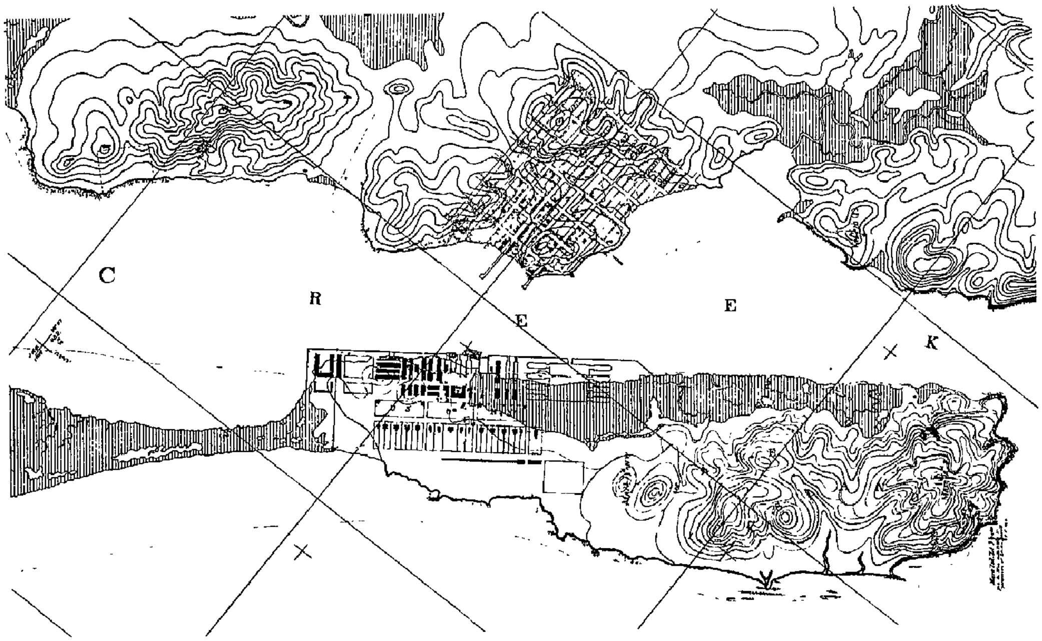


FIGURE 101.—Section of topographic survey of 1856 showing narrow neck of marshland in the "Mare Island in All Its Extent" controversy (*see* 414).

away peninsula to the west had been by the continual and gradual process of accretion" and "has not been by avulsion, not by annexation of islands."[5]

## 414. "Mare Island in All Its Extent"

Early surveys find many legal applications in waterfront property disputes, particularly in areas where improvements have been made and it becomes necessary to know where the high- or low-water line was located as of a prior date.

In a case involving a Spanish grant in 1841 of Mare Island, Calif., "in all its extent," it was important to determine the physical condition and outline of the island at the time of the grant in order to ascertain what was actually included by the conveyance. The area in controversy consisted of marshland (*see* fig. 101), since reclaimed and improved. The land had been used by the Government as a naval reservation on which some $2,000,000 in improvements had been expended. Suit was brought by the Government to quiet its title to the

5. *Rockaway Pacific Corp.* v. *State*, 203 N.Y. Supp. 279, 286, 288 (1924). The judgment was affirmed *per curiam* by the New York Court of Appeals. *Rockaway Pacific Corp.* v. *State*, 154 N.E. 603 (1926). (*See* note 123 *infra*.)

land. The defendants, who claimed under a patent from the State of California, contended that the lands in question were below high tide and therefore not within the exterior boundaries of Mare Island, but passed to California under the Swamp Lands Act (*see* 361).

The Government made an elaborate presentation of evidence which consisted of surveys by the Coast Survey since 1850, as well as some early Spanish maps. A Bureau official gave testimony on the interpretation of the surveys. Based on this evidence, the lower court found for the Government and this was affirmed by the Supreme Court of the United States.

With regard to the contention that the lands were below high tide, the Supreme Court held that the resolution of this issue turned upon the appraisal of the evidence, particularly the surveys and charts, and the inferences to be drawn from it. Since both lower courts found against the defendants on this issue, the Court said it would accept their findings that the lands in question were within the original grant of "Mare Island in all its extent." [6]

## 415. The "Tidelands" Controversy

Of the recent cases in which the Bureau participated, perhaps the most important were those dealing with ownership of the submerged lands in the open sea. These are commonly, but erroneously, referred to as the "tidelands" cases.[7]

The Bureau's association with these cases began shortly after the Supreme Court in 1947 declared that the State of California was not the owner of the submerged lands off its coast seaward of the ordinary low-water mark and outside of the inland waters of the state, but that the Federal Government had paramount rights in and full control over them.[8] For the purpose of determining the precise boundary between federal and state jurisdiction, the Court named a Special Master to hold hearings and to make recommendations.

At the request of the Attorney General of the United States, the Bureau assisted the Department of Justice in preparing its case before the Special Master. The spheres in which the Bureau participated related to the meaning and location of the ordinary low-water mark along the California coast, and the ascer-

6. *United States* v. *O'Donnell*, 303 U.S. 501, 508 (1938).

7. Tideland is the land covered and uncovered by the daily rise and fall of the tide. More specifically, it is the zone between the mean high-water line and the mean low-water line along a coast, and is commonly known as the "shore," "foreshore," or "beach." (*See* figs. 2 and 20, Volume One.) In the "tidelands" controversy, the land in litigation was the submerged lands seaward of the low-water line (*see* Volume One, Part 1, 111).

8. *United States* v. *California*, 332 U.S. 19 (1947).

tainment of the seaward limits of inland waters at indentations—both of which defined the federal-state boundary. Officials of the Bureau also appeared as expert witnesses before the Special Master and gave testimony on our tidal practices, on our cartographic usage, and on the interpretation of our early surveys.

The final report of the Special Master to the Supreme Court was favorable to the Government on all matters in which the Bureau assisted.[9]

## 42. UTILIZATION OF BUREAU SERVICES

The Coast Survey is not a regulatory agency such as the Interstate Commerce Commission, nor is it clothed with legal functions such as are vested in the Justice Department. It could not, for example, of its own volition undertake to determine the boundary between territorial waters and the high seas, or between two states, because it is not charged specifically with such functions, nor are they necessary for a proper administration of the duties that are conferred on the Bureau by law (*see* Part 1, 14). But because of our association with and interest in the sea, together with our long experience in surveying and charting, it would be entirely appropriate for the Bureau to render such advice as may be sought in arriving at a formula of delimitation. And once a formula has been established, it would be within the Bureau's competence to apply it in accordance with its best technical judgment, and either lay it down on the charts or demarcate it on the ground pursuant to a court order, an act of Congress, or a compact between states. The Bureau's advice and services in such matters have been repeatedly sought. Several such cases will be noted because of their still current interest.

### 421. The Maryland–Virginia Boundary Dispute

#### 4211. *The 1877 Arbitration*

In the Maryland–Virginia boundary dispute, the advice and services of the Coast Survey were sought by the two states in the matter of the interpretation of the Award of the Arbitrators of 1877 insofar as it pertained to the south bank

9. For a full discussion of this controversy, the participation of the Coast Survey, and an analysis of the Special Master's recommendations, *see* Volume One, Part *1*, *passim*.

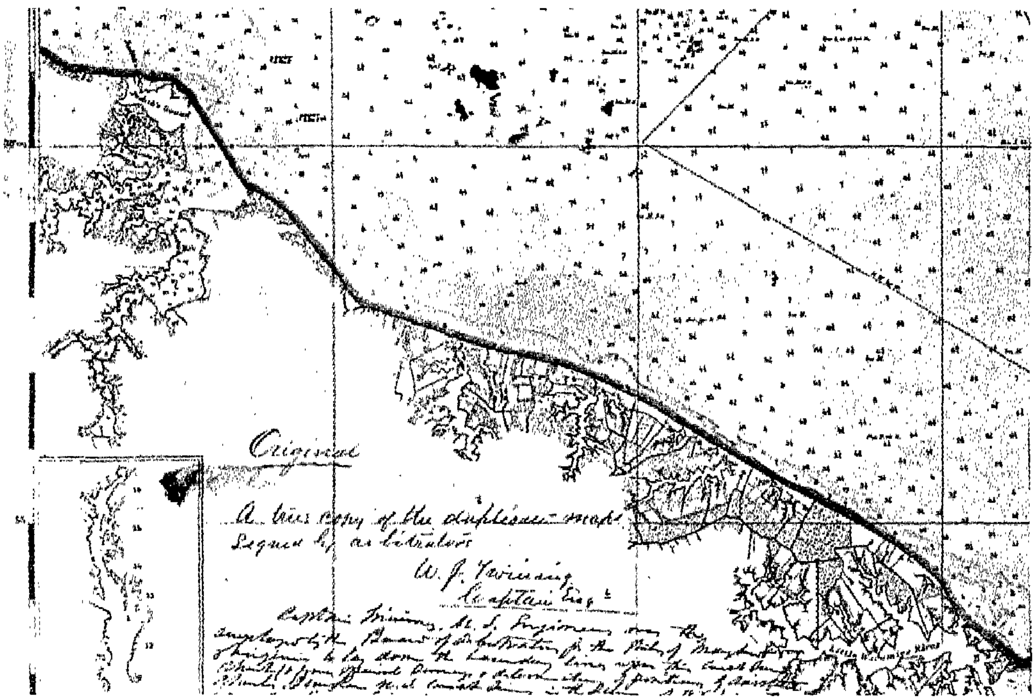

FIGURE 102.—Map accompanying the Award of the Arbitrators of 1877 (Maryland–Virginia boundary).

of the Potomac River between Jones and Smith Points.[10] The boundary from about 1 mile west of Judith's Creek on the lower Potomac (*see* fig. 102) to the Pocomoke River, was laid down by the arbitrators on Coast Chart No. 33 (Chesapeake Bay) of the Coast and Geodetic Survey (Sheet No. 3, Potomac Entrance, Tangier and Pocomoke Sounds, issue of 1877), and latitudes, longitudes, courses, and distances measured thereon and included in the award. The award, with accompanying map, was approved, confirmed, and ratified by the General Assembly of Virginia (Acts of 1877/8, chap. 246, approved Mar. 14, 1878) and accepted by the General Assembly of Maryland (Acts of 1878, chap. 374, approved Apr. 1, 1878). The consent of Congress was obtained Mar. 3, 1879 (20 Stat. 481).[11]

10. The Award of the Arbitrators of 1877 was the culmination of interstate controversy, discussion, and settlement which began about 1661, an important milestone being the Compact of 1785. For a history of the events leading up to the arbitration, *see* MATHEWS AND NELSON, REPORT ON THE LOCATION OF THE BOUNDARY LINE ALONG THE POTOMAC RIVER BETWEEN VIRGINIA AND MARYLAND IN ACCORDANCE WITH THE AWARD OF 1877 (1928).

11. *Id.* at 9. The chart referred to was filed as part of the award. A copy of this chart is available in the archives of the Coast Survey.

The award proper [12] dealt for the most part with the boundary from Chesapeake Bay to the Atlantic Ocean, over which the principal dispute centered. The arbitrators were not in agreement as to this portion of the boundary but were unanimous as to the boundary along the Potomac River. The arbitrators were of the opinion that the intent of the charter from Charles I to Lord Baltimore on June 20, 1632, was to include the whole of the Potomac River, and that there was nothing in the charter which required the line to leave the river bank. They held it was highly improbable that the two termini of the line should both have been fixed on the south side of the river (the right bank or right-hand side when facing downstream) without a purpose to put the line itself on the same side. They found that by the original charter the boundary line of Maryland was set at the high-water mark along the south bank of the Potomac,[13] but since Virginia from the earliest period of her history used the south bank of the river as if the soil to low-water mark had been her own, together with the fact that the Compact of 1785 declared that "the citizens of each State respectively shall have full property on the shores of Potomac and adjoining their lands, with all emoluments and advantages thereunto belonging, and the privilege of making and carrying out wharves and other improvements," they considered it as established that she had a proprietary right on the south shore to that mark.[14]

The boundary portions of the award contained two provisions which gave rise to later uncertainty and with which the Bureau became associated. The basic provision defined the boundary on the Potomac as "following the meanderings of said river by the low-water mark, to Smith's Point."

In further explanation of the award, the arbitrators added the following provision: "3. The low-water mark on the Potomac, to which Virginia has a right in the soil, is to be measured by the same rule [that used in determining the line on the Pocomoke River], that is to say, from low-water mark at one headland to low-water mark at another, without following indentations, bays, creeks, inlets, or affluent rivers." [15]

Obviously, these provisions are not sufficiently precise to permit laying down the line along all parts of the river without first resorting to certain

12. *Opinions and Award of Arbitrators of 1877*, MARYLAND AND VIRGINIA BOUNDARY LINE. This published volume is undated, but was received in the Coast Survey library Aug. 8, 1899.

13. The language of the charter was in Latin and read *"ad ulterioram predicti fluminis ripam et eam sequendo* etc.," which the arbitrators translated as "to the further bank of the aforesaid [Potomac] river and following it." *Id.* at 7, and *Marine Ry. & Coal Co.* v. *United States*, 257 U.S. 47, 63 (1921).

14. *Opinions and Award of Arbitrators, supra* note 12, at 8, 15, 16. The compact provided that the Potomac should be considered as a common highway for navigation and commerce to citizens of both states, with a common right of fishing. In return, Virginia permitted the free passage of Maryland ships through the lower Chesapeake Bay between the Virginia capes. For recent developments concerning this compact and the adoption of a new compact, *see* 4214.

15. *Id.* at 29, 31. The arbitrators also expressed the opinion that certain islands were "not *in*, but *upon* the river" and were situated on the Virginia side at the low-water mark. *Id.* at 17.

interpretative principles. The line drawn on the south shore of the Potomac so far as it goes follows the shoreline, crossing the minor indentations, but the award does not indicate which of the indentations that diverge from the course of the main river are to be included in the headland-to-headland provision. With the exception of the 17-mile stretch of the river from Smith's Point to Judith's Creek, which was shown on the chart accompanying the award (*see* text accompanying note 11 *supra* and fig. 102), there was no cartographic expression by the arbitrators concerning the location of the line for the rest of the Potomac River.

### 4212. *Coast Survey Participation*

The first involvement of the Coast Survey in this boundary dispute came in 1889 when both Maryland and Virginia requested the Superintendent of the Coast Survey to detail an officer to examine and locate that portion of the boundary line near Hog Island in the lower Potomac River (*see* fig. 103).[16] The problem turned upon the technical interpretation of the data given in the award as applied to the projection of a line representing the thread of a stream (the Pocomoke River) to that of a line along the shore (the right bank of the Potomac River). Henry L. Whiting, an assistant in the Survey, was named as sole arbiter in the case.[17]

Based on an examination of the award and the accompanying chart, Whiting laid down the following principle of interpretation: " 'The *low-water mark is to be measured'*—from headland to headland—without following indentations, bays, creeks, inlets, or affluent rivers; for the reason that such lateral features are incidental to the general system of the river and can not properly be made factors in determining its true physical limits." He concluded that the line on the map "clearly illustrates the intended location of the boundary line, and conforms to the terms and meaning of the award," thus ruling out the Geological Survey delineation.[18]

16. It appears that subsequent to acceptance of the award by the two states and its approval by Congress the maps of the U.S. Geological Survey showed the location of the boundary line in accordance with its interpretation of the intent of the award. The significant difference between this interpretation and the chart accompanying the award was in the vicinity of Hog Island near the western end of the chart. (*See* maps attached to MATHEWS AND NELSON (1928), *op. cit. supra* note 10.)

17. Annual Report, U.S. Coast and Geodetic Survey 92–94 (1890).

18. *Id.* at 622, 623. Latter-day elaboration of this principle by the Bureau is to the effect that the award of the arbitrators indicated an intent to give to Maryland ownership of the main highway by which the waters of the Potomac find their way to the sea, but did not include certain features on the Virginia side which were collateral to but not an integral part of the main waterway. Tributary waterways, such as bays, creeks, inlets, and affluent rivers were considered pertinent to the bank rather than to the bed of the river and therefore embraced within the headland-to-headland proviso of the award. Letter of June 19, 1950, from Director to Commonwealth Attorney of Virginia.

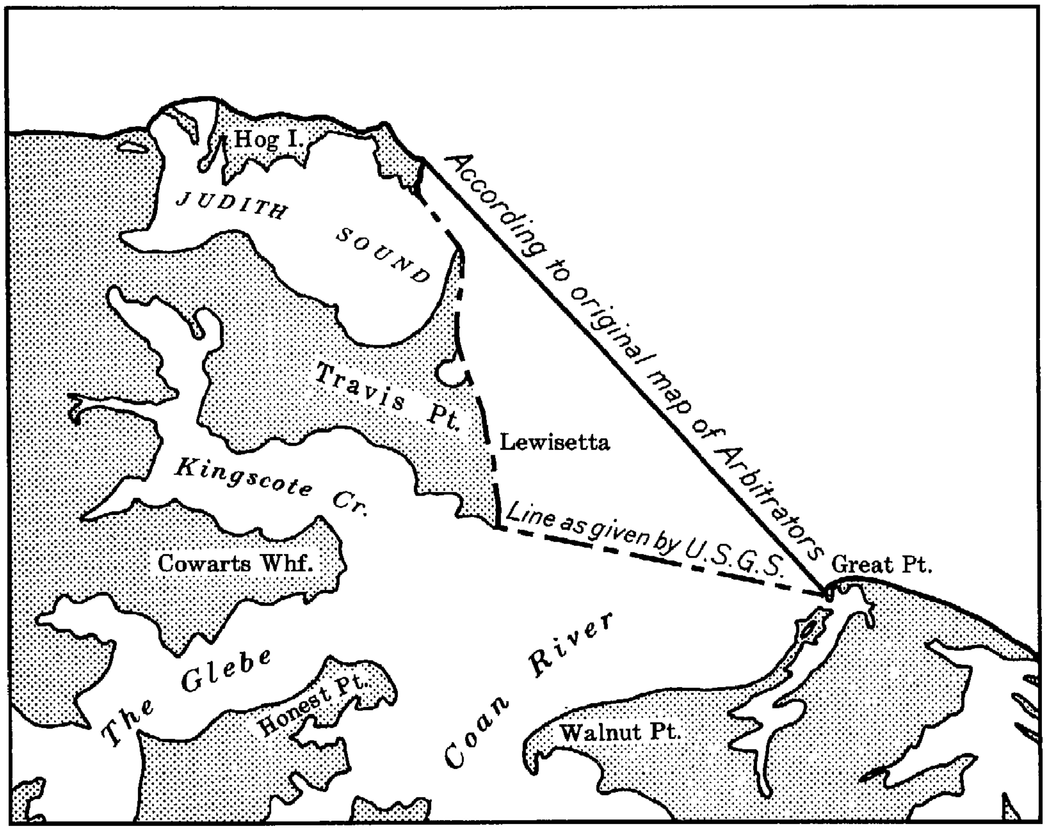


FIGURE 103.—Maryland-Virginia boundary in vicinity of Hog Island (*see* 4212).

While the Whiting decision disposed of the Hog Island area, it still left open the question of applying the provisions of the award and the interpretation of Whiting to the rest of the boundary along the Potomac and representing them on a map. This was referred to the State Geologists of Virginia and Maryland in 1927.[19]

In laying down the line on the maps, the geologists found that the line drawn on the map accompanying the award "follows the shoreline, crossing the minor indentations due to creeks but does not indicate that the line was to follow a straight line from headland to headland where the indentations are slightly divergent from the course of the main river and not the result of erosion by entering tributary streams." They, therefore, agreed that "the arbitrators had in mind to follow in a general way the course of the south bank of the river as shown by its general figure and the erosion of its banks by its waters without

19. MATHEWS AND NELSON (1928), *op. cit. supra* note 10, at 2, 13.

taking into consideration the minor sinuosities due to the entrance of streams or the flooding of low areas due to an erosion of the shore below low-water mark by such tributaries." [20]

A map delineation of the boundary line from Jones Point in Alexandria to Smith's Point at the mouth of the river was laid down on six charts of the Coast Survey and bound with the geologists' report (*see* note 10 *supra*).[21] The geologists recommended the demarcation of the boundary to be accomplished by skilled and impartial engineers under the supervision of commissioners representing both states. They submitted a proposed bill for concurrent acceptance by the legislatures of the states which recited that the drawing of the boundary line on maps by them is in accordance with their interpretation of the Award of 1877; that after ratification by both states, the Coast and Geodetic Survey, or other federal agency, be solicited "to supply the necessary skilled and impartial engineers who shall survey said line and properly mark and document it on the ground with sufficient points to insure that it may be readily recognized or restored if destroyed"; and that after the line is surveyed and marked on the ground, congressional approval be sought "in order that thereafter there may not arise any question of controversy." [22]

### A. DEMARCATION OF BOUNDARY LINE

The commissioners conferred with the Bureau requesting the appointment of an engineer "to supervise the actual marking of the line and to determine the location of the reference points in order that the matter might be redetermined or relocated at any time in the future by reference to the general triangulation system of the United States Coast and Geodetic Survey." [23] This was the second involvement of the Coast Survey in the Maryland-Virginia boundary dispute.

Between July and October 1929, 58 boundary witness monuments were erected above the high-water line and their geographic positions determined. All were marked with the standard mark of the Virginia-Maryland Boundary

20. *Id.* at 15, 16.

21. The line is shown in red on the charts and the variations based on maps prepared by the U.S. Geological Survey shown in blue.

22. *Id.* at 47, 48. The line and recommendations were approved by Virginia (Acts of Assembly 1928, chap. 477) and by Maryland (Acts of Assembly 1929, chap. 50) and the geologists were commissioned to define the line on the ground.

23. MATHEWS AND NELSON, REPORT OF THE MARKING OF THE BOUNDARY LINE ALONG THE POTOMAC RIVER IN ACCORDANCE WITH THE AWARD OF 1877, 3 (1930). This is in the same volume with MATHEWS AND NELSON (1928), *op. cit. supra* note 10.

Commission. The work was tied in horizontally to the triangulation network of the country, but no tidal control was used for determining the low-water line, points on the boundary to which references were made by distance and azimuth being selected from a physical inspection of the shore and predicted tides.[24]

The work of the Coast Survey was approved in December 1929 by the commissioners acting for the two states. Consent of Congress to the marked boundary line was held unnecessary by the Legislative Counsel of the U.S. Senate because acceptance by Congress of the Award of 1877 implicitly gave the states authority to carry the award into effect.[25]

The most recent involvement of the Coast Survey in the Maryland–Virginia boundary dispute grew out of a proceeding to determine whether a pier on the Virginia shore in the vicinity of Fairview was in Maryland or Virginia. The Coast Survey was approached by the State of Virginia for a reinterpretation of the "headland-to-headland" provision of the Award of 1877 with respect to the area in question. The Bureau was of the opinion, however, that whatever speculation may have remained as to the intent of the arbitrators to include or exclude portions of the river from Maryland or Virginia ownership was resolved when the boundary line was marked on the ground and accepted by both states. That determination placed the boundary in the vicinity of Fairview at the low-water mark and not on a line between headlands. *See* letter noted in note 18 *supra.*[26] In the litigation that ensued, Virginia contended that a *de novo* interpretation of the boundary was in order because the boundary constituted a compact between the two states and required the approval of Congress. The court however ruled that approval of the Award of 1877 was sufficient, as the

24. E. B. Latham was the Coast Survey engineer in charge of the project. The geodetic definition of points on the boundary line with distance and azimuth references to the marked monuments and descriptions of the monuments and stations, together with sketches showing the relation of the monuments to the boundary line, are contained in MATHEWS AND NELSON (1930), *op. cit. supra* note 23. These are unadjusted field positions on the North American datum. The positions of the marked boundary witness monuments have now been adjusted to the North American 1927 Datum and may be obtained from the Coast Survey archives. Points on the boundary line as located in 1929 may be obtained from the distance and azimuth values measured at that time. (At boundary witness monument 39, the distance to the point on the boundary line should be 40 feet instead of 276 feet as published in *id.* at 11. This was disclosed during the adjustment made in 1959.)

25. *Id.* at 32. A boundary between two states may be changed by agreement of the state legislatures, but this agreement must be approved by Congress. This follows from Art. I, sec. 10, cl. 3, of the Constitution of the United States which provides that "No State shall, without the Consent of Congress . . . enter into any Agreement or Compact with another State." Neither can the United States change a state boundary without the consent of the State. The conditions under which ratification by Congress is essential are described at length in *Virginia* v. *Tennessee,* 148 U.S. 503 (1893) (*see* 342).

26. If the more modern rule of the semicircle for determining when an indentation in a coast is part of the inland waters of a nation (*see* Volume One, Part 1, 421), so as to justify the drawing of a headland-to-headland line across the indentations, were to be applied to the Virginia shore of the Potomac River, the net result would be essentially the boundary line marked by the Coast Survey in 1929.

survey was made merely to carry the award into effect (*see* text at note 25 *supra*).[27]

### 4213. *A Shifting or Fixed Boundary*

The question has arisen whether the low-water boundary established in 1929 between Maryland and Virginia is a fixed or a shifting boundary. It is a well-settled principle of riparian law that where the sea or an arm thereof is a boundary, gradual and imperceptible changes brought about by *erosion* (a washing away of the soil or an encroachment of the water) or *accretion* (a deposit of alluvial soil or recession of the water) operate to change the boundary of the riparian land (*see* note 34 *infra*). This has sometimes been referred to as the ambulatory or shifting nature of a water boundary. The rule is, however, not inflexible and two riparian owners with a common water boundary may agree that the boundary as established at a given time shall remain so forever. Where the language of an agreement is specific and definite, no uncertainties will arise. But where the language is unclear, then the intent of the parties must be deduced from the circumstances surrounding the establishment of the boundary.[28]

This aspect of the status of the Maryland–Virginia boundary line along the Potomac River has never been adjudicated, and it would be beyond the purview of this publication to express an opinion on this point. However, certain technical circumstances exist that may have an important bearing on the status of the boundary. It is these that will be considered and clarified.

As discussed in 4211 and 4212, four significant dates are associated with the establishment and marking of the boundary line, to wit: 1632, the date of the charter to Lord Baltimore; 1877, the Award of the Arbitrators; 1927, the map de-

27. The decision of the arbitrators as to the low-water mark on the Virginia shore being the boundary between Maryland and Virginia was approved by the Supreme Court of the United States in the case of *Maryland* v. *West Virginia*, 217 U.S. 577, 580 (1910) and applied to the Maryland–West Virginia boundary.

28. Thus, for example, in the Chamizal Arbitration between the United States and Mexico in 1910 over the movement southward of the Rio Grande into Mexican territory, the question was whether the river boundary under the treaties of 1848 and 1853 was a fixed or a shifting one. The International Boundary Commission said that because there was a legitimate doubt as to the true construction of these treaties, "the subsequent course of conduct of the parties, and their formal conventions, may be resorted to as aids to construction." This conduct, together with the language of the conventions, it held, was "wholly incompatible with the existence of a fixed line boundary." *The Chamizal Arbitration Between the United States and Mexico*, 5 AMERICAN JOURNAL OF INTERNATIONAL LAW 782, 798 (1911). On the other hand, the United States-Canadian boundary was held by the International Boundary Commission to be a fixed boundary in the position as marked, regardless of later changes which may occur in streams. This was based on the Treaty of Apr. 11, 1908, between the United States and Great Britain, which contained the following statement: "The line so defined and laid down shall be taken and deemed to be the international boundary." DOUGLAS, BOUNDARIES, AREAS, GEOGRAPHIC CENTERS, AND ALTITUDES OF THE UNITED STATES AND THE SEVERAL STATES (2d ed.) 22, BULLETIN 817, U.S. GEOLOGICAL SURVEY (1932).

lineation of the boundary line by representatives of the two states; and 1929, the date of marking the boundary on the ground by the Coast and Geodetic Survey.

In considering these several dates, it is important to note that in their award the Arbitrators of 1877 made no reference to the low-water mark as it existed in 1632, but rather showed the boundary line in a portion of the Potomac River on a chart published in 1877. And it is significant that while the original grant to Lord Baltimore placed the Maryland boundary at the high-water mark along the Virginia shore, the arbitrators set the boundary at the low-water mark (albeit on the basis of prescription) in order to give to Virginia the continued use of its shore.[29]

When in 1927 the representatives of the two states interpreted the Award of 1877, they delineated the boundary on then current charts rather than on charts that reflected an 1877 shoreline.[30] What needed clarification was not so much the actual location of the boundary, but rather an interpretation of the award with respect to the meanderings of the river and the effect of bays, creeks, and other tributary waterways on the boundary. For an actual map location of the boundary line with respect to geographic coordinates, the charts are of too small a scale (1: 40,000, or 1 in. = 3,333 ft.) to represent with accuracy a boundary along the low-water line. The map delineation can at best be considered pictorial only.[31]

Up to the time of marking the boundary line in 1929, the technical evidence seems clear that a shifting boundary theory was followed. And the question raised is whether the circumstances surrounding the marking of the line in 1929 altered this theory.

The survey of 1929 established 58 boundary witness monuments by triangulation between Jones Point and Smith's Point with an equal number of points on the low-water line referenced to the monuments by azimuth and distance (*see* text at note 24 *supra*). The survey covered a linear distance of 100 nautical miles on the Virginia shore, so that points were located on the boundary at an average of 2 miles apart. No survey was made of the low-water line between these points nor were the points themselves determined by levels from tidal bench marks, but a selection was made based on the physical appear-

29. This could only be accomplished on the theory of a shifting boundary. If otherwise, any accretion that came about would have the effect of depriving Virginia of its shoreline and the boundary would no longer follow the "meanderings of said river by the low-water mark, to Smith's Point," as provided in the award (*see* text at note 15 *supra*, and note 60 *infra*).

30. The charts are actually based on surveys of 1902–1907.

31. This delineation was approved by the legislatures of the two states and a survey and marking of the boundary authorized. MATHEWS AND NELSON (1930), *op. cit. supra* note 23, at 3.

ance of the shore and predicted tides.[32] It would seem that if the line was intended to be a fixed boundary, a survey would have been made of the actual low-water line (as determined from tidal bench marks) on a reasonably large scale. In the demarcation of the District of Columbia–Virginia boundary line (*see* 4223 A), the high-water line was determined by levels from tidal bench marks and the line mapped at a scale of 1:4,800 or 1 in. = 400 ft., even though the law establishing the boundary recognized the shifting boundary theory.[33]

It is recognized that points on the boundary line were determined in latitude and longitude (*see* note 24 *supra*), a facet which would seem to favor a fixed-boundary theory, yet these are points at the extremities of sections of the line that depart from the low-water line to cut across tributary waterways (*see* MATHEWS AND NELSON (1930)), *op. cit. supra* note 23, at 2–33. Such sections of the boundary line might properly be considered relatively fixed.[34]

32. This method was also used in establishing the low-water boundary between New Jersey and Delaware on the New Jersey side of the Delaware River. *See* Brittain, *Report on Marking the Delaware–New Jersey Boundary,* Special Rept. 202 of 1934 (Coast Survey archives).

33. 59 Stat. 552 (sec. 101) (1945). In *New Jersey* v. *Delaware* (Decree), 295 U.S. 694 (1935), where the low-water mark was established along the New Jersey shore of the Delaware River in much the same way as in the Maryland–Virginia boundary line (*see* note 32 *supra*), the Supreme Court retained jurisdiction "for the purpose of a resurvey of said boundary line in case of physical changes in the mean low water line . . . which may, under established rules of law, alter the location of such boundary line." *Id.* at 698.

34. In this connection, *Raglan* v. *Johnston Rock Co.,* 123 P. 2d 883 (1942) (Calif.), is of interest. A boundary line, which fixed the dividing line as the center of a non-navigable stream "as now situated" and then delineated the line by "metes and bounds" (*see* 3741 C) was held to be simply a determination that the center of the stream *at present* has a definite and fixed location and is not a permanent dividing line. *Id.* at 885. In *Ghione* v. *State,* 175 P. 2d 955, 961 (1946), although involving river bed lands not subject to tidal flow, the Supreme Court of Washington stated the rule of accretion, or the moving boundary theory to be as follows: "A thorough review of the policy and precedent which give rise to the rule will be found in *Jefferis* v. *East Omaha Land Co.,* 134 U.S. 178 (1890). It is said that this rule of accretion is everywhere admitted and applies to both tidewaters and fresh waters." This is part of the broad doctrine that, under our dual sovereignty system (*see* 211), the title and rights of riparian proprietors in the soil below high-water mark of navigable waters are governed by the laws of the several states rather than by federal law. This control extends to such attributes of ownership of waterfront property as the right of ingress and egress, the right to wharf out, the right to accretions to the land, and rights in the tidelands themselves—commonly called riparian rights. Thus, some states have extended riparian titles outward to the low-water mark or to the thread of non-tidal navigable streams. This is the normal situation and appellate Federal courts accept the interpretation of the highest court of a state as to what the state law is. However, where a situation involves a federal question, federal law applies. This was established by the Supreme Court in *Borax Consolidated, Ltd.* v. *Los Angeles,* 296 U.S. 10 (1935) (*see* Volume One, Part 1, 6413), and was recently followed in *United States* v. *Washington,* 294 F. 2d 830 (1961), where the United States Court of Appeals upheld the Government's contention that federal law should apply because of the underlying federal title (the lands in question were part of the public domain until patented to a Quinault Indian). And since accretion is an attribute of title, the determination of its limits is also a right asserted under federal law. (Federal law follows the common law of England (*see* 251) which holds that the owner of land bounded by the sea owns any additions thereto resulting from accretion.) The Court of Appeals thus recognized the shifting boundary theory. It also followed the rule established in the *Borax* case, *supra,* that the boundary of the land in question is the line of ordinary high water as determined by the course of the tides and is the average elevation of all high tides as observed through a complete tidal cycle of 18.6 years. (If state law applied, then it was contended that "ordinary high water" has been interpreted by the Washington courts to mean the line of vegetation.) The decision was finalized in Mar. 1962, when the Supreme Court declined to review the finding of the lower court. *United States* v. *Washington,* 369 U.S. 817 (1962).

The reference in the report of the geologists that the line be marked "in order that the matter might be redetermined or relocated at any time in the future by reference to the general triangulation system" (*see* text at note 23, *supra*), is interpreted to mean that any future location of the low-water line could be made from the established triangulation markers.[35]

### 4214. *Recent Developments—A New Compact*

The Maryland–Virginia Compact of 1785 was again catapulted into the news in 1957 when the Maryland Legislature voted to abrogate the compact and enacted a statute requiring all Virginians who may desire to fish in the Potomac River to apply for a Maryland license.[36] Virginia challenged Maryland's right to take such unilateral action and filed suit in the Supreme Court. The Court appointed a Special Master who was to develop the facts by calling witnesses and taking testimony and then to make recommendations to the Court on legal points. Through the Master's efforts a joint group was set up to explore the possibility of working out a new compact. This was accomplished late in December 1958 when the Potomac River Compact of 1958 was created. This was ratified by both states,[37] after which Congress gave its consent on September 27, 1962.[38] This was signed by the President on October 10, 1962, and it became Public Law 87–783 (76 Stat. 797).

Insofar as the Maryland–Virginia boundary line along the Potomac is concerned, the new compact makes no change. Maryland retains its territorial jurisdiction over the waters of the Potomac to the mean low-water line on the Virginia shore "as defined in the Black-Jenkins Award of 1877 and as laid out in the Mathews-Nelson Survey of 1927, beginning at the intersection of the

35. In *Steelman* v. *Field*, 128 S. E. 558, 560 (1925), involving lands at Assateague Anchorage, the Supreme Court of Appeals of Virginia held to the shifting boundary theory and stated the law to be according to Sec. 3574 of the 1919 Code that riparian rights along bays, rivers, creeks, and shores of the sea extends to low-water mark, and "however this line may thus change, either for the advantage or disadvantage of the riparian owner, low-water mark remains his true boundary under the Virginia statute. The court cited with approval the holding in *Lamprey* v. *State and Metcalf*, 53 N. W. 1139, 1142 (1893) (Minn.) that the purpose of such rule is "to preserve the fundamental riparian right—on which all others depend, and which often constitutes the principal value of land—of access to the water." In Maryland, the 1951 Code (Art. 54, sec. 45) provides that "The proprietor of land bounding on any of the navigable waters of this State, is hereby declared to be entitled to all accretions to said land by the recession of said water, whether heretofore or hereafter formed or made by natural causes or otherwise." *Wagner* v. *Baltimore*, 124 A. 2d 815, 818 (1956).

36. The basis for this action was that since the Constitution of the United States (adopted 4 years after the Compact of 1785) rendered the "free passage" clause of the compact obsolete (*see* note 14 *supra*) there was no longer a *quid pro quo* agreement and hence the compact was invalid.

37. Both states agreed to the compact by means of concurrent legislation, being Chap. 269 of the Acts of the General Assembly of Maryland of 1959, and Chaps. 5 and 28 of the 1959 Extraordinary Session of the General Assembly of Virginia.

38. H. J. Res. 659, 87th Cong., 2d sess., and S. Rept. 2155 (1962). One of the essential provisions in the new compact is the creation of a bistate Potomac River Fisheries Commission charged with the regulation of the river's fishing laws.

Potomac River and the District of Columbia line at Jones Point and running to Smiths Point" (*see* 4211 and 4212).[39]

### 422. The District of Columbia–Virginia Boundary Line

The demarcation of the District of Columbia–Virginia boundary line is another example of cases in which the Bureau's services were sought in a legal-technical capacity. An act of Congress, approved October 31, 1945 (59 Stat. 552), directed the Coast and Geodetic Survey to survey and mark the line separating the two jurisdictions which the act determined to be the present (the effective date of the act) mean high-water mark along the Virginia shore, except at Alexandria where it follows the established pier-head line.

#### 4221. *Background of the Controversy*

The original limits of the District of Columbia included an area 10 miles square on both sides of the Potomac River ceded to the Federal Government by Maryland and Virginia.[40] On March 30, 1791, President Washington issued a proclamation in which the exact boundaries of the District were set out as follows:

> Beginning at Jones's Point, being the upper cape of Hunting Creek, in Virginia, and at an angle in the outset of 45 degrees west of the north, and running in a direct line 10 miles for the first line; then beginning again at the same Jones's Point and running another direct line at a right angle with the first across the Potomac, 10 miles for a second line; then, from the termination of the said first and second lines, running two other direct lines, of ten miles each, the one crossing the Eastern Branch aforesaid, and the other the Potomac, and meeting each other in a point.[41]

39. 76 Stat. 800 (1962). Under the new compact, citizens of each state enjoy equal fishing rights in the Potomac River, the same as they did under the Compact of 1785, and existing rights of riparian owners of each state along the shores of the river are perpetuated. *Id.* at 797 and 803.

40. On Dec. 23, 1788, Maryland passed an act ceding to the United States any district in the state not exceeding 10 miles square for use as the seat of government of the United States. And on Dec. 3, 1789, Virginia passed a similar act ceding an area not more than 10 miles square for the same purpose. Douglas (1932), *op. cit. supra* note 28, at 132.

41. *Id.* at 133–134. This proclamation was issued pursuant to two acts of Congress, approved July 16, 1790 (1 Stat. 130) and Mar. 3, 1791 (1 Stat. 214), respectively, accepting the cessions of the two states and providing for a survey and demarcation of the 10-mile square District. *Ibid.* The District of Columbia originally was divided into two counties—the County of Washington, comprising the area lying on the east side of the Potomac River, and the County of Virginia consisting of the area on the west side of the river. 2 Stat. 103, 105 (1801). Although originally planned to be exactly 10 miles square, it has been found that the northeast side measures 263.1 feet more, the southeast side 70.5 feet more, the southwest side 230.6 feet more, and the northwest side 63.0 feet more than 10 miles. The lines do not bear exactly 45° from the meridian, the greatest variation being 1'.75. Also the northern point is not exactly north of the southern point, but bears 5'19".7 west of north of it which corresponds to a distance of 116 feet. Baker, *Surveys and Maps of the District of Columbia*, 6 The National Geographic Magazine 149, 152–153 (1894).

The portion of the District originally ceded to the United States by Virginia was receded to Virginia in 1846.[42] The southwestern boundary of the District thus became coincident with that part of the boundary of Maryland prior to December 23, 1788, the date of the original cession by Maryland (*see* note 40 *supra*). However, January 24, 1791, the date when President Washington issued a proclamation naming commissioners to survey and define the District, has been accepted as determinative of the boundary with Virginia.[43]

The question as to the exact location of the boundary line on the Virginia shore (whether high-water line or low-water line) had been the subject of controversy ever since the retrocession in 1846 to Virginia of lands ceded by it to the United States. Finally, by an act of Congress, approved March 21, 1934 (48 Stat. 453), and an act of the Virginia General Assembly, approved March 24, 1932, a commission was named "for the purpose of surveying and ascertaining the boundary line between the District of Columbia and the State of Virginia," and to mark the boundary line by suitable monuments.[44]

In determining the location of the boundary line, the Commission was instructed to take into consideration, among other things, the "several decisions of the Supreme Court of the United States in relation thereto, the findings and reports of the Maryland and Virginia Boundary Commission of 1877" [this must mean the Arbitration of 1877 (*see* 4211)], and "the Compact of 1785" between the two states (*see* 4211).[45]

In the Arbitration of 1877, it was established that the original charter from Charles I to Lord Baltimore gave to Maryland the entire Potomac River "to the further bank of the aforesaid river" (*see* note 13 *supra*), which the arbitrators determined to be the high-water line on the Virginia shore. However, in the light of the Compact of 1785, which gave to the riparian owners of each state rights and privileges in the shores of the Potomac, and the long user by Virginia of the soil to low-water mark, the arbitrators decided that the boundary between the two states in 1877 is at the low-water mark along the Virginia shore. The boundary between Maryland and West Virginia (carved from Virginia in 1862) was adjudicated by the Supreme Court of the United States in 1910 as along the low-water line of the West Virginia shore of the Potomac on the basis

42. 9 Stat. 35–36 (1846). This act was declared in full force and effect by Presidential Proclamation on Sept. 7, 1846. *Id.* at 1000.

43. RICHARDSON, 1 MESSAGES AND PAPERS OF THE PRESIDENTS 100 (1789–1897). *See also* comments of Department of Justice on Establishing a Boundary Line Between the District of Columbia and the Commonwealth of Virginia in H. Rept. 595, 79th Cong., 1st sess. 3 (1945), and 59 Stat. 552 (1945).

44. The act of 1934 creating the Commission is included in the Report of the District of Columbia–Virginia Boundary Commission, H. Doc. 374, 74th Cong., 2d sess. 1 (1936).

45. *Ibid.* The Commission understood this instruction to mean that it was to take account not only of the legal rights of the two sovereignties but also their respective equitable rights. *Id.* at 3.

of the Compact of 1785 and the Arbitration of 1877.[46] These several pronouncements settled, in the view of the boundary commissioners, the boundary question along the Potomac River except for the 10- or 12-mile stretch that is common to the District of Columbia and Virginia.

The boundary aspect of the controversy therefore centered around the question of what cognizance should be taken in 1935 of the findings of the arbitrators in 1877 in a controversy that concerns a cession of land made by Maryland to the United States in 1791.

The legal principle involved in waterfront boundary disputes is that the boundary shifts with changes brought about by natural forces, such as erosion and accretion, but not by artificial causes, such as reclamation or filling. Therefore, the critical date for the determination of the boundary line was January 24, 1791 (*see* text at note 43 *supra*), except as later modified by natural changes.

The Boundary Commission in its findings considered the location of the 1791 line (high water or low water) to be a matter of conjecture and since it could not be definitely reestablished, the equitable solution, in its judgment (following the arbitrators of 1877 (*see* 4211)), was to locate "the low-water mark as of today [1935, the date of rendering its report] . . . running from headland to headland across creeks and inlets." The Commission stated that the boundary line as recommended "is based upon the fact that by every act and function of government, by continued occupation and possession and the exercise of ownership, from its earliest history to the present time, the Commonwealth of Virginia has exercised and acquired full and complete sovereignty and jurisdiction over the territory involved." [47]

46. *Maryland* v. *West Virginia*, 217 U.S. 577 (1910). Although the question of a high-water boundary or a low-water boundary along the Potomac was not placed squarely in issue but arose from the opposing decrees proposed by the two litigants, the Court followed the reasoning of the Arbitrators of 1877 and stated that "the privileges therein reserved [in the Compact of 1785] respectively to the citizens of the two States on the shores of the Potomac are inconsistent with the claim that the Maryland boundary on the south side of the Potomac River shall extend to high-water mark." It therefore held the boundary to be at low-water mark. *Id.* at 580, 581.

47. Report of the District of Columbia–Virginia Boundary Commission, *supra* note 44, at 19, 20. This was contested by the Government on the ground that the maps and surveys submitted to the Commission (some of which originated with the Coast Survey) established with all necessary certainty the high-water line of 1791. (Personnel of the Bureau interpreted the early surveys and maps for the Commission.) A composite map was submitted showing the original high-water line in relation to the existing high-water line. Statement on behalf of the United States before the Judiciary Committee of the House of Representatives 42–45, in *Hearing on H.R. 9670*, 74th Cong., 2d sess. (1936). (The statement contains reproductions of surveys made between 1791 and 1864.) For a comprehensive list of maps of Washington and the District of Columbia up to 1894, *see* Baker, *supra* note 41, at 167–178. A detailed topographic survey of the District of Columbia was made by the Coast Survey between 1880 and 1891 at a scale of 1: 4,800. The survey comprised 43 sheets. A series of published maps (58 in number) based on these surveys and at the same scale was completed in 1895. These surveys and maps do not cover the central portion of the city which is covered by the King Plats surveyed in 1803 at a scale of 1: 2,400 and published in map form (16 in number) at the same scale.

Following the Commission's report, a bill was introduced in Congress embodying substantially the recommendations of the Commission and charged the Coast and Geodetic Survey with the duty of surveying and marking the line on the ground.[48] As written, the bill was emphatically opposed by the Department of Justice on the ground that the Compact of 1785 had been construed by the Supreme Court and found that it neither changed nor affected the boundary line in question, and that upon a full reconsideration of the subject the Court said that the construction adopted by the arbitrators of 1877, and recited in *Maryland* v. *West Virginia, supra* note 46, was a mistaken construction.[49]

## 4222. *The Act of October 31, 1945*

In 1945, legislation was again initiated looking toward a settlement of the boundary question which had been mooted for a great many years. The Committee report on the bill stated that its purpose was "to establish a definite clear-cut boundary line, easy to recognize and convenient for police and court jurisdiction, between the District of Columbia and the Commonwealth of

48. H.R. 9670, 74th Cong., 2d sess. (1936). This bill was never enacted into law.

49. Statement on Behalf of the United States, *supra* note 47, at 8–17. Several cases had been before the Supreme Court of the United States involving ownership along the Potomac River and, although Virginia was not a party in these suits, the Court had construed the boundary of the District of Columbia to be at the high-water line along the Virginia shore. The first of these was *Morris* v. *United States,* 174 U.S. 196 (1899). Although this was a controversy between the United States and private individuals as to reclaimed land on the District of Columbia side of the river, the Court stated that the grant to Lord Baltimore in 1632 by King Charles I carried the title on the Potomac River to the high-water mark on the Virginia shore. *Marine Railway & Coal Co.* v. *United States,* 257 U.S. 47 (1921), involved the validity of a claim asserted by the railway company to a strip of land in Battery Cove on the Virginia side which was below the low-water mark but which had been filled in by the United States and enclosed with a fence at the high-water mark. The Court held that the Compact of 1785 had no bearing on the case because it was a regulation of commerce only and left the question of boundary open to long continued disputes until settled by the Arbitration of 1877. But that was an arbitration, the Court said, as to the boundary between the two states as they then were and did not purport to affect the boundary of the District. And the Court said further that they knew of no reason for construing the charter to Lord Baltimore as meaning to low-water mark and that it should be drawn from headland to headland. (If this had been upheld then a line so drawn at Battery Cove would have placed the filled-in land in Virginia.) Finally, in *Smoot Sand and Gravel Corporation* v. *Washington Airport,* 283 U.S. 348 (1931), the airport sought to prevent the gravel company, operating under a Government contract, from excavating, filling, and constructing a wall between high- and low-water mark on the Virginia side of the river opposite the District of Columbia. The sole question was whether the boundary line between Virginia and the District of Columbia was at the high- or low-water mark on the Virginia side of the Potomac. The Court held that under the original charter the Maryland boundary ran to high-water mark on the Virginia shore and that nothing had happened since then (insofar as the Virginia–District of Columbia line was concerned) to change that boundary, thus following the holding in *Marine Railway & Coal Co.* v. *United States, supra.* The Court distinguished *Maryland* v. *West Virginia, supra* note 46, as being a suit to settle a portion of the boundary line between those states and could not affect the District of Columbia. It reiterated its disagreement with the construction given the Compact of 1785 by the Arbitration of 1877.

Virginia.[50] The bill was approved October 31, 1945, and became Public Law 208, 79th Cong., 1st sess. (59 Stat. 552).

### A. BOUNDARY PROVISIONS OF THE ACT

The basic boundary provisions of the act are embodied in Section 101 which establishes the boundary line between the District of Columbia and the Commonwealth of Virginia as follows:

> Said boundary line shall begin at a point where the northwest boundary of the District of Columbia intercepts the high-water mark on the Virginia shore of the Potomac River and following the present mean high-water mark; thence in a southeasterly direction along the Virginia shore of the Potomac River to Little River, along the Virginia shore of Little River to Boundary Channel, along the Virginia side of Boundary Channel to the main body of the Potomac River, along the Virginia side of the Potomac River across the mouths of all tributaries affected by the tides of the river to Second Street, Alexandria, Virginia, from Second Street to the present established pierhead line, and following said pierhead line to its connection with the District of Columbia–Maryland boundary line; that whenever said mean high-water mark on the Virginia shore is altered by artificial fills and excavations made by the United States, or by alluvion or erosion, then the boundary shall follow the new mean high-water mark on the Virginia shore as altered, or whenever the location of the pierhead line along the Alexandria water front is altered, then the boundary shall follow the new location of the pierhead line. (*See* fig. 104.)

Section 104 construes the reference to "present" mean high-water mark as the mean high-water mark existing on the effective date of the act.

Section 105 authorizes, empowers, and instructs the United States Coast and Geodetic Survey "to survey and properly mark by suitable monuments the said boundary line as described in Section 101." The Bureau is further empowered to monument from time to time those sections of the boundary line as may be changed in accordance with the provisions in Section 101.[51]

50. H. Rept. 595 (to accompany H.R. 3220), 79th Cong., 1st sess. 1 (1945). The report states further that the United States Supreme Court has set the boundary line at the high-water mark of the Potomac on the Virginia shore as it existed when the District of Columbia was created in 1791, and that the line has never been specifically determined and monumented and has been greatly altered by various federal projects so that the boundary line lies in many places some distance from the river. *Ibid.* The report is accompanied by a map, dated Feb. 1943 (prepared by the National Capital Park and Planning Commission), showing lands owned by the United States on the Virginia side of the Potomac River in relation to the high-water mark of 1791.

51. Other sections of the act provide for the land between the present mean high-water mark and the mean high-water mark of Jan. 24, 1791, being "ceded to and declared to be henceforth within the territorial boundaries, jurisdiction, and sovereignty of the State of Virginia," the United States retaining concurrent jurisdiction over such area (Sec. 102); for the retention of "right, title, or interest of the United States to the lands lying between the mean high-water mark as it existed January 24, 1791, and the boundary line as described in section 101" (Sec. 103); for the applicability of the U.S. Criminal Code to the George Washington Memorial Parkway and the Washington National Airport as are situated within the Commonwealth of Virginia (Sec. 106); and for the consent by Virginia to exclusive jurisdiction by the United States over the Washington National Airport, subject to certain rights reserved to Virginia (Sec. 107).

### 4223. *Coast Survey Participation*

The boundary survey by the Coast Survey was begun officially on March 27, 1946, when single-lens photographs were taken of the project area at a scale of approximately 1 : 6,800. On May 9, 1946, instructions were issued covering the preparation of planimetric maps, at a publication scale of 1 : 4,800, of the boundary line and adjacent areas.

The project was to include the entire southwest boundary of the District from Chain Bridge to Jones Point and was to extend from the approximate mean low-water line inshore to Washington Street in Alexandria, to the Jefferson Davis Highway from Alexandria to Rosslyn, to the top of the bluff line from Rosslyn to Chain Bridge. It was also to include the National Airport, the Pentagon area, the street system of Rosslyn, and the east shoreline of the river from Memorial Bridge to Chain Bridge as well as the islands. (*See* fig. 104.)

The greatest emphasis, both as to detail and accuracy, was of course placed on the mean high-water line, and the pierhead line at Alexandria. Well-defined natural and cultural features were to be within 0.5 mm. of correct geographic position on the published maps, and the mean high-water line within 0.3 mm. of correct position. These limits correspond to ground accuracies of 2.5 m. and 1.5 m., respectively.

#### A. DEMARCATION OF BOUNDARY LINE

For demarcating the boundary line, a combination of geodetic and photogrammetric methods was used.

(*a*) *Geodetic Work*.—The existing triangulation in the area was extended by second-order triangulation and traverse to boundary witness monuments located on the fast land near the water's edge. A total of 15 such monuments, numbered 1 to 11 and 11A to 14, were established spaced less than a mile apart, monuments 1 and 14 being placed as nearly as possible on the extension of the northwest and southeast boundary lines of the District of Columbia, by computing the position of a preliminary stake and placing the station by measurement in relation to the stake. In addition to the latitude and longitude, the elevation above mean high water was also determined for each boundary witness monument from existing Coast Survey bench marks.[52] At each boundary

52. The mean high water for the locality was found to be 1.86 feet above the datum of the precise level net, which is mean sea level (*see* note 54, *infra*).

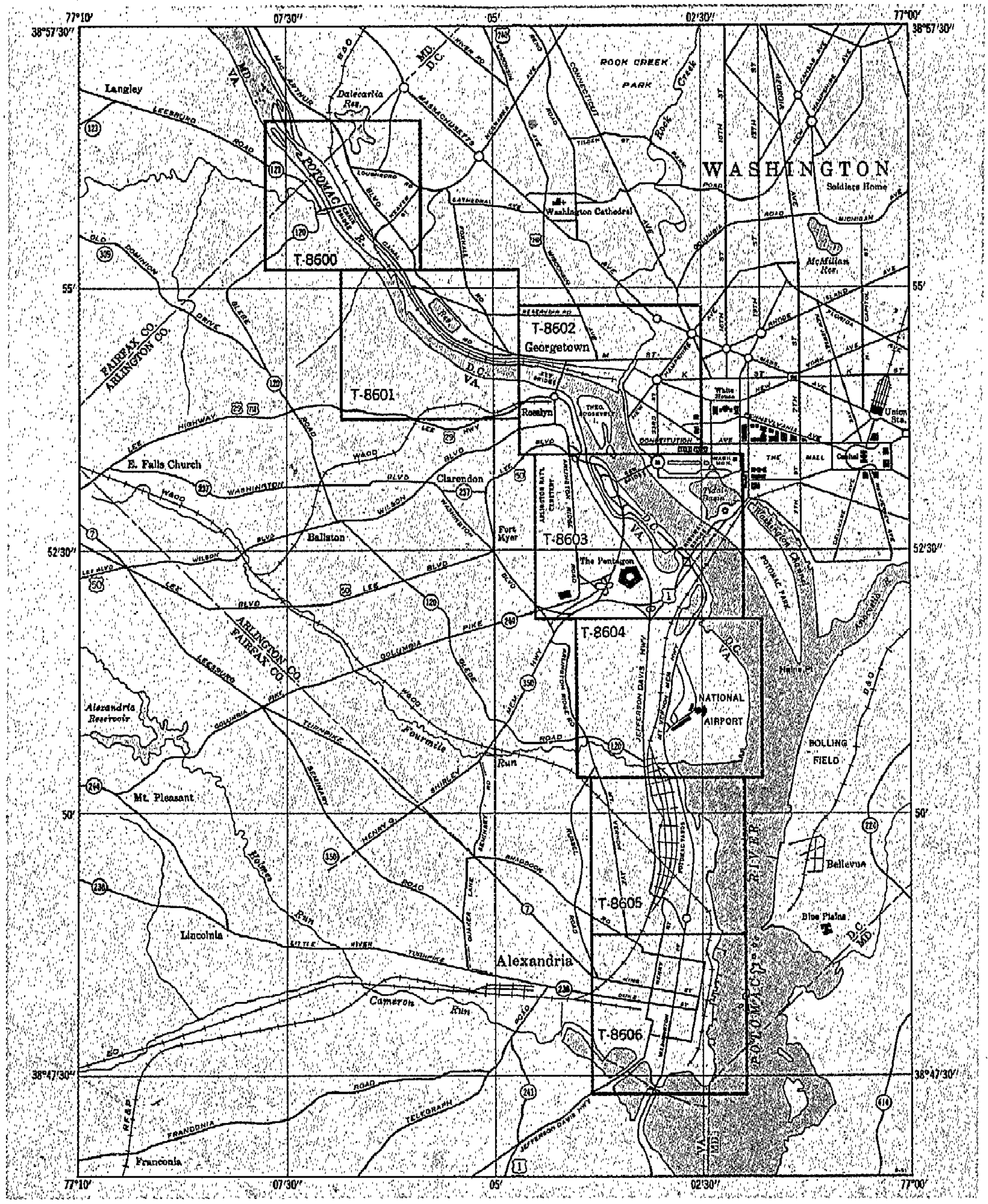


FIGURE 104.—Index of planimetric maps covering the District of Columbia–Virginia boundary.

witness mark a distance and direction was taken to the mean high-water mark as determined by spirit leveling.[53]

(*b*) *Photogrammetric Work*.—Prior to compilation of the manuscript maps, the mean high-water line was identified on the photographs from a field examination. Various methods were used to accomplish this depending upon the character of the area. Around Chain Bridge, it was impossible to identify sufficient points on the photographs to accurately sketch the line. Planetable methods were used working directly on the photographs from identifiable points but without the aid of elevations. Below Chain Bridge to approximately Key Bridge, the mean high-water line was definite and could be identified on the photographs. Small sections not otherwise easily identified were determined by short taped distances from identifiable points. In most of the other areas, spirit leveling was resorted to, the lines starting and closing on established bench marks (in a few cases, short sections of the line were started but did not close on bench marks), the line being plotted by taking measurements to nearby identifiable points on the photographs.[54]

In compiling the manuscript maps, the position of the mean high-water line on the photographs, as determined during the field inspection, was used. The low-water line was derived from photographs taken at low water.

After compilation of the planimetric maps on the Zeiss stereoplanigraph,[55] and the establishment of the 15 boundary witness monuments with reference distances to points on the mean high-water line (*see* text at note 53 *supra*), the map manuscripts were field edited. All the newly established boundary witness monuments were occupied with the planetable and the mean high-water line run in for about 200 feet on each side of the station. The reference measurements from the witness monuments to the mean high-water line were also checked.[56]

53. For the record of the geodetic work, *see* Bolstad, *Triangulation and Traverse, Virginia–District of Columbia Boundary Line,* Season's Rept. 4 of 1947, and GTZ computations (Accession No. G–7079) in Coast Survey archives.

54. *See* Descriptive Report for Registers Nos. T–8600 (1947) and T–8601 (1947), at pages 3 and 4 of Field Inspection Report. The leveling is based on bench-mark elevations determined from tide observations made between 1932 and 1942 by the Coast and Geodetic Survey. The elevation of mean high water is 3.27 feet above the low-water datum for Washington, the latter being 1.41 feet below the datum for the precise level net, thus making the elevation of mean high water 1.86 feet above the precise level net. *Id.* at page 3 of Compilation Report.

55. The stereoplanigraph is an advanced stereoscopic plotting instrument, utilizing full-size diapositives (contact prints from the aerial film onto 3⁄16-inch glass plates). Swanson, Topographic Manual (Part II) 468–469, Special Publication No. 249, U.S. Coast and Geodetic Survey (1949).

56. Descriptive Report for Registers Nos. T–8600 (1947) and T–8601 (1947) at page 2 of the Field Edit Report.

B. THE PUBLISHED MAPS

The District of Columbia–Virginia boundary line is published in a series of seven planimetric maps (no contours), at a scale of 1:4,800 (1 in. = 400 ft.), numbered consecutively from Register No. T–8600 to Register No. T–8606 inclusive.[57] The maps are based on a geographic grid using a polyconic projection and are referred to the North American 1927 Datum. In addition, tick marks for two rectangular grids are also shown—the Washington Suburban Sanitary Commission grid and the Virginia (North Zone) State Coordinate System grid.

The mean high-water line is shown by a heavy solid line and generally marked "D.C." on one side and "Va." on the other side. The boundary witness monuments are identified by a triangle with a dot in the center and marked "D.C.–Va. Boundary W. M. No. -------- 1946," and are numbered consecutively from 1 to 14, including one numbered 11A, beginning at a point about one-half mile above Chain Bridge near where the high-water line intersects the northwestern boundary line of the District of Columbia. The approximate low-water line is indicated by a dotted line lighter in weight than the high-water line.

That part of the boundary line formed by the pierhead line at Alexandria is symbolized by a long and two short dash heavy line and labeled "Pierhead Line."[58]

(*a*) *Oblique Boundary at Second Street, Alexandria, Va.*—The oblique boundary in the vicinity of Second Street at Alexandria, Va. (*see* Register No. T–8605 (1946–1948)), is a cartographic determination. The centerline of Second Street was projected eastward (true bearing of S. 81°00′ E.) until it intercepted the mean high-water line. From here, the boundary line was drawn as a straight line to Point D′, an unmarked point in the water, denoting the northerly end of the Alexandria pierhead line, the position of which was determined from the Army Engineers coordinates. The scaled bearing of this line is S. 63°54′ E. (true), and the scaled distance is 738 feet, which must of course be considered approximate because it is not a computed value. (*See* fig. 105.) The former published distance of 667 feet is therefore in error.

(*b*) *Maryland–Virginia Boundary Line.*—At the southern terminus of the District of Columbia–Virginia boundary line in the vicinity of Jones Point (*see* Register No. T–8606 (1946–1948)), the cartography also includes the location of

57. These maps are lithographic prints in black and white, approximately 20 by 28 inches in size, and are identified as T-sheets. They were completed in 1948 and are now available at the Washington Office of the Coast and Geodetic Survey.

58. The pierhead line was transferred from Plans 1 and 2 (scale, 1:2,000) of the Army Engineers.

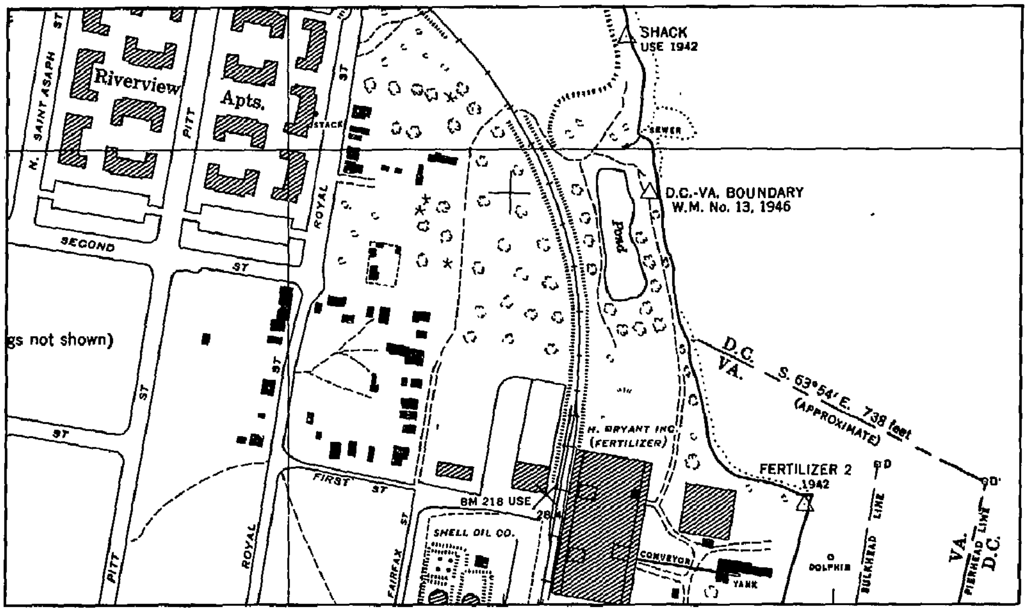


FIGURE 105.—Detail of District of Columbia–Virginia boundary in vicinity of Second St., Alexandria, Va. (*see* 4223 B(*a*)).

the Maryland–Virginia boundary line immediately southward from its junction with the District of Columbia–Virginia boundary line, in order to have complete cartographic representation within the map limits. This delineation of the Maryland–Virginia boundary around Jones Point is the first to be based upon an accurate topographic map showing present conditions (1946). It conforms to the Award of the Arbitrators of 1877 that the boundary is to follow "the meanderings of the said river [the Potomac] by the low-water mark, to Smith's Point" (*see* 4211). The Maryland–Virginia boundary line must therefore continue along the southeast boundary of the District of Columbia extended until it intercepts the low-water mark along the Virginia shore.[59] From here the boundary follows the low-water mark around Jones Point in a southerly and westerly direction until it meets the Maryland–Virginia boundary line across Hunting Creek (*see* fig. 106).[60]

59. This is so because if the Act of Oct. 31, 1945 (*see* 4222) had not established the pierhead line as the boundary, the District of Columbia–Virginia boundary would have extended to the high-water mark along the Virginia shore.

60. This final leg of the Maryland–Virginia boundary line (between a point on the low-water line near Reference Monument 57 and a point on the low-water line near Reference Monument 58) was determined in 1929 to be in azimuth 181° 45′12″. MATHEWS AND NELSON (1930), *op. cit. supra* note 23, at 13. The distance from Reference Monument 58 to the boundary point on the low-water line was found in 1929 to be 42 feet. This boundary point on the present survey falls just inshore of the mean high-water line,

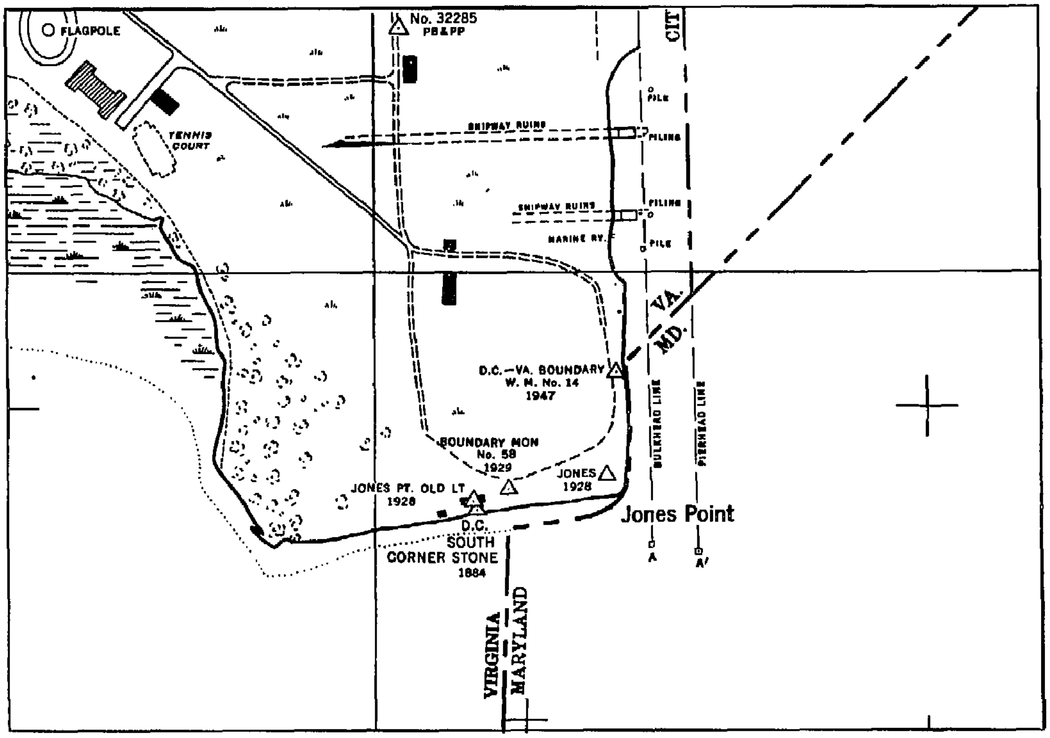


FIGURE 106.—Southern terminus of District of Columbia–Virginia boundary in vicinity of Jones Point showing also Maryland–Virginia boundary (*see* 4223 B(*b*)).

(*c*) *Boundary at Tributary Waterways.*—Although the law as written would seem to confine the provision "across the mouths of all tributaries affected by the tides of the river" (*see* 4222 A) to the section of the river between the southern end of Boundary Channel (*see* Register No. T–8603 (1946–1948)) and Second Street, Alexandria (*see* Register No. T–8605 (1946–1948)), it is believed that the intent was to have this qualification apply to the entire boundary line from the northwest boundary line of the District to Second Street, Alexandria, thus following in general the Award of 1877 for the Maryland–Virginia boundary (*see* 4211). The boundary line as delineated on the maps does not show a headland line across tributaries, but this fact should be kept in mind in the consideration of the boundary line at such tributaries as Roaches Run and Fourmile Run (*see* Register No. T–8604 (1946–1948)).

showing an accretion to have taken place, the 1946 low-water line (verified in 1949) in this area being 87 feet from Reference Monument 58. This points up the weakness of the fixed boundary theory where a water boundary is concerned (*see* 4213). If this theory were applied to the area around Jones Point, Virginia's boundary would no longer be at the low-water line and the intent of the Award of 1877 (*see* text following note 14 *supra*) would be defeated.

### 423. Low-Water Line Survey of Louisiana Coast

A recent example of the utilization of Bureau services for a comprehensive boundary determination is the cooperative agreement entered into in 1957 between the State of Louisiana, the Bureau of Land Management, and the Coast and Geodetic Survey for mapping the low-water line along the Louisiana coast. The purpose of the survey was to establish an accurate baseline from which the seaward boundary of Louisiana was to be measured, thereby defining the federal-state boundary under the Submerged Lands Act (67 Stat. 29 (1953)), and the Outer Continental Shelf Lands Act (67 Stat. 462 (1953)). The field work and preparation of the maps (60 in all) were accomplished exclusively by the Coast Survey. Photogrammetric procedures were used in which the aerial photography was closely coordinated with actual tidal conditions as determined from a number of tide stations established in the area. For a detailed description of this project, *see* Volume One, Part 2, 17.[61]

## 43. NAVIGABLE WATERS

What have been heretofore discussed are some of the more obvious legal aspects of the Bureau's work—that is, where the Bureau participates directly, or through its records and data. In addition, it deals indirectly with a wide variety of subjects, some of which have legal significance. One of these is in the field of navigable waters.

The Coast and Geodetic Survey has more than a passing interest in navigable waters, since they form the natural habitat of a major part of the Survey's operations. The organic act establishing the Coast Survey provides for the making of surveys and charts for the safe navigation of marine commerce, which presupposes an interest and operation in navigable waters (*see* Part 1, 1211). In addition, the law of navigable waters is intimately bound up with the ebb and

61. Associated with this low-water line survey and representing another facet of the utilization of Bureau services, is the professional advice furnished the Department of Justice on the location of the entire Louisiana "coast line" as defined in the Submerged Lands Act (*see* Volume One, Part 2, 123). This request was made by the Solicitor General of the United States as being "within the particular competence of the Coast and Geodetic Survey." Involved was an examination of principles proposed by the Department of Justice and the specific technical questions raised, all considered in the light of the position advocated by the United States at the 1930 Hague Conference for the Codification of International Law; of the proceedings before the Special Master in *United States* v. *California* and his technical recommendations to the Supreme Court; of the 1956 draft articles of the International Law Commission; and of the 1958 Geneva Convention on the Territorial Sea and the Contiguous Zone. *See* Volume One, *passim.* This study was made by the author and the results embodied in a comprehensive memorandum dated Apr. 18, 1961, from the Director to the Solicitor General. A copy of the memorandum and associated correspondence is filed in the Coast Survey library and is identified as Accession No. 62515.

flow of the tide, historically and currently, in the matter of the public right of user of such waters, and in the ownership of the soil under them.

The law of navigable waters has had an interesting development in American jurisprudence. It begins with Article I, section 8, clause 3 of the Constitution—known as the commerce clause—which gives Congress the power "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes." The full import of this grant of authority did not appear until 1824—many years after the adoption of the Constitution—when the Supreme Court of the United States in a landmark case laid down the doctrine that state action affecting interstate or foreign commerce which is in conflict with congressional action is invalid.[62] This was the first clear indication of the extent of the power granted under the commerce clause.

In addition to establishing the doctrine of supremacy of a federal law over a state law in this area of constitutional interpretation, the Supreme Court also settled two other momentous questions which the case raised: (1) What constitutes commerce, that is, whether it includes navigation; and (2) to what commerce the power of the Federal Government extends. As to the first, the Court said: "The mind can scarcely conceive a system for regulating commerce between nations, which shall exclude all laws concerning navigation, which shall be silent on the admission of the vessels of the one nation into the ports of the other . . . . The power over commerce, including navigation, was one of the primary objects for which the people of America adopted their government . . . . a power to regulate navigation, is as expressly granted, as if that term had been added to the word 'commerce'."[63]

As to the second—the commerce to which the federal power extends—the Court held it applied to every species of commercial intercourse between the United States and foreign nations, and no trade of any kind can be carried on between this country and any other to which this power does not extend. And the same applies to commerce among the several states which of necessity must be commerce with the states. It is commerce which concerns more states than one. But it does not apply to the completely internal commerce of a state, the latter regulation being reserved for the state itself.

62. *Gibbons* v. *Ogden*, 9 Wheat. 1 (22 U.S., 1824). The State of New York under a statute had granted to two individuals the exclusive right to navigate the waters within its jurisdiction with vessels propelled by steam. Gibbons, the appellant, was operating steamboats between New York and New Jersey under authority of a coasting license under a 1793 act of Congress (1 Stat. 305). The New York court upheld the validity of the statute which virtually established a monopoly in the grantee. On appeal, the Supreme Court reversed this holding on the basis that the New York law was inconsistent with the license granted under the act of Congress.

63. *Id.* at 83–85. By judicial interpretation, therefore, the Court established the doctrine that the power to control and protect navigation on navigable interstate rivers and other bodies of water was a necessary incident of the power to regulate commerce, so far as that navigation may be connected with commerce with foreign nations, or among the several states, or with the Indian tribes.

The *Gibbons* case marked the beginning of a long line of decisions that established the power of the United States to regulate interstate commerce free from state infringement. When Congress by an expression of its will occupies the field, that action is conclusive of any right to the contrary asserted under state authority. *Wisconsin* v. *Duluth*, 6 Otto 379, 387 (96 U.S., 1878). The case, however, left unsettled the important question whether a state may lawfully legislate regarding subjects pertaining to interstate or foreign commerce upon which Congress had passed no law. This arose in a later case involving the regulation of pilots.[64]

## 431. The English Doctrine of Navigability

The next important development in the law of navigability in the United States was predicated upon a misapplied doctrine of the English law. The English rule emanated from a case involving ownership of part of a fishery in the Banne River, about 2 leagues from the sea where the stream was tidal, under a grant of land from the Crown adjoining the fishery together with the fisheries within the land, but excepting three parts of the fishery. The question raised

64. *Cooley* v. *The Board of Wardens of the Port of Philadelphia*, 12 How. 299 (53 U.S., 1852). This case involved a Pennsylvania statute establishing a system of regulations affecting pilotage in the port of Philadelphia and imposing certain monetary penalties for failure to comply with such rules. The law was enacted under authority of Sec. 4 of the Act of Aug. 7, 1789 (1 Stat. 54) which provides "That all pilots in the bays, inlets, rivers, harbors and ports of the United States, shall continue to be regulated in conformity with the existing laws of the States respectively wherein such pilots may be, or with such laws as the States may respectively hereafter enact for the purpose, until further legislative provision shall be made by Congress." Although the Pennsylvania law was a regulation of commerce, the Supreme Court upheld it on the ground that it concerned a matter properly lending itself to local state control, rather than requiring a uniform law, and one for which Congress had not legislated other than to indicate an intention to leave such regulation to the states. The application of this doctrine in a given case is not always a simple matter because of the absence of definite criteria for distinguishing whether a particular subject of commercial regulation admits of and requires uniform and national control, or whether it is sufficiently local in character to make state regulation permissible. For a history of pilotage in the United States, *see* Jones, Pilotage in the United States, Special Agents Series—No. 136, U.S. Department of Commerce (1917). Pilotage information for the various U.S. ports is contained in the *Port Series*, published jointly by the Corps of Engineers, Dept. of the Army, and the Maritime Administration, Dept. of Commerce. Pilotage information contained in the various *Coasts Pilots* of the Coast and Geodetic Survey is based on the *Port Series*. A summary of state laws pertaining to pilotage is contained in *Responsibilities and Qualifications of Pilots Under State Laws*, American Pilots' Association (1937).

*Great Lakes Pilotage.*—Pilotage on the Great Lakes is under federal control. This was established by the Act of June 30, 1960 (74 Stat. 259), identified as the "Great Lakes Pilotage Act of 1960." Prior to this there was no statutory requirement for compulsory pilotage of registered vessels of the United States or foreign vessels navigating U.S. waters of the Great Lakes. Opening of the St. Lawrence Seaway resulted in an upsurge of the entry of foreign vessels into these waters. This, together with the entry of U.S. ocean vessels into the area, presented a definite threat to safe navigation, which called for remedial action. S. Rept. 1284, 86th Cong., 2d sess. 3, 4, 10 (1960). The act is under the administration of the Secretary of Commerce and this authority has been delegated by the Secretary to the Great Lakes Pilotage Administration under Department Order No. 169, effective Sept. 8, 1960, and Department Order No. 169 (revised), effective Nov. 13, 1962. For regulations governing Great Lakes pilotage as promulgated by the Great Lakes Pilotage Administration, *see* 26 Fed. Reg. 951 (1961).

was whether the grant carried with it ownership of the fourth part. The court answered this in the negative.[65] The court classified rivers as of two kinds—navigable and not navigable—and said: "Every navigable river, so high as the sea flows and ebbs in it, is a royal river, and the fishery of it is a royal fishery, and belongs to the King by his prerogatives; but in every other river not navigable, and in the fishery of such river the terre [land] tenants on each side have an interest of common right." [66] But the court did not define a navigable river. It merely said that in navigable rivers subject to tidal influence, the title to the soil was in the King, but that in non-navigable rivers the title is in the adjoining land owners. This left a strip of navigable water—from the point where the tide ceased to the point where the navigable character of the river ceased—upon which the court made no ruling as to ownership of the soil. Yet the inference has been drawn, erroneously, that in England the only rivers that are navigable are those in which the tide ebbs and flows.

The true English doctrine seems to be that navigable water is not synonymous with or limited to tide water. Lord Hale, in his treatise *De Jure Maris* (By the Law of the Sea), which was written soon after the decision in the *Banne* case, makes no distinction between fresh and salt rivers in point of navigability, for he says "there be other rivers, as well fresh as salt, that are of common or public use for carriage of boats and lighters. And these, whether they are fresh or salt, whether they flow and reflow or not, are prima facie *publici juris* [of public right] common highways for man or goods." And in other passages, Lord Hale refers to public rivers as those capable of being navigated, and whenever he wishes to make a distinction depending on tide water, he always refers to navigable waters where the tide ebbs and flows, thus indicating that he did not consider it sufficient to refer to tidal water by the word navigable only.[67]

65. *The Royal Fishery of the Banne*, Davies Rep. 149 (circa 1604). *See also* ANGELL, LAW OF TIDE WATERS 75 (1847). This case was decided at a time when ownership of the land was carefully apportioned so that every part of it had, in theory at least, an owner. All that was not in private ownership was held to belong to the King, but the fact that he held his title for the benefit of his subjects was not clearly perceived. FARNHAM, 1 THE LAW OF WATERS AND WATER RIGHTS 108 (1904).

66. *Id* at 109. The basis of the King's interest in such navigable tidal rivers is that they partake of the nature of the sea (his proper inheritance) and is said to be a branch of the sea so far as it flows. The King has the same prerogative and interest in the branches of the sea as he has in the sea itself.

67. *Id.* at 113, 114. The decisions of the courts are even more explicit. When examined, the rule is found to be fairly uniform that navigable waters are those which are navigable in fact, and not those which are merely tidal. Thus, in *Blount* v. *Layard*, decided by the English Court of Appeals and reported in a note in [1891] 2 Ch. 681, it was said: "We are dealing with the Thames, which is not a tidal river at the place in question. But on the other hand, it is a navigable river,—that is, all the Queen's subjects have the right of passing and repassing on it." And in *Lenconfield* v. *Lonsdale*, L.R. 5 C.P. 665, the court said: "There is a part of the river, intermediate between the tidal flow and the upper fresh water, where the river is navigable, but not tidal." For other English cases dealing with the subject, *see* FARNHAM, *supra* note 65, at 114–117, and note to *Willow River Club* v. *Wade*, XLII L.R.A. (1913 ed.) 305, 307–309 (1898).

## 432. The American Doctrine of Navigability

### 4321. *The Tidal Test—Palmer* v. *Mulligan*

The misinterpreted *Banne* case, *supra* note 65, was the basis for the early American doctrine of navigability and had the effect of excluding for two generations the admiralty jurisdiction from our great rivers and inland seas.[68] It was Chancellor Kent, of the New York Supreme Court, who ruled in the early case of *Palmer* v. *Mulligan* [69] that according to the common law of England only tidal streams were navigable, and since the Hudson River at the place in question was above the influence of the tide it was not a navigable river in the common-law sense; therefore, title to the soil was in the owners of the adjoining land.

This doctrine of limiting navigable waters to tide waters was carried by Chancellor Kent into his *Commentaries* and was later adopted by Angell in his work on *Tide Waters,* both widely used text books at the time. The eminence of the authors and the lack of original authorities led many of the state courts to follow it.[70]

68. *Admiralty law* is that branch of the body of the law which governs in maritime matters. Admiralty law does not have its antecedents in the English common law, as does the body of our other unwritten laws (*see* 251), but originated with the customs and usages of the countries bordering the Mediterranean and the Baltic seas. Admiralty jurisdiction in the United States has as its origin Art. III, sec. 2, cl. 1 of the Constitution, which provides that, "The judicial Power [of the Federal Government] shall extend . . . to all Cases of admiralty and maritime Jurisdiction." This has been held by construction to confer legislative power in Congress, independent of its power over commerce. Therefore, the admiralty law of the United States is administered by the Federal courts as a distinct legal system. This jurisdiction is exclusive, and cannot be enlarged or restricted by state legislation. For the exercise of admiralty jurisdiction, two concurrent elements must be present: (1) a navigable waterway which is part of an interstate or international highway, and (2) a vessel or craft used or capable of being used as a means of transportation on such waterway. In the adjudication of admiralty cases, one of the important principles applied is the legal personality of the vessel. This assumes to make the vessel herself the wrongdoer and gives the courts power to proceed *in rem,* that is, against the offending vessel or cargo (the vessel is sued or "libeled"), instead of *in personam,* as in the ordinary courts, against the owner of the vessel. This extraordinary power to proceed in rem is based on the practical consideration of obtaining monetary satisfaction by arresting the offending vessel and subjecting it to judicial sale, although the owner may be a citizen of and resident in a foreign State, and thus not subject to the ordinary process. As a matter of public policy this doctrine has not been applied to public vessels (naval and other Government owned) because it would remove them from service. However, under a special statutory provision the Government permits itself to be sued as an owner in personam, but the damage sustained is adjudicated the same as it would be were the action in rem between the vessels themselves. *Watts* v. *United States,* 123 Fed. 105 (1903). Another principle peculiar to American admiralty courts is the doctrine of equal responsibility for unequal fault. If both vessels have violated a rule and collision results, each vessel is liable for 50 percent of the total loss, regardless of her degree of fault. *The Marian,* 66 F. 2d 354 (1933). Admiralty jurisdiction has grown through congressional action and through judicial interpretation to keep pace with the needs and development of our waterborne commerce.

69. 3 Caines 307 (1805), 2 Am. Dec. 270. This case involved title to the soil of the Hudson River at Stillwater, N.Y., and the right to place structures on its bed.

70. In *Veazie* v. *Dwinel,* 50 Me. 479, 484 (1862), a statute permitting the construction of dams in non-navigable rivers was held to authorize them in all cases where the tide did not ebb and flow. And in *Welles* v. *Bailey,* 10 Atl. 565 (1887), it was decided that the rule that rivers were navigable in fact was never formally adopted in Connecticut, which implies that rivers above the ebb and flow of the tide, although navigable in fact, are not considered navigable waters.

The doctrine of Chancellor Kent was also followed for many years in the Federal courts in connection with admiralty jurisdiction, and it was assumed in the early cases that such jurisdiction was limited to cases arising upon the high seas and upon rivers as far as the ebb and flow of the tide extended.[71]

### 4322. *The Navigability Test—The Genesee Chief* v. *Fitzhugh*

The tidal test was successfully maintained in the Federal courts until the year 1851 when a new test of navigability was invoked by the Supreme Court. In a libel brought under the Act of February 26, 1845 (5 Stat. 726), which extended the admiralty jurisdiction of the Federal district courts to certain cases upon the lakes and navigable waters connecting them, the Court was called upon to pass upon the constitutionality of the 1845 Act.[72] In reexamining its former decisions, which declared the admiralty jurisdiction to be limited to waters subject to the ebb and flow of the tide (*see* note 71 *supra*), the Court pointed out that the tidal test in England was a reasonable one because there was no navigable stream of importance in that country beyond the ebb and flow of the tide. Tide water and navigable water thus became synonymous there. And as there could be no use for an admiralty jurisdiction where there could be no navigation, this test of navigability of those waters became substituted as the rule, instead of the navigability itself.[73] Such a rule could have no pertinency to the rivers and lakes of this country because of the broad differences existing between the topography of the British island and that of the American Continent. Since many of our rivers could be navigated successfully for a thousand miles above the head of tide water as they could below, it was not reasonable to adopt such an artificial rule as the test of admiralty jurisdiction in this country. "It is evident," the Court said, "that a definition that would at this day limit public rivers in this country to tide-water rivers is

71. In both *The Steamboat Thomas Jefferson,* 10 Wheat, 428 (23 U.S., 1825) and *The Steamboat Orleans* v. *Phoebus,* 11 Pet. 175 (36 U.S., 1837), the Supreme Court denied admiralty jurisdiction to the Federal district courts because the vessels libeled were not on tide waters.

72. *The Genesee Chief* v. *Fitzhugh,* 12 How. 443 (53 U.S., 1851). The case arose as a result of a collision on Lake Ontario. The *Genesee Chief* was libeled for damages in a Federal district court sitting in admiralty. The 1845 Act was challenged on the ground that the admiralty power conferred by the Constitution on Federal courts did not extend to cases originating above tide water in our rivers and lakes, and that Congress could not extend it by legislation. Both lower courts held for the libelant, and this was affirmed by the Supreme Court.

73. This definition, which had been adopted in England, the Court pointed out, was equally proper in this country at the time of the adoption of the Constitution and our courts of admiralty went into operation. In the Thirteen Original States, the far greater portion of the navigable waters are tide waters, and in the states which were at that period in any degree commercial, every public river was tide water to the head of navigation. *Id.* at 455.

utterly inadmissible. We have thousands of miles of public navigable water, including lakes and rivers in which there is no tide. And certainly there can be no reason for admiralty power over a public tide-water, which does not apply with equal force to any other public water used for commercial purposes and foreign trade. The lakes and the waters connecting them are undoubtedly public waters; and we think are within the grant of admiralty and maritime jurisdiction in the Constitution of the United States." (*See* note 68 *supra.*)[74] The 1845 Act was therefore a legitimate extension of that jurisdiction to navigation on the lakes and the navigable waters connecting them. The Court then expressly overruled its former restrictive decisions and adopted the more liberal principle that the test of navigability is the actual navigable capacity of the waterway and not the extent of tidal influence.

The decision in *The Genesee Chief, supra* note 72, having removed the imaginary line of tide water which was supposed to circumscribe the jurisdiction of the admiralty courts, there no longer existed any reason why the general admiralty powers conferred on all the district courts by the Judiciary Act of 1789 should not be exercised wherever there was navigation which could give rise to admiralty and maritime causes. The foundation was thus laid for extending this jurisdiction to the great rivers of the country above the head of tide water. Thus, *Fretz* v. *Bull,* 12 How. 466 (53 U.S., 1851), upheld jurisdiction of a collision on the Mississippi River above tide water; and *Jackson* v. *The Magnolia,* 20 How. 296 (61 U.S., 1858), upheld jurisdiction on the Alabama River far above the ebb and flow of the tide on a stream whose course was wholly within the limits of the State of Alabama.[75]

While the admiralty jurisdiction conferred on the district courts of the United States is exclusive of the state courts, the latter do deal with the question of navigability as it affects the public use of certain waters, the public right to fish, and questions of riparian ownership. These are matters of local law, and Federal courts consider themselves bound by local decisions in such matters, unless a federal question is involved (*see* note 34 *supra*).

74. *Id.* at 457. The Court noted that the rule laid down is in accord with Sec. 9 of the Judiciary Act of 1789 (1 Stat. 76), which declared that the district courts "shall also have exclusive original cognizance of all civil causes of admiralty and maritime jurisdiction . . . on waters which are navigable from the sea by vessels of ten or more tons burthen." The jurisdiction is thus made to depend upon the navigable character of the water, and not upon the ebb and flow of the tide. *Ibid.*

75. The latter case, decided 6 years after *The Genesee Chief,* was thought to present an occasion when the doctrines announced there might be reconsidered, and modified, if not overruled. But the principles established were reaffirmed after a careful and full consideration. And this has been the law ever since without question.

## 433. Legal Concept of Navigability

While the decision in *The Genesee Chief* was a jurisdictional one, once the tidal test was jettisoned and the doctrine of that case firmly established in our jurisprudence, the way was cleared for the courts to define more specifically the test of navigability, insofar as it related to the regulatory power of Congress under the commerce clause (*see* 43). Accordingly, in 1871, the Supreme Court laid down its oft-quoted definition of navigability, namely:

> Those rivers must be regarded as public navigable rivers in law which are navigable in fact. And they are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade or travel on water.[76]

This test of navigability does not depend upon the manner or mode by which commerce is or may be conducted, nor upon the difficulties attending navigation, such as those caused by falls, rapids, or sandbars. The true criterion is the capability of use by the public for purposes of transportation and commerce, rather than the extent and manner of that use. If a stream is capable in its natural state of being used for purposes of commerce, no matter in what mode the commerce may be conducted, whether in vessels propelled by steam, sail, oars, or poles, it is navigable in fact and becomes in law a public highway. But this does not mean that every ditch or inlet in which the tide ebbs and flows, nor every small creek in which a fishing skiff or gunning canoe can be made to float at high water is a navigable highway. To have the character of a navigable stream it must be generally and commonly useful to some purpose of trade or agriculture.[77]

### 4331. *Navigable Waters of the United States*

For waters to come within the meaning of the acts of Congress, whether for purposes of admiralty jurisdiction or for regulation, they must not only be navigable but they must also be *navigable waters of the United States*. And to constitute such waters they must "form in their ordinary condition by themselves, or by uniting with other waters, a continued highway over which commerce is or may be carried on with other States or foreign countries in the customary modes in which such commerce is conducted by water." This was the doctrine laid down by the Supreme Court in *The Daniel Ball, supra* note

76. *The Daniel Ball* v. *United States*, 10 Wall. 557, 563 (77 U.S., 1871). This was a suit against a steamer drawing 2 feet of water and navigating entirely within the State of Michigan on a short river emptying into Lake Michigan.

77. *The Montello*, 20 Wall. 430, 442 (87 U.S., 1874).

76, at 563.[78] And it falls within this category even if it is an artificial canal, as long as it forms a means of communication between ports and places in different states, even though the canal is wholly within the body of a state and subject to its ownership and control.[79]

The rule of *The Daniel Ball* and *The Montello* regarding navigable waters of the United States had not been departed from, although it had been interpreted and applied in many different factual situations. Even as late as 1935 it was held that an interstate stream is navigable in fact only when it is so used or susceptible of being used in its "natural and ordinary condition." *United States* v. *Oregon,* 295 U.S. 1 (1935). But in 1940 and 1941, two cases were decided by the Supreme Court—the *Appalachian Power Co.* case and the *Atkinson* case (sometimes referred to as the *Red River* case)—both of which extended the legal concept of navigability, and served to increase materially the power of the Federal Government over the waters of the United States.[80] These decisions must be read against the background of increasing interest by the Federal Government—beginning with the Federal Water Power Act of 1920 (41 Stat. 1063)—in the streams and rivers of the country from the standpoint of their multipurpose use for power, reclamation, and navigation.[81]

(*a*) *The Appalachian Power Case.*—This case related to the construction of a hydroelectric dam by the Appalachian Electric Power Co. on the New River just above Radford, Va., and involved the scope of the federal commerce power in relation to conditions in licenses required by the Federal Power Commission for the construction of such dams in navigable waters of the United

78. This is in contradistinction to navigable waters of a state, which comprise those waterways that lie wholly within its limits and have no navigable connection with any navigable waters outside the boundaries of the state. Such intrastate waters are subject to regulation and control by state laws and do not fall within the jurisdiction of Congress nor of the laws enacted by it for the preservation and protection of navigable waters of the United States. *The Montello,* 11 Wall. 411, 415 (78 U.S., 1870).

79. *Ex parte Boyer*, 109 U.S. 629 (1884), and *The Robert W. Parsons*, 191 U.S. 17 (1903). The first involved a collision on the Illinois and Lake Michigan Canal, an artificial navigable waterway, 60 feet wide and 6 feet deep, connecting the Mississippi River with Lake Michigan and wholly within the State of Illinois (it was held immaterial that one or the other of the vessels was on a voyage within the state); the second involved the Erie Canal which connects the Hudson River with Lake Erie but entirely within the State of New York. Other examples of such canals are the St. Clair Ship Canal connecting St. Clair River with St. Clair Lake; the St. Mary's Canal connecting Lake Superior with Lake Huron; and the Welland Canal between Lake Ontario and Lake Erie.

80. *United States* v. *Appalachian Electric Power Co.*, 311 U.S. 377 (1940); *Oklahoma ex rel. Phillips* v. *Guy F. Atkinson Co.*, 313 U.S. 508 (1941). In the *Appalachian* case, *amici curiae* briefs were filed in behalf of the Appalachian Company by the attorney generals of 41 states on the ground that the power to prohibit the erection in navigable waters of structures deemed to impair navigation does not comprehend a power to exact conditions, unrelated to navigation, for the permission to erect such structures.

81. Under the act, Congress created a Federal Power Commission with authority to license the construction of dams in navigable waterways under certain specified conditions. Major multiple-purpose projects have been authorized by the Boulder Canyon Project Act (45 Stat. 1057 (1928)), and upheld in *Arizona* v. *California,* 283 U.S. 423 (1931); the Tennessee Valley Authority Act (48 Stat. 58 (1933)), and upheld in *Tennessee Electric Power Co.* v. *Tennessee Valley Authority,* 306 U.S. 118 (1939); the Fort Peck Dam, Bonneville Dam, Parker Dam, Grand Coulee Dam, and Central Valley Project (49 Stat. 1028 (1935)).

States. The determination of the case rested on the question whether the New River, a tributary of the Kanawah and Ohio Rivers, is or is not a navigable water of the United States. The Supreme Court answered this in the affirmative and thereby reversed the concurrent findings of the two lower Federal courts.[82]

Although the Court reaffirmed the doctrine of *The Daniel Ball* (*see* text at note 76 *supra*), insofar as the basic concept of navigability was concerned, it held, in addition, that, while navigability is a factual question, in appraising the evidence of navigability it is erroneous to consider only the natural and ordinary condition of the waterway, but "its availability for navigation must also be considered." Said the Court:

> "Natural and ordinary condition" refers to volume of water, the gradients and the regularity of the flow. A waterway, otherwise suitable for navigation, is not barred from that classification merely because artificial aids must make the highway suitable for use before commercial navigation may be undertaken. Congress has recognized this in section 3 of the Water Power Act [41 Stat. 1063 (1920)] by defining "navigable waters" as those "which either in their natural or improved condition" are used or suitable for use . . . . Nor is it necessary that the improvements should be actually completed or even authorized. The power of Congress over commerce is not to be hampered because of the necessity for reasonable improvements to make an interstate waterway available for traffic.[83]

Based on the *Appalachian* decision, it must now be held that the phrase "susceptible of being used in their ordinary condition," in *The Daniel Ball* definition, is not to be construed as eliminating the possibility of determining navigability in the light of the effect of future reasonable improvements. This was the Government's contention. And it appears that considerable latitude may be exercised in the application of this doctrine, for although the Chief of Engineers found that the cost of improving the New River would involve the "expenditure of vast and prohibitive sums," (*United States* v. *Appalachian Electric*

82. The basis for the Court's reversal of the factual findings of both lower courts, usually not disturbed on appeal unless clear error is shown (*Brewer Oil Co.* v. *United States*, 260 U.S. 77, 86 (1922)), was that the circumstances called for the application of judicial standards for determining whether the conditions in respect to the capacity of the New River for use in interstate commerce make it a navigable stream within the constitutional requirements. "Both the standards and the ultimate conclusion," the Court said, "involve questions of law inseparable from the particular facts to which they are applied." *United States* v. *Appalachian Electric Power Co., supra* note 80, at 404.

83. *United States* v. *Appalachian Electric Power Co., supra* note 80, at 407, 408. In appraising the evidence of navigability of the New River, the Court re-emphasized some of the legal tests of navigability it formerly enunciated, to wit: A waterway once found to be navigable remains so; navigability does not require continuous use of the waterway since the character of the region, its products, and the difficulties or dangers of navigation influence such use; small traffic compared to the available commerce of the region is sufficient; absence of use over long periods of years, because of changed conditions, the coming of the railroad, or improved highways, does not affect the navigability of rivers in the constitutional sense; and navigability may be of a substantial part only of the waterway in question. Such evidences of non-navigability in whole or in part are to be appraised in totality to determine the effect of all. *Id.* at 408–410. (*See* 435.)

*Power Co.,* 23 F. Supp. 83, 96 (1938)), the Supreme Court, nevertheless, concluded it was navigable.[84]

(*b*) *The Atkinson or Red River Case.*—The doctrine of the *Appalachian* case was extended in the *Red River* case, *supra* note 80, so as to apply to any stream or watershed which contributes to a navigable stream or river and itself becomes subject to the control and regulation of the Federal Government. Involved was the validity of a federal statute authorizing the construction of a dam and reservoir for flood-control purposes in the *non-navigable* upper reaches of the Red River.[85] The State of Oklahoma sought to enjoin construction of the dam on the ground that its primary purpose was the generation of power rather than flood control, and that no part of the Red River in Oklahoma was navigable (the Supreme Court so found). In denying the injunction and upholding the statute, the Supreme Court stated that one purpose behind construction of the dam was the promotion of navigation downstream, that flood control had a vital relationship to the broader aspects of the commerce power, and that the power of flood control extends to the non-navigable tributaries of navigable streams. The Court held there was "no constitutional reason why Congress or the courts should be blind to the engineering prospects of protecting the nation's arteries of commerce through control of the watersheds" or why they should not "treat the watersheds as a key to flood control on navigable streams and their tributaries . . . . The fact that ends other than flood control will also be served, or that flood control may be relatively of lesser importance, does not invalidate the exercise of the authority conferred on Congress."[86]

Hence, from the standpoint of federal control over the navigable waters of the United States, the case stands for the doctrine that flood control and waterway development are now recognized as of equal validity with the maintenance of navigation as constitutional objectives of Congress. Such control now extends

84. Two justices dissented from the majority view, their strongest objection being that the announced doctrine means that if by reasonable improvement the stream may be rendered navigable then it is navigable without such improvement. In their view, such a doctrine would mean that "every creek in every state in the Union which has enough water, when conserved by dams and locks or channeled by wing dams and sluices, to float a boat drawing two feet of water, may be pronounced navigable because, by the expenditure of some enormous sum, such a project would be possible of execution. In other words, Congress can create navigability by determining to improve a non-navigable stream." *Id.* at 433.

85. The Red River forms part of the boundary between Oklahoma and Texas and is a tributary of the Mississippi River. The act passed by Congress in 1938 (52 Stat. 1215) authorized among other things the construction of the Denison Reservoir on the Red River in Texas and Oklahoma. It was established that the lower reaches of the Red River were at one time used for navigation and that at the time of the decision the river was navigable from its conflux with the Mississippi for 122 miles upstream.

86. *Oklahoma* v. *Atkinson, supra* note 80, at 526, 534.

to a program for the development of an entire watershed, not merely the navigable portions of streams in that watershed.[87]

### 434. Summary of Development of Law of Navigability

From the decisions cited it would appear that in the development of the law of navigability in the United States we have indeed moved far from the restrictive doctrine of Chancellor Kent (*see* 4321). These developments, chronologically, may be summarized as follows:

1787—Congress given power to regulate interstate and foreign commerce (Art. I, sec. 8, the Constitution of the United States).

1805—Tidal test for navigable waters adopted by Chancellor Kent of the New York Supreme Court (*Palmer* v. *Mulligan,* 3 Caines 307, 2 Am. Dec. 270).

1825—Tidal test followed by Supreme Court in denying admiralty jurisdiction to Federal district courts because vessels libeled were not on tide waters (*The Steamboat Thomas Jefferson,* 10 Wheat. 428 (23 U.S.)).

1851—Tidal test overruled by Supreme Court and navigable waters of the United States declared not to be limited by the flux and reflux of the tide but rather by the actual navigable capacity of the waterway, thus extending the admiralty jurisdiction to the lakes and rivers above the head of tide water (*The Genesee Chief* v. *Fitzhugh,* 12 How. 443 (53 U.S.)).

1871—Public navigable waters defined as those waters that are susceptible of being used in their ordinary condition as highways of commerce over which trade and travel are or may be conducted in the customary modes of trade or travel on water (*The Daniel Ball,* 10 Wall. 557 (77 U.S.)).

87. The doctrines of the *Appalachian* and *Red River* cases were cited with approval by the Supreme Court in the later case of *United States* v. *Grand River Dam Authority,* 363 U.S. 229 (1960). Under the Flood Control Act of 1941 (55 Stat. 638, 645), Congress incorporated the Grand River plan into a comprehensive plan for regulation of navigation, control of floods, and production of power on the Arkansas River and its tributaries. Pursuant to the act, the Federal Government constructed a dam, for flood control and power purposes, at Fort Gibson, Okla., on the Grand River, a non-navigable stream but a tributary of the Arkansas River which is navigable. The Grand River Dam Authority, a State of Oklahoma agency, planned a similar dam at Fort Gibson and had made preliminary surveys and acquired lands, easements, and rights-of-way prior to construction by the Federal Government. The Authority sued the Government seeking compensation, under the 5th amendment to the Constitution, for the taking of its water rights and its franchise to develop electric power at that site. The United States Court of Claims upheld the Authority's claim on the ground that while the right of a state to control and utilize the water of a non-navigable stream within its boundaries is subordinate to the right of the United States to control such waters to the fullest extent necessary to improve or regulate navigation on a navigable river to which the non-navigable stream is a tributary, if the Government's action results in the taking of private property, the United States must pay just compensation for the property so taken. And the Court of Claims found there was a taking because the State of Oklahoma, under its doctrine of prior appropriation for beneficial use, owns the waters of the Grand River, a non-navigable stream. *Grand River Dam Authority* v. *United States,* 175 F. Supp. 153, 155, 156, 157 (1959). On appeal, the judgment was reversed, the Supreme Court holding that when the United States appropriates the flow either of a navigable or a non-navigable stream pursuant to its superior power under the commerce clause, it is exercising established prerogatives and is beholden to no one. "The Court of Claims," it said, "erred in failing to distinguish between an appropriation of property and the frustration of an enterprise by reason of the exercise of a superior governmental power . . . . The United States did not appropriate any business, contract, land, or property of respondent . . . . The frustration . . . which resulted when the United States chose to undertake the project on its own account did not take property from respondent in the sense of the Fifth Amendment." *United States* v. *Grand River Dam Authority, supra,* at 233, 236.

1884—Doctrine of *The Daniel Ball* extended to include an artificial canal which forms a means of communication between ports and places in different states (*Ex parte Boyer,* 109 U.S. 629).

1940—Concept of navigability broadened to include waterways that may be made available for navigation through future reasonable improvements (*United States* v. *Appalachian Electric Power Co.,* 311 U.S. 377).

1941—Navigability concept further broadened to include the non-navigable upper reaches of an entire watershed for the purpose of flood control and the promotion of navigation downstream (*Oklahoma* v. *Atkinson Co.,* 313 U.S. 508).

## 435. Some Indicia of Navigability

Besides the legal tests of navigability which the Supreme Court reemphasized in the *Appalachian* case (*see* note 83 *supra*), there are other indicia which courts have applied to particular situations. The important difference between navigable and non-navigable bodies of water is in the right of the public to use them. Where the stream in question is not navigable the overwhelming weight of authority is to the effect that the owner of the land in which the waterway is located has complete control over the stream, to the exclusion of everyone else. In the case of navigable streams, while the state laws differ as to ownership of the beds, they are in agreement as to the public right of passage, regardless of who owns the beds.

The basic test of navigability of waters in the United States is whether they are navigable in fact, without regard to tidal flow. But irrespective of whether the tidal test of navigability is recognized or rejected, all tidewater is prima facie navigable. This presumption, however, is not conclusive, and a river, creek, or inlet into which the tide flows is not navigable unless it is actually adapted for public navigation.[88] Where the tidal test is applied, tide waters are those in which the tide ordinarily ebbs and flows, including the sea, and also bays, rivers, and creeks, so far as they answer this description. A body of water cannot be considered as tidal merely because under unusual conditions the level of the water is affected by the tide, nor is the amount of salt in the water at the place in question material.[89] And it is immaterial whether current is present, as where the water is a bayou of a navigable river.[90] A stream or other body of water

88. *Van Cortlandt* v. *New York Cent. R. Co.,* 250 N.Y. Supp. 298 (1931). The court here said: "The fact that the tide ebbs and flows thereon does not necessarily tend to demonstrate its navigable character." *Id.* at 305. However, there are some jurisdictions that recognize only the tidal test as determinative of whether the waters are public or private. And a waterway though navigable in fact but not subject to tidal influence would not be a public water. This is the law in New Jersey as expressed in the case of *Schultz* v. *Wilson,* 131 A. 2d 415, 420 (1957). State sovereignty over submerged lands is determined by the same test in New Jersey. *Id.* at 423.

89. Tiffany, A Treatise on the Modern Law of Real Property 591 (1912).

90. *Turner* v. *Holland,* 33 N.W. 283, 289 (1887) (Mich.).

is not made non-navigable by the presence of obstructions such as falls, rapids, and sandbars;[91] and waters navigable at high tide but not at low tide are still navigable.[92]

A test of navigability frequently applied is whether the stream or other body of water, by its depth, width, and location is rendered available for commerce, whether or not it is actually so used. The ease or difficulty of navigation is not controlling, and it is immaterial what kind of vessels are or can be employed, or whether the stream is used by boats or rafts or for floating logs.[93]

Another test sometimes recognized is that the stream or waterway must lead from one public terminus to another either alone or in connection with other waters, or at least the existence or absence of such termini or connection is a factor to be considered in passing on the question of navigability.[94]

(*a*) *Proof of Navigability.*—The navigability or non-navigability of a body of water is ordinarily a question of fact to be established by appropriate evidence, including opinions of persons who by training and experience are competent, and to be resolved by a jury. This is particularly true where navigability is doubtful. But where the facts are undisputed or ascertained, the question may be one of law.[95] However, courts will take judicial notice of the navigability of streams constituting great national highways of commerce, as well as the navigability or non-navigability of smaller streams within its jurisdiction.[96]

(*b*) *Public Use of Navigable Waters.*—Navigability, when asserted as a right arising under the Constitution of the United States, under an international treaty, or under a federal statute, is determined according to federal law. But when these are not involved, then the law of the place where the lands are situated governs. These laws are not uniform. The law seems generally clear that the public right of navigation extends to a new navigable channel over the land of a person who has obstructed the flow of water in the original channel, and to a stream as improved by straightening and deepening, as well as a slip

91. *United States* v. *State of Utah,* 283 U.S. 64, 86 (1931).

92. *Oakland* v. *Oakland Waterfront Co.,* 50 Pac. 277, 285 (1897) (Calif.).

93. *United States* v. *State of Utah, supra* note 91, at 82; *Wisconsin Public Service Corp.* v. *Federal Power Commission,* 147 F. 2d 743, 747 (1945).

94. *Taylor Fishing Club* v. *Hammett,* 88 S.W. 2d 127, 129 (1925) (Tex.).

95. *Coates v. United States,* 110 F. Supp. 471 (1953). The nautical charts and hydrographic surveys of the Coast and Geodetic Survey showing depths, width, and location of a body of water would be taken into consideration in appraising the evidence of navigability and in establishing its capability of use for transportation and commerce. And where the tidal test prevails, as in New Jersey (*see* note 88 *supra*), the tidal records of the Bureau could be a controlling factor.

96. In *Continental Land Co.* v. *United States,* 88 F. 2d 104, 108 (1937), a Federal court took judicial notice that the Columbia River is a navigable stream in fact as well as in law. On considerations of actual capacity and utility for purposes of navigation, numerous specific rivers and waters have been declared to be navigable, or public, either in whole or in part. These are set out in 65 *Corpus Juris Secundum,* at 58–60.

after it has been widened and lengthened. But where navigable water is created by the work of man out of privately owned land, the decisions are not in agreement.[97]

The public use of navigable waters is entirely separate and distinct from the rights of the owner of the land under water. And this is true whether ownership of such land remains in the state or has been conveyed to private individuals. *Lewis Blue Point Oyster Cultivation Co.* v. *Briggs,* 229 U.S. 82 (1913).

(*c*) *Public Use of Shores.*—The public has a right, equal with the riparian owner, to a reasonable use of the shore of a tidal stream between high- and low-water marks. And where the shore belongs to the state, the public right to use it extends to all lands below high-water mark not used, built on, or occupied. *Rhode Island Motor Co.* v. *Providence,* 55 Atl. 696 (1903). But these rights have been said to be of a restricted nature and include only passing, fishing, bathing, hunting, and navigation. *People* v. *Brennan,* 255 N.Y. Supp. 331, 334 (1931).

## 44. RIPARIAN RIGHTS

Another of the legal aspects of the Bureau's work, which flows from the nature of its work and the area in which it operates, is in the field of riparian rights—that is, rights inherent in the ownership of lands bordering navigable waters. Broadly speaking, these rights include ownership of the strip of land between high and low water, commonly known as the shore (beach) or tidelands, and this will be discussed first.

97. Thus, in New Jersey it was held that where the waters of a lake were so raised by a dam built across its outlet that a swamp about 3,000 feet long and from 200 to 500 feet wide, which had previously been separated from the lake by a causeway, was flooded to a depth of 3 feet at high water, the right of the public to navigate the lake proper did not extend to the swamps on its being flooded, and that the public was without right to navigate the channel dredged across it. *King* v. *Muller,* 67 Atl. 380, 384 (1907). On the other hand, in Wisconsin it was held that "When the owner of the land raised the lake level so as to cover it, such land immediately became subject to use by the public as a part of the natural lake bed . . . by the same right that the public used any other part of the lake . . . . The principle is well settled that if the volume or expanse of navigable waters be increased artificially, the public right is correspondingly increased." *Village of Pewaukee* v. *Savoy,* 70 N.W. 436, 438 (1899). The doctrine of this case was applied to a situation where a man-made harbor (created out of land in private ownership) that opened on Long Island Sound, on the ground that one who creates, or allows to continue, a condition whereby his land is submerged by navigable waters which the public may reach without trespassing on his upland, should be required to accept the public right of navigation as a legal concomitant of that condition. And this appears to be the rule in the majority of jurisdictions. *People of the State of New York* v. *Kraemer, et al.,* 164 N.Y.S. 2d 423, 431 (1957). This right includes the right to anchor. *Id.* at 433. The court in this case took judicial notice of the *Coast Pilots* of the Coast Survey describing the area in question. *Id.* at 426–427.

## 441. The Shore Lands or Tidelands

The Bureau receives many inquiries pertaining to this subject. Many of these carry the impression that the Federal Government as such is the owner of the shore as well as the lands underlying navigable waters, probably arising from the fact that it exercises control over such waters or because it surveys and charts such areas. To clarify this it is necessary to go back to the historical development of our country and to the relationship existing between the several states and the Federal Government (*see* 211).

The English possessions in America were claimed by right of discovery by subjects of the King in trust for the people. After the American Revolution the Thirteen Original Colonies became sovereign states and, as successors to the Crown, became vested with the title to all lands within their boundaries, including those over which the tide ebbed and flowed and to the beds of inland navigable waters.

With the adoption of the Constitution and the formation of the Federal Government, the latter succeeded only to such rights as the states chose to surrender. The primary purpose was to carve from the general mass of legislative powers then possessed by the states such portions as were thought desirable to vest in the central government, leaving those not included in the enumeration still in the states (*see* 2111). While the right to regulate commerce was expressly conferred, and impliedly the concomitant right to control navigation, no title to the tidelands nor to the submerged lands under navigable inland waters was thereby conferred. As the United States Government is one of delegated, limited, and enumerated powers, any power not expressly granted or necessarily implied in the Constitution is beyond its scope. These therefore remained in the several states, to be disposed of by them as they deemed fit, or to be reserved for their own uses, subject generally to the public rights of navigation and fishing. New states, entering the Union subsequent to the adoption of the Constitution, were admitted on an equal footing with the Original States (*see* 341) and therefore acquired the same rights in the tidelands and submerged lands under inland navigable waters.[98]

Each state has dealt with this matter according to its own views of justice and policy, some retaining title in such lands, while others have recognized them as appurtenant to the upland, and still others have granted rights therein

98. These doctrines were laid down by the Supreme Court in two early cases that have become landmarks in the field of riparian law—*Martin* v. *Waddell,* 16 Pet. 367 (41 U.S., 1842), involved the ownership of an oyster bed in Raritan Bay, N.J. (one of the Original States); and *Pollard's Lessee* v. *Hagan,* 3 How. 212 (44 U.S., 1845), involved ownership of tidelands along Mobile River, Ala. (one of the subsequently admitted states).

to individuals, independent of the ownership of the uplands. For example, in Massachusetts, by virtue of an old colonial ordinance dating back to 1641–1647, the title of the owner of land bounded by tidewater extends from high-water mark over the shore or flats to low-water mark, if not beyond 100 rods (1,650 feet) from the high-water mark.[99] On the other hand, in New Jersey the courts have held that a riparian owner owns to high-water mark and that the state can convey the land between the high- and low-water marks to anyone free from any rights of the abutting upland owner.[100] And in Virginia the upland owner has title to ordinary low-water mark.[101]

(*a*) *The Rule in the Federal Courts.*—The rule in the Federal courts as to title to the shore lands and the right of alienation by the state is that the titles are in the several states, subject to the powers granted to the Federal Government for regulating and improving navigation, but that the policies to be followed in granting rights in the shore lands to individuals, and the effect of such grants, must be determined by the states themselves through their legislatures and courts. This was stated by the Supreme Court in the leading and oft-cited case of *Shively* v. *Bowlby*.[102] After a thorough review of the authorities, including the laws in the Original States as to ownership of the shore and the rights of an upland owner, the Court summarized its findings as follows:

> Lands under tide waters are incapable of cultivation or improvement in the manner of lands above high water mark. They are of great value to the public for the purposes of commerce, navigation and fishery. Their improvement by individuals, when permitted, is incidental or subordinate to the public use and right. Therefore the title and the control of them are vested in the sovereign for the benefit of the whole people.
>
> At common law [*see* 251], the title and the dominion in lands flowed by the tide were in the King for the benefit of the nation. Upon the settlement of the Colonies, like rights passed to the grantees in the royal charters, in trust for the communities to be established. Upon the American Revolution, these rights, charged with a like trust, were vested in the

99. *Iris* v. *Town of Hingham*, 22 N.E. 2d 13, 15 (1939) (Mass.). Grants made by the colony prior to the adoption of the ordinance ran only to high-water mark.

100. The New Jersey law with reference to grants in the shore was reviewed by the Supreme Court of the United States in *Hoboken* v. *Pennsylvania Railroad Co.*, 124 U.S. 656 (1888), and the right of the state to make such grants upheld. The Court stated: "the lands below high-water mark, constituting the shores and submerged lands of the navigable waters of the State, were, according to its laws, the property of the State as Sovereign. Over these lands it had absolute and exclusive dominion, including the right to appropriate them to such uses as might best serve its views of the public interest." *Id.* at 688. In New Jersey, as in almost all states, the boundary of upland bordering the sea is the ordinary high-water mark (*see* note 104 *infra*).

101. *Miller* v. *Commonwealth*, 166 S.E. 557 (1932) (Va.). The court stated the rule in Virginia as follows: "Wherever the land granted was bounded by a tidal water so as, under the common law [*see* 251], to pass title to high-water mark, this act [Act of Feb. 16, 1819] extended the limits of the grant to ordinary low-water mark." *Id.* at 566.

102. *Shively* v. *Bowlby*, 152 U.S. 1 (1894). The case involved the question of the effect of a grant by the United States of certain lands below high-water mark along the Columbia River, Oreg., while Oregon was still a territory, as against deeds of conveyance to the same lands from the state (*see* note 103 *infra*).

original States within their respective borders, subject to the rights surrendered by the Constitution of the United States.

Upon the acquisition of a Territory by the United States, whether by cession from one of the States, or by treaty with a foreign country, or by discovery and settlement, the same title and dominion passed to the United States, for the benefit of the whole people, and in trust for the several States to be ultimately created out of the Territory.

The new States admitted into the Union since the adoption of the Constitution have the same rights as the original States in the tide waters, and in the lands under them, within their respective jurisdictions. The title and rights of riparian or littoral proprietors in the soil below high water mark, therefore, are governed by the laws of the several States, subject to the rights granted to the United States by the Constitution.

The United States, while they hold the country as a Territory, having all the powers both of national and of municipal government, may grant, for appropriate purposes, titles or rights in the soil below high water mark of tide waters. But they have never done so by general laws; and, unless in some case of international duty or public exigency, have acted upon the policy, as most in accordance with the interest of the people and with the object for which the Territories were acquired, of leaving the administration and disposition of the sovereign rights in navigable waters, and in the soil under them, to the control of the States, respectively, when organized and admitted into the Union.[103]

Except in matters governed by the Federal Constitution or by acts of Congress, the law to be applied by the Federal courts is the law of the state, and decisions of the highest state courts are a part of such law (*see* 23 and text at note 32 thereof). And in the *Shively* case, *supra,* the Court held that the title and rights of riparian or littoral proprietors in the soil below high-water mark of navigable waters are governed by the local laws of the several states, subject to the rights granted to the United States by the Constitution.[104]

103. *Id.* at 57. The Supreme Court affirmed the finding of the Oregon court that the grant from the United States passed no title or right, as against the subsequent deeds from the state, in lands below high-water mark, stating that "Grants by Congress of portions of the public lands within a Territory to settlers thereon, though bordering on or bounded by navigable waters, convey, of their own force, no title or right below high water mark, and do not impair the title and dominion of the future State when created; but leave the question of the use of the shores by the owners of the uplands to the sovereign control of each State, subject only to the rights vested by the Constitution in the United States." *Id.* at 58.

104. *Diversity of State Laws.*—A useful compilation of the laws in the various states dealing with ownership of shore lands, and other riparian matters was made in 1960 by Col. H. C. Gee for the American Society of Civil Engineers and embodied in a report entitled "State Regulation of Coastal Structures." The report is based on a questionnaire sent to the governors and attorney generals of the 30 coastal states of the Union bordering on the Great Lakes, the Atlantic Ocean, the Gulf of Mexico, and the Pacific Ocean. Six questions were propounded dealing with the following matters: (1) the upland boundary of tidal and submerged coastal lands of the state, (2) the name and address of the agency which administers tidal and submerged lands for the state, (3) the rights of the upland owner in the adjoining submerged lands of the state, (4) a citation of laws designed to protect an upland owner against damage caused by a neighbor, (5) the delegation of authority by the sovereign state to any subordinate political subdivision in the general field of coastal engineering, and (6) provisions of laws of the various states dealing with the protection of sovereign rights in bottom lands under tidal waters.

As an indication of the absence of uniformity in state laws, the report cites the answers to question (1) which showed the following: Of the seven Great Lakes states, four use the water's edge, one the low-water mark, one the high-water mark, and one ordinary high water; of the five Pacific Ocean states, four use mean high water and one, Alaska, uses mean low water; of the five Gulf states, two use mean high water, one uses lower high water, one highest water during winter, and one mean higher high water; and

## 442. Nature of Riparian Rights

The owner of land contiguous to a navigable body of water acquires by virtue of that ownership certain rights—termed riparian rights—which include principally the right of access to the navigable waters; the right to build piers, wharves, docks, and other improvements to the line of navigation; the right to reclaim land; and the right to accretions to his lands.[105] These rights do not depend upon ownership of the soil under water but upon lateral contact with the water. It is a universal rule that for riparian rights to attach to a tract of land, the water must form a boundary of the tract. And if a particular tract is entirely cut off from a river by an intervening tract and the latter is gradually washed away until the remoter tract is reached by the river, the remoter tract becomes riparian as much as if it had been originally such.[106] In common with the public, a riparian owner enjoys the right of navigation, bathing, and fishing in such waters, as well as in the foreshore.

### 4421. *The Right of Access*

The right of access to navigable water is a fundamental riparian right which a riparian or littoral owner has, in the absence of an otherwise controlling local law limiting such right. This is distinct from, and in addition to, the general right of the public to use such waters, or to use the beach.[107] The right of access has been held to be the basis for recognizing the doctrine of accretion.[108] It

of the 15 Atlantic states, eight use mean high water and seven use mean low water, with one of the latter group, Maryland, using mean high water for Chesapeake Bay.

The answers to question (3) showed that all but four states recognize that upland owners have rights of ingress and egress, fishing, hunting, boating and wharfage on the navigable waters covering the adjoining submerged land. A majority of the states also recognizes that the public has certain rights on and over the tidal land which include free and unrestricted passage along the shore of tidal waters between mean high water and mean low water.

The report contains a tabular summary of the replies to questions (1) through (5), and an Appendix giving in detail the reply of each of the 30 states to the six questions propounded.

A copy of this report was furnished the author by Colonel Gee, with permission to use all or any part of it. The report is filed in the Coast Survey library and is identified as Accession No. 62516.

105. While the word "ripa," which is the foundation of the word "riparian," properly means "banks," as distinguished from "shores of the sea," the word in its general use is broad enough to cover ownership of land in both situations, and the rights upon both kinds of water are of the same nature. Farnham, 1 The Law of Waters and Water Rights 281 (1904). The word "littoral" is often used with respect to sea waters or the waters of a lake.

106. *Welles* v. *Bailey, supra* note 70, at 566.

107. *United States* v. *River Rouge Imp. Co.,* 269 U.S. 411 (1926).

108. In *Lamprey* v. *State and Metcalf,* 53 N.W. 1139, 1142 (1893) (Minn.), the court pointed out that the usual reason given for the right to accretion is that the riparian owner is liable to lose soil by the action or encroachment of the water. "But it seems to us," the court said, "that the rule rests upon a much broader principle, and has a much more important purpose in view, viz. to preserve the fundamental riparian right—on which all others depend, and which often constitutes the principal value of land—of access to the water." (*See also* text at note 120 *infra.*)

attaches to the entire frontage of the riparian owner and does not ordinarily depend on the ownership of the lands between low-water mark and the line of navigability, or of land below high-water mark.

(*a*) *Wharfing Out.*—The right of access includes the right to wharf out to deep water—that is, the right to construct and maintain a wharf, dock, or pier from his land to the navigable portion of adjoining waters—subject to the general rules imposed by the legislature (*see* 443).[109] This right has been placed on various grounds. One is that the riparian owner's right of access includes the right to connect his waterfront with the point of navigability.[110] It has also been placed on the ground that the owner of the upland has a qualified interest in the soil under the edge of the water at the shore, so as to give him a right to construct and maintain piers.[111] The doctrine has also been placed on the ground of usage. The limitation upon the right to construct wharves and piers is that they must not unreasonably interfere with the right of public navigation. Where a wharf is to be constructed in a navigable water of the United States (*see* 4331), permission from the Secretary of War must first be obtained, but such license does not authorize the erection without the consent of the state or its grantee which owns the land under water.[112] And where the act of Congress requires affirmative authorization by Congress before wharves may be erected to new harbor lines established by the Secretary of War, such establishment is not in itself a sufficient authorization.[113]

(*b*) *Use of Shores by Riparian Owner.*—Generally a riparian owner has the right to the exclusive use of the land between high- and low-water marks (the shore), and he may use it in any way not inconsistent with the public right of navigation nor inconsistent with the rights of other riparian owners. And where the seashore belongs to the state, the public right to use it for passage,

109. A *wharf* is an artificial landing place for the purpose of loading or unloading goods. It may be built out from the upland and form an extension thereof or it may be made on the land at the water's edge. A *dock* is an artificial basin or inclosure in connection with a harbor, for the reception of vessels; the slip or waterway extending between two piers or projecting wharves, or cut into the land for the reception of ships. A *pier*, in its customary sense, means a structure extending from the solid land out into the water to afford convenient passage for persons and property to and from vessels alongside the pier. In this sense, it is the same as a projecting wharf. 94 *Corpus Juris Secundum*, at 567, 568, 570.

110. *Miller* v. *Mendenhall*, 44 N.W. 1141 (1890) (Minn.). The court in this case said "the right of access and communication with the navigable waters, which pertain peculiarly to the ownership of the upland . . . necessarily includes the right to fill in and to build wharves and other structures in the shallow water in front of such land, and below low-water mark, and the exercise of such rights, though subject to state regulation, can only be interfered with for public purposes." *Ibid.*

111. *Tuck* v. *Olds*, 29 Fed. 738 (1886).

112. It was held in *Strandholm* v. *Barbey*, 26 P. 2d 46, 52 (1933) (Oreg.), that a license issued by the United States Engineers authorizing construction of a wharf on Sand Island, Oreg., was a mere declaration that the structure would not interfere with navigation, and not a declaration by authority of Congress that licensee could erect the wharf without first obtaining authority from the State of Oregon.

113. *White, Gratwick & Mitchell* v. *Empire Engineering Co.*, 210 N.Y. Supp. 563 (1923).

navigation, and fishing extends to all lands below high-water mark not used, built on, or occupied.[114]

Where the riparian owner owns to low water, as in Massachusetts, the right to use of the shore is exclusive, subject to the public right of navigation until built on or enclosed. On this, the Supreme Court of the United States, in its interpretation of the decisions of the Massachusetts courts involving the ordinance of 1641–1647 (*see* text at note 99 *supra*), has said that the right of the owner of such land has always been subject to the following rule: "that until he [the owner] shall build upon his flats or inclose them, and whilst they are covered with the sea, all other persons have the right to use them for the ordinary purposes of navigation; so long as the owner of the flats permits the sea to flow over them, the individual right of property in the soil beneath does not restrain or abridge the public right."[115]

### 4422. *The Right to Reclaim Land*

In a number of states, the owner of land on tide water may make use of the shore, though it belongs to the state, for the purpose of reclaiming it to low-water mark, as long as it does not interfere with the public rights of fishing and navigation, and in so doing conforms to all regulations imposed by the state.[116] Where this has been complied with, the made land becomes an integral part of the owner's upland and his title will extend to the new high-water mark.[117]

### 4423. *The Right to Accretion*

One of the most valuable of rights that inures to the ownership of land bordering navigable waters is the right to preserve contact with the water by appropriating the accretions which form along the shore; that is, the right to the land formed by natural causes through the action of the water to which the land is contiguous. Such additions fall into two classes—accretion and reliction. With these will be considered the processes of erosion and avulsion, both of which effect a loss of riparian land. It is important for those dealing with these problems to be able to determine whether the changed condition

114. *Rhode Island Motor Co.* v. *Providence*, 55 Atl. 696 (1903) (R.I.).

115. *The City of Boston* v. *Lecraw*, 17 How. 426, 433 (58 U.S., 1855).

116. *Panama Ice & Fish Co.* v. *Atlanta & St. A.B. Ry. Co.*, 71 So. 608, 609 (1916) (Fla.).

117. *United States* v. *Mission Rock Co.*, 189 U.S. 391, 406 (1903). In California, the upland owner is entitled to accretion from natural causes alone, and all artificial fills belong to the state or its grantees. *Los Angeles* v. *Anderson*, 275 Pac. 789, 791 (1929).

of a stream or waterfront is due to any of these processes. This might require the use of extrinsic evidence (*see* text following note 122 *infra*).

(*a*) *Accretion*.—This is defined as the process of gradual and imperceptible addition to riparian land made by the water to which the land is contiguous.[118] The key words are "gradual and imperceptible." If the addition is not of this character, then it is not accretion. The addition must be so gradual that no one can tell how much is added at each moment of time. A test frequently used as to what is gradual and imperceptible is that although the witnesses may see from time to time that progress has been made, they could not perceive it while the process was going on.[119] The law on the subject is based on the impossibility of identifying from day to day small additions or subtractions from land caused by the constant action of running water.

The case for the doctrine of accretion has been stated by the Minnesota court, in applying the rule to an inland lake, to be as follows: "The incalculable mischiefs that would follow if a riparian owner is liable to be cut off from access to the water, and another owner sandwiched in between him and it, whenever the water line had been changed by accretions or relictions, are self-evident, and have been frequently animadverted on by the courts . . . . If the rule contended for by the appellants is to prevail, it would simply open the door for prowling speculators to step in and acquire title from the state to any relictions produced in the course of time by the recession of the water, and thus deprive the owner of the original shore estate of all riparian rights, including that of access to the water (*see* note 108 *supra*). The endless litigation over the location of the original water lines, and the grievous practical injustice to the owner of the original riparian estate, that would follow, would, of themselves, be a sufficient reason for refusing to adopt any such doctrine." [120]

Accretion is to be distinguished from "alluvion." While the terms are frequently used synonymously, a more accurate usage would be to consider accretion as the act or process and alluvion as the deposit itself.[121]

118. *Crow* v. *Johnston,* 194 S.W. 2d 193, 196 (1946) (Ark.). Accreted lands are additions to areas of realty from gradual deposit by water of solid material, whether mud, sand, or sediment, producing dry land which before was covered by water, along banks of navigable streams. *Smith* v. *Whitney,* 74 P. 2d 450, 453 (1937) (Mont.). The term "accretion" includes sediment and silt deposited on the riparian owner's land as well as that deposited along the shore. *Tallassee Power Co.* v. *Clark,* 77 F. 2d 601, 604 (1935).

119. *Crow* v. *Johnston, supra* note 118, at 196. The word "imperceptible" means that the addition is such that its progress is not perceptible, although the fact of the addition may be perceptible after a long lapse of time.

120. *Lamprey* v. *State and Metcalf, supra* note 108, at 1142.

121. *Cunningham* v. *Prevow,* 192 S.W. 2d 338, 341 (1945) (Tenn.). "Batture" is a term used to denote an elevation of the bed of a river under the surface of the water, and sometimes used to signify the same elevation when it has risen above the surface. *Conkey* v. *Knudsen,* 8 N.W. 2d 538, 541 (1943) (Neb.).

A variant of the accretion doctrine is where changes in shoreline are brought about by natural causes but induced by artificial structures, as, for example, where jetties or breakwaters have been built, and, thereafter, by gradual and imperceptible processes, accretions to the shoreline occur as a result of the artificial structures. The rule applied in the Federal courts is to treat such changes as natural accretions for the benefit of the adjacent riparian owner.[122]

In determining whether true accretion has taken place, sources of evidence frequently resorted to are topographic and hydrographic surveys showing conditions of the physical geography of our coasts at various dates and the nature and rate of change at a particular place. In *Rockaway Pacific Corp.* v. *State,* 203 N.Y. Supp. 279, 286 (1924), extensive use was made of the progressive surveys of the Coast Survey, dating back to the year 1835, to show the method of growth of Rockaway Point, Long Island. In finding that the Point grew westward as a result of true accretion, the court said, significantly: "We are firmly impressed . . . by the vast amount of documentary evidence introduced, including maps and charts of all kinds, that for a considerable period of time . . . the growth of Rockaway peninsula to the west had been by the continual and gradual process of accretion." (*See* 413.)[123]

In *Horne* v. *Howe Lumber Co.,* 190 S.W. 2d 7, 10 (1945) (Ark.), it was held that the evidence, including plat of the original survey made by the Federal Government in 1825 and geodetic surveys made by the War Department, established that the land in controversy resulted from accretion.

(*b*) *Reliction.*—Reliction (or dereliction) is the term applied to land that has been covered by water but which has become uncovered by the recession of the water from the land, due, for example, to a lowering of sea level, or, in the case of a lake, to the drying up of the bed.[124] As in the case of accretion, the recession of the water must be gradual and imperceptible. Temporary subsidence of the water due to the seasons does not constitute reliction. Although, technically speaking, land uncovered by a gradual subsidence of the water is not an accretion but a reliction, the terms are often used interchangeably, and the law relating to accretions applies in all its features to relictions.[125]

122. *County of St. Clair* v. *Lovingston,* 23 Wall. 46, 66–69 (90 U.S., 1874). In California, a different rule is applied, with accretions so added being regarded as artificial in character, and, as against the state or its grantee, the riparian owner is not entitled to claim such accretion (*see* note 117 *supra*). *Carpenter* v. *City of Santa Monica,* 147 P. 2d 964, 972–975 (1944).

123. Copies of Bureau charts and surveys used in this litigation are contained in the brief for the Rockaway Pacific Corp., filed in the Supreme Court of the State of New York (Appellate Division), a copy of which has been placed in the Coast Survey library and identified as Accession No. 62517.

124. *McClure* v. *Couch,* 188 S.W. 2d 550, 553 (1945) (Tenn.).

125. *Hanson* v. *Thornton,* 179 Pac. 494, 496 (1919) (Oreg.).

(*c*) *Erosion.*—The rule which operates in favor of a riparian owner, increasing his land holding as a result of accretion or reliction, also operates against him when the water by slow process encroaches on his land. Such process is known as erosion or submergence. It is sometimes given as the justification for the doctrine of accretion, since a riparian owner must run the risk of losing some of his land by erosion (*see* note 108 *supra*). Erosion has been defined judicially as the gradual eating away of a riparian or littoral owner's soil by the operation of currents or tides.[126] Where a riparian tract completely disappears by erosion so that an adjoining nonriparian tract becomes adjacent to the water, the latter tract becomes riparian and the new tract carries with it all the riparian rights that the original tract had.[127]

(*d*) *Avulsion.*—Avulsion has been defined as the loss of lands, such as those bordering on the seashore, by sudden or violent action of the elements, perceptible while in progress.[128] The property of the part thus separated continues in the original proprietor, and in this respect avulsion differs from accretion in that in the latter case the addition becomes the property of the owner of the lands to which the addition is made.[129] Where running streams are the boundaries between states, the same rule applies as between private proprietors, and, if the stream from any cause, natural or artificial, suddenly leaves its old bed and forms a new one by the process of avulsion, the resulting change of channel works no change of boundary, which remains in the middle of the old channel though no water may be flowing in it, and irrespective of subsequent changes in the new channel.[130]

126. *Michelson* v. *Leskowicz*, 55 N.Y.S. 2d 831, 838 (1945).

127. *Welles* v. *Bailey*, *supra* note 70, at 566. The owners of land submerged by the creation of a navigable lake by an earthquake have been held not to lose title to their tracts as long as they can be reasonably identified. *State* v. *West Tennessee Land Co.*, 158 S.W. 746, 752 (1913) (Tenn.). The court found no existing precedent for this situation, but it did find that many of the boundary monuments of the various tracts could be identified in the clear waters of the lake.

128. *Schwartzstein* v. *B.B. Bathing Park*, 197 N.Y. Supp. 490, 492 (1922). Accretion, reliction, and erosion are gradual processes, whereas avulsion is a sudden process.

129. *Rees* v. *McDaniel*, 21 S.W. 913, 915 (1893) (Mo.).

130. *Arkansas* v. *Tennessee*, 246 U.S. 158, 173 (1918). To constitute avulsion, rather than accretion, so as to preclude a change in the boundary, the general rule is that there must be a detachment of earth from one side of the river and a deposit of the same earth on the other side in such a manner that it can be identified as the land of the other owner. *Nebraska* v. *Iowa*, 143 U.S. 359, 366 (1892). But under a statute, it has been held that if the change is so sudden that the owner of the land washed away is able to point out approximately as much land added to the opposite bank as he had washed away, the doctrine of avulsion applies, and there is no change in the boundary line. *Willett* v. *Miller*, 55 P. 2d 90, 94 (1935) (Okl.). The decisions of the Supreme Court establish the following criteria for the differentiation between accretion and avulsion: (1) Due regard must be given to the speed of the accretion as well as the rapidity of the tearing down of the bank, and (2) that there must be conclusive evidence that the earth forming the new bank originated in the bank torn down. SKELTON, THE LEGAL ELEMENTS OF BOUNDARIES AND ADJACENT PROPERTIES 343 (1930).

A. DIVISION OF ACCRETIONS

In the division of accretions between riparian owners, as with the apportionment of flats, dock privileges, made land, and similar rights, many nice questions have arisen which courts have frequently been called upon to resolve. To formulate a general rule, applicable to all situations, is virtually an impossibility because of the diversity and irregularity in the form of the seashore. Courts have recognized this. Therefore, the aim in all cases has been to apportion the accretions so as to do justice to each adjoining owner. The principle applied is to give to each proprietor a width at the new shoreline proportional to that which he had at the old shoreline before the accretion took place. This has been referred to as the "proportionate shoreline method."

In an early Massachusetts case, *Inhabitants of Deerfield* v. *Pliny Arms,* 34 Mass. 41, 45 (1835), the court stated the rule to be, as follows: "The rule is, 1. To measure the whole extent of the ancient bank or line of the river [usually the high-water shoreline], and compute how many rods, yards or feet, each riparian proprietor owned on the river line. 2. The next step is, supposing the former line, for instance, to amount to 200 rods, to divide the newly formed bank or river line into 200 equal parts, and appropriate to each proprietor as many portions of this new river line, as he owned rods on the old. Then, to complete the division, lines are to be drawn from the points at which the proprietors respectively bounded on the old, to the points thus determined as the points of division on the newly formed shore." [131]

While the above is the general rule, courts also recognize exceptions by taking into account particular circumstances. For example, where there is a deep indentation or a sharp projection on the original shoreline, the general line of the shore would be taken in computing the proportion, irrespective of the irregularity.[132]

The general rule for the division of accretions is equally applicable to the division of cove flats, where adjoining riparian owners are entitled to such flats under a statute. The boundary line of low-water mark (a line joining the headlands of the cove) is divided between the several riparian owners in proportion to their respective holdings at high-water mark. Thus, if the length

131. This doctrine was confirmed by the Supreme Court of the United States in *Johnston* v. *Jones,* 1 Bl. 209, 222 (66 U.S., 1861), and was cited in the more recent case of *Swarzwald* v. *Cooley,* 31 P. 2d 381, 383 (1934) (Calif). The new lines, thus formed, will be either parallel, divergent, or convergent, depending on whether the new shoreline equals, exceeds, or falls short of the old; that is, whether it is straight, convex, or concave. For illustrations of the proportionate shoreline method as applied to these three types of shoreline, *see* BROWN, BOUNDARY CONTROL AND LEGAL PRINCIPLES 206 (1957).

132. In apportioning accretions in a circular body of water, as where a lake has dried up, a method sometimes used is to draw radiating lines from the center of the lake to the terminal points of the various parcels of land at the old shoreline of the lake. *Scheifert* v. *Briegel,* 96 N.W. 44 (1903) (Minn.).

of the line of low water is 1,000 feet and the length of the line of high water is 2,000 feet, then each riparian owner would be entitled to one-half of the width of his high-water mark holding.[133]

## 443. Governing Laws

It was previously pointed out that rights of riparian or littoral proprietors in the soil below high-water mark are governed by the laws of the several states, subject to the powers granted to the Federal Government for regulating and improving navigation (*see* 441(*a*)).[134] While the principles of riparian rights are much the same in all the states where riparian lands exist, the extent of such rights is a matter governed by the statutes and court decisions of the various states, and these must be consulted as far as each particular state is concerned. For example, each state has power to settle for itself the title to land formed by accretion within its boundaries.[135]

It is sometimes thought that an owner of riparian lands has a right of access to the water as a matter of right, by reason of the contiguity of his lands to such waters, with the resultant right to build or wharf out to the line of navigation. This is the rule in some of the states; others give to the upland owner merely a preferential right to acquire same, but subjecting such lands to state regulation and control as far as placing any piers, wharves, or structures thereon, or making any other use thereof.[136]

133. *Rust* v. *Boston Mill Corp.*, 23 Mass. 158 (1828); *Wonson* v. *Wonson*, 96 Mass. 71 (1867) (this deals with a situation where the low-water mark extends beyond the headlands of the cove). A variant of this rule, applicable under certain conditions, is to run a base line across the mouth of the cove and from the terminals of the various parcels at high-water mark draw lines at right angles to the base line. *Gray* v. *Deluce*, 59 Mass. 9 (1849). For a comprehensive treatment of the surveying and legal aspects of division of accretions; apportionment of navigable waters; division of docking privileges; division of flats, coves, and lakes; and related matters, including many illustrations and citations to adjudicated cases, *see* Clark, A Treatise on the Law of Surveying and Boundaries (2d ed.) Chap. 14 (1939).

134. Wherever a federal question is involved, federal, not state, law applies. *Borax Consolidated, Ltd.* v. *Los Angeles*, 296 U.S. 10, 22 (1935).

135. *Iowa* v. *Carr*, 191 Fed. 257, 261 (1911).

136. For a discussion of this phase of riparian rights, *see* Brown, Shore Control and Port Administration 61–72, Corps of Engineers, U.S. Army (1923). A summary outline of the rights of riparian owners, in 39 of the states in conterminous United States, is contained in Clark, A Treatise on the Law of Surveying and Boundaries (3d ed.) 618–627 (1959).

# APPENDIXES A TO G

APPENDIX A

# Glossary of Terms Used

*(This glossary is intended to serve as a ready reference to the legal and technical terms used in Volume Two, whether or not they are defined in the text. Many terms are common to both volumes. Where a term is actually discussed in Volume Two, the definition has been included; otherwise, the incorporation is by reference only. Figure references are to those in the text.)*

## A

**Accretion.**—The gradual and imperceptible accumulation of land by natural causes, as out of the sea or a river. This may result from a deposit of alluvion upon the shore, or by a recession of the water from the shore. Accretion is the act, while alluvion is the deposit itself. See *Riparian Rights, Alluvion, Gradual and Imperceptible.*

**Accuracy of Horizontal Control.**—See *Triangulation Classification.*

**A Change in the Horizontal Datum.**—Changes in the latitudes and longitudes of triangulation stations resulting in a shift in the projection lines on a survey sheet. See *United States Standard Datum, North American 1927 Datum.*

**Acre.**—A unit of area measurement in public land surveys. An acre equals 10 square chains, or 43,560 square feet; 640 acres equal 1 square mile. See *Chain.*

**Act of Apr. 5, 1960.**—This act had for its purpose the removal of geographical limitations on the activities of the Coast Survey. *See* Appendix C.

**Act of Aug. 6, 1947.**—The first of the recent legislation to define the function and duties of the Coast and Geodetic Survey (*see* Appendix C). It did not change previous authorizations to any great extent but eliminated a number of obsolete statutes and assembled into one place various items of substantive legislation which had been enacted at different times since 1807. See *Act of Apr. 5, 1960.*

**Act of Feb. 19, 1895.**—An act to adopt special rules for the navigation of harbors, rivers, and inland waters of the United States. Section 2 authorized the Secretary of the Treasury (now delegated to the Commandant of the Coast Guard) "to designate and define by suitable bearings or ranges with light houses, light vessels, buoys or coast objects, the lines dividing the high seas from rivers, harbors and inland waters." This determined the scope of application of the two sets of rules for navigation. See *Rules of the Road Boundary Lines.*

**Act of Feb. 10, 1807.**—The organic act of the Coast and Geodetic Survey. It authorized President Jefferson "to cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shores of the United States." See *Marine League, Survey of the Coast, "Comprehending All Islands Within Twenty Leagues of Any Part of the Shores of the United States."*

**Act of July 10, 1832.**—Revived the Act of Feb. 10, 1807, for the Survey of the Coast. See *Act of Feb. 10, 1807.*

**Act of June 20, 1878.**—An appropriation act in which the name Coast and Geodetic Survey was first mentioned. This is considered as the date of change from the name Coast Survey. *See* Appendix C.

**Act of Mar. 3, 1871.**—Authorized an extension of the triangulation in the interior of the country so as to provide a geodetic connection between the Atlantic and Pacific coasts and to provide starting data for federal and state surveys.

**Act of Oct. 31, 1945.**—See *District of Columbia–Virginia Boundary Line.*

**Ad Coelum.**—To the sky. See *Ad Coelum Doctrine.*

**Ad Coelum Doctrine.**—A 16th century English legal maxim which stated that to whomsoever the soil belongs, he owns also to the sky and to the depths. This doctrine has been limited by 20th century courts to extend only to so far above the ground as the landowner can reasonably occupy or use in connection with the land. See *Ad Coelum, United States* v. *Causby.*

**Ad Hoc.**—For this; for this special purpose.

**Adjoiner.**—In land description, the call for the line of an adjoining tract. See *Call.*

**Adjusted Position.**—An adjusted geographic position of a point on the earth in which discrepancies arising from errors in the observational data are removed; a fixed position. See *Field Position.*

**Adjustment** (Leveling).—The determination and application of corrections to orthometric differences of elevation or to orthometric elevations, to make the elevations of all bench marks consistent. See *1929 General Adjustment, Orthometric Correction.*

**Administrative Boundary Lines.**—Boundaries established for administrative purposes rather than as a division of sovereignty. Such delineations are limited to the purposes intended. Examples of such lines are the Rules of the Road boundary lines, and the lines adopted by the Bureau of the Census for determining the outer limits of the United States. See *Rules of the Road Boundary Lines.*

**Administrative Branch.**—Applied to administrative agencies whose activities often represent a fusion of legislation, execution, administration, and adjudication. They are usually staffed with experts in the respective fields. See *Administrative Procedure Act.*

**Administrative Procedure Act.**—The Act of June 11, 1946, under which procedural protections surrounding the administrative process are established as well as the standards of judicial review. See *Administrative Branch, Judicial Review.*

**Admiralty Law.**—That branch of the body of the law which governs in maritime matters; administered in the United States by the Federal courts as a distinct legal system, the jurisdiction being exclusive and cannot be enlarged or restricted by state legislation. Admiralty jurisdiction requires the presence of two concurrent elements: (1) a navigable waterway which is part of an interstate or international highway, and (2) a vessel or craft used or capable of being used as a means of transportation on such waterway.

**Admission of New States.**—The creation of new states out of existing territory of the United States is derived from Art. IV, sec. 3, cl. 1, of the Constitution, which provides that "New States may be admitted by the Congress into this Union." See *Enabling Act.*

**Admission of States to Union.**—*See* Table 1.

**Aerial Photography Index.**—Indexes of the aerial photography of the Coast Survey prepared on 1: 250,000 scale base maps.

**Affluent River.**—A stream flowing into a larger stream or lake; a tributary stream.

**Aid Proof.**—A copy of the latest new print of a chart on which are indicated all changes in aids to navigation and important corrections that are applied to the printing plate before the next printing of the chart. Aid proofs are changed with every new print of a chart. See *New Print.*

**Aid to Navigation.**—A device external to a boat or vessel designed to assist in determination of position, a safe course, or to warn of dangers. Examples are: Lighthouses, lights, buoys, daybeacons, radio beacons, and electronic devices.

**Air Commerce.**—Defined in the Federal Aviation Act of 1958 as "any operation or navigation of aircraft which directly affects, or which may endanger safety in, interstate, overseas, or foreign air commerce."

**Alaska Purchase.**—The last of the major acquisitions to the territory of the United States. Purchased from Russia under a convention signed Mar. 30, 1867, and proclaimed June 20, 1867.

**Alidade.**—A part of the instrumental equipment of the planetable consisting of a straight-edge ruler upon which a telescope is mounted, the telescope having motion in a vertical plane only, so that its line of collimation is always parallel to the edges of the ruler (fig. 41). See *Planetable.*

**Alkali Flat.**—An alkaline, marshy area in an arid region. In the dry season, it is a barren area of hard mud covered with alkali (a soluble salt or mixture of soluble salts). Symbolized on early topographic surveys by an open dot pattern (*see* (*J*) in fig. 44).

**Alluvion.**—The soil that is deposited along a river or the sea by gradual and imperceptible action of the sea. See *Accretion.*

**Aluminum-Mounted Sheets.**—Bristol board mounted on aluminum to eliminate distortion of the paper and used subsequent to 1932 in planetable surveying. Replaced the cloth-mounted Whatman sheets formerly used.

**Ambulatory Boundary.**—A shifting water boundary. See *Shifting Riparian Boundary.*

**American Meridian.**—The meridian passing through the center of the dome of the old Naval Observatory in Washington, D.C., which under the Act of Sept. 28, 1850, was to be used as the initial or zero of longitudes for all astronomical purposes in the United States. The act was repealed Aug. 22, 1912. Many early state surveys are referred to this meridian. Its value west of Greenwich is $77°03'06''.276$ on the North American 1927 Datum. See *Greenwich Meridian.*

**American Polyconic Projection.**—Same as *Polyconic Projection.*

**Amicus Curiae Brief.**—*See* Volume One, Appendix A.

**Annexation by Joint Resolution.**—Territory annexed by a simple majority in both Houses of Congress and approval by the President See *Annexation by Treaty.*

**Annexation by Treaty.**—Territory annexed by a two-thirds favorable vote in the Senate. See *Annexation by Joint Resolution.*

**Annual Sea Level.**—Sea level derived from tidal observations extending over a period of 1 year. See *Mean Sea Level.*

**Antarctic Treaty.**—A treaty which entered into force in 1961 between the United States, Russia, and 10 other nations to maintain the Antarctic as a peaceful international preserve.

**Apparent Shoreline.**—The outer edge of marine vegetation (marsh, mangrove, cypress) delineated on photogrammetric surveys where the actual shoreline is obscured.

**Appellant.**—See *Petitioner.*

**Appellate Court.**—A court having jurisdiction of appeal and review. See *Appellate Jurisdiction.*

**Appellate Jurisdiction.**—*See* Volume One, Appendix A.

**Appellee.**—See *Respondent.*

**A Priori.**—That kind of reasoning which deduces consequences from definitions formed, or principles assumed; deductive reasoning.

**Artificial Monument.**—An artificial object found on the land, such as a highway, wall, ditch, or post. See *Monument, Natural Monument.*

**Astronomic Azimuth.**—The azimuth which results directly from observations on a celestial body. See *Laplace Azimuth.*

**Astronomic Determination.**—The position of a point on the surface of the earth, with reference to the equator and to a principal meridian, determined by observations on the stars. See *Geodetic Determination.*

**Atlantic Neptune.**—An atlas of charts compiled between 1775 and 1781 by Des Barres, the Royal Surveyor General for the colonies, from surveys by British naval vessels, from private surveys, and from records by the Lords of Trade.

**Atoll.**—A coral island or islands, consisting of a belt of coral reef surrounding a central lagoon.

**Attorney-General v. Chambers** (4 De G. M. & G. 206).—An 1854 leading English case in which the word "ordinary," as applied to tides, was first construed as meaning the medium tides between the springs and neaps, and that the landward limit of the seashore is the line of the medium high tide between the springs and the neaps. *See* Appendix D.

**Authentication.**—The act or mode of giving authority or legal authenticity to a statute, record, or other written instrument so as to render it legally admissible in evidence. See *Certify, Seal.*

**Authority Note.**—The note included on a chart which gives the names of the federal agencies that have contributed to the information used in the compilation.

**Automatic Tide Gage.**—An instrument that automatically registers the rise and fall of the tide. Those used by the Coast and Geodetic Survey draw a continuous graph in which the height of the tide is represented by the ordinates of the curve and the corresponding time by the abscissae. The first gage of this type was installed at Governor's Island, N.Y., in the winter of 1844–1845.

**Avulsion.**—The loss of lands bordering on the seashore by sudden or violent action of the elements, perceptible while in progress; a sudden and rapid change in the course and channel of a boundary river. Neither of these changes works a change in the riparian boundary. See *Accretion, Erosion, Reliction, Boundary River.*

**Award of the Arbitrators of 1877.**—The culmination of interstate controversy, discussion, and settlement of the Maryland-Virginia boundary dispute which began about 1661, an important milestone being the Compact of 1785. Defined the boundary on the Potomac as "following the meanderings of said river by the low-water mark, to Smith's Point," which was to be "from low-water mark at one headland to low-water mark at another, without following indentations, bays, creeks, inlets, or affluent rivers." See *Maryland-Virginia Compact of 1785.*

**Awash 1/4 Tide.**—A notation (or similar notation) used on some surveys to indicate the status of a rock awash. Interpretation of such notation is that the rock was awash when the tide had risen to one-fourth its height above the sounding datum See *Rock Awash, Plane of Reference.*

**Awash Rock.**—Same as *Rock Awash.*

**Azimuth.**—The horizontal direction reckoned clockwise from the meridian plane. In the geodetic work of the Coast Survey, azimuths are measured clockwise from the south following continental European practice.

**Azimuth Mark.**—A mark established in conjunction with a triangulation station which gives directional control for future surveys and avoids the need of establishing a true meridian line by local surveyors and engineers. See *Azimuth.*

## B

**Bache, Alexander Dallas.**—Noted American scientist and educator and great-grandson of Benjamin Franklin. Succeeded Hassler as Superintendent of the Coast Survey and directed its operations from 1843 to 1867 (*see* fig. 3).

**Backshore** (according to Coastal Engineering).—The zone of the shore that lies between the foreshore and the coast and is covered by water during exceptional storms only (*see* fig. 86).

**Bank of a River** (Legal).—The water-washed and relatively permanent elevation or acclivity at the outer line of the river bed which separates the bed from the adjacent upland, whether valley or hill, and serves to confine the waters within the bed and to preserve the course of the river. See *Bed of a River* (Legal), *Right Bank* (River), *Left Bank* (River).

**Bare Rock.**—In Coast Survey terminology, a rock extending above the plane of mean high water. See *Rock Awash.*

**Base** (also called Base Line).—In geodetic surveying, the side of one of a series of connected triangles of a triangulation network the length of which is measured on the ground with prescribed accuracy. From these bases and the measured angles the lengths of all other sides of the triangulation are computed by trigonometric methods. See *Triangulation.*

**Base Line** (Geodetic Surveying).—Same as *Base.*

**Baseline** (International Law).—A term used in the law of the sea to indicate the reference line from which the outer limits of the marginal sea and other offshore zones are measured; the dividing line between inland waters and the marginal sea. See *Normal Baseline, Straight Baselines, Headland-to-Headland Line.*

**Base Line** (Public Lands Surveys).—A true east-west line (a parallel of latitude) extending both east and west of the initial point in the rectangular system of surveys. Together with the principal meridian they constitute the axes of a system and the initial point constitutes the origin of that system (fig. 97). See *Initial Point, Principal Meridian, Rectangular System of Surveys.*

**Basic Geodetic Networks of the Country.**—The networks of triangulation and precise levels established by the Coast Survey throughout the country (*see* figs. 4 and 15), which provide rigid frameworks of horizontal control (latitudes and longitudes and plane coordinates) and vertical control (elevations above mean sea level) for all types of accurate maps and surveys and engineering projects. See *Triangulation, Leveling.*

**Basic Survey.**—A hydrographic survey so complete and thorough that it does not need to be supplemented by other surveys, and is adequate to supersede, for charting purposes, all prior hydrographic surveys of the area.

**Batture.**—An elevation of the bed of a river under the surface of the water; sometimes used to signify the same elevation when it has risen above the surface.

**Bay** (according to Geneva Convention).—A well-marked indentation whose penetration is in such proportion to the width of its mouth as to contain landlocked waters and constitutes more than a mere curvature of the coast. The area of such an indentation must be as large as, or larger than, the semicircle whose diameter is a line drawn across the mouth of the indentation. See *Semicircular Rule, Conventions on the Law of the Sea, Bay* (General).

**Bay** (General).—An indentation of the coast; an embayment; a subordinate adjunct to a larger body of water; a body of water between and inside of two headlands. See *Open Bay, Closed Bay, Bay* (according to Geneva Convention).

**Beach.**—Same as *Tidelands.*

**Bed of a River** (Legal).—That portion of its soil which is alternately covered and left bare, as there may be an increase or diminution in the supply of water, and which is adequate to contain it at its average and mean stage during the entire year, without reference to the extraordinary freshets of the winter or spring, or the extreme droughts of the summer or autumn.

**Bench Mark.**—A marked point whose elevation above or below an adopted datum is known and which provides a starting point for a survey or engineering operation where elevation is a significant factor. See *Standard Disk.*

**Bench Mark** (Geodetic).—A bench mark set to reference a station in the level net of the country and the elevation of which is determined with relation to the Sea Level Datum of 1929. See *Bench Mark* (Tidal).

**Bench Mark** (Tidal).—A bench mark set to reference a tide staff at a tide station and the elevation of which is determined with relation to the local tidal datum. Established wherever tides are observed, no matter how short the series, and the zero of the tide staff is connected by spirit levels to these marks. Elevations of tidal bench marks are determined with reference to the local planes of high water, mean sea level, low water, and other tidal planes.

**Bering Sea Fur Seal Arbitration.**—*See* Volume One, Appendix A.

**Bessel Spheroid of 1841.**—The spheroid used in the Bureau's work between 1844 and February 1880. The semimajor axis=6,377,397.2 meters, the semiminor axis=6,356,079.0 meters, and the ellipticity=1/299.15. See *Clarke Spheroid of 1866.*

**Best Evidence.**—Primary evidence, as distinguished from secondary; original, as distinguished from substitutionary; the highest evidence of which the nature of the case is susceptible. See *Best Evidence Rule.*

**Best Evidence Rule.**—The rule that the highest available degree of proof must be produced; that is, that no evidence which is merely substitutionary in its nature can be received as long as original evidence can be had. See *Best Evidence.*

**Bilby Steel Tower.**—A triangulation tower consisting of two steel tripods, one within the other, designed by J. S. Bilby of the Coast and Geodetic Survey. First put into use in 1927.

**Bill of Rights.**—The first ten amendments to the Constitution.

**"Bis" Sheet.**—A redrawing of an original topographic survey that has become dilapidated through continued use.

**Black–Jenkins Award of 1877.**—Same as *Award of the Arbitrators of 1877.*

**Board of Surveys and Maps.**—Created by President Wilson on Dec. 30, 1919, to coordinate the activities of the various map-making agencies of the Government and to standardize results. On Jan. 4, 1936, the name was changed to Federal Board of Surveys and Maps, and on Mar. 10, 1942, it was abolished by President Roosevelt.

**Boat Sheet.**—The work sheet used by the hydrographer in the field for plotting the details of a hydrographic survey as it progresses. It is similar to the smooth sheet, with projection lines, control stations, shoreline, and proposed sounding lines. Corresponds to what was termed in early instructions for hydrographic work as "diagram," "sounding-sheet," and "working-sheet." See *Smooth Sheet.*

**Bonne Projection.**—A modification of the simple conic projection, by Rigobert Bonne, in which all parallels are subdivided according to their values on the earth. Its characteristics are curved meridians except the central one, concentric arcs of circles for all parallels, and nonorthogonality of intersections except at the central meridian. The scale along all the parallels is correct by construction, which makes the projection more suitable for maps having considerable north-south extent than the simple conic. See *Simple Conic Projection.*

**Borax Consolidated, Ltd. v. Los Angeles** (296 U.S. 10).—A 1935 landmark case in the law of tidal boundaries, in which the Supreme Court established the doctrine that in construing a federal grant, the common-law term "ordinary high water mark," as the boundary between upland and tideland, is to be interpreted as "the mean high-tide line"; that is, as neither the mean of the spring tides nor the mean of the neap tides, but a mean of all the high tides. The case also established the first precise standard for the demarcation of the line of mean high water on the ground; that is, by using for the plane of mean high water a determination from "an average of 18.6 years" as near as possible (citing Tidal

Datum Planes, Special Publication No. 135, U.S. Coast and Geodetic Survey (1927)). *See* Appendix D.

**Bottom Characteristics.**—Designations used on surveys and charts to indicate the consistency, color, and classification of the sea bottom. Thus, "soft gray sand, shells, pebbles" is designated "sft gy S Sh P."

**Bottom Samples.**—Samples of the bottom obtained by means of a coring device or by dredging.

**Boundary River.**—A river that forms the dividing line between two political jurisdictions. River boundaries are delimited as (1) the geographic middle or *medium filum acquae,* (2) the middle of the channel or *thalweg,* and (3) the shore or bank. See *International River, National River.*

**Bounds.**—The limiting lines or boundary lines, either real or imaginary, which enclose or mark off a tract of land, or the natural or artificial marks which indicate the beginning and ending. See *Metes and Bounds.*

**Bowie Method of Triangulation Adjustment.**—A special method (similar to that used in the adjustment of a first-order level net) devised in the Coast Survey for adjusting the triangulation nets in the western and eastern portions of the country. See *North American 1927 Datum.*

**Bridgeport Harbor, Conn.**—The first published chart of the Coast Survey of which there is a present record. Engraved commercially in 1835.

**Bromide.**—A photographic process, used in the Coast Survey for making copies of original surveys, in which the subject is first photographed at a reduced scale on a film or glass negative and then enlarged on bromide paper to the desired scale. The paper does not come in contact with the negative. See *Photostat.*

**Bulkhead Line.**—The line to which solid or solid filled structures may be built (fig. 105). See *Pierhead Line, Harbor Line.*

**Buoyage System in the United States.**—The system by which buoys are marked (as to shape and color) and numbered for the safe navigation of the waters of the United States. It dates back to the act passed by Congress on Sept. 28, 1850. See *Lateral System.*

**Buoy-Control Method.**—A system of accurately located buoys on which three-point fixes could be observed, or to which distances could be measured by radio acoustic methods, for extending hydrographic surveys beyond the visibility of shore control. See *Radio Acoustic Ranging.*

## C

**Call.**—A reference to, or statement of, an object, course, distance, or other matter of description in a survey or grant requiring, or calling for a corresponding object, or other matter of description, on the land. See *Locative Call, Descriptive Call.*

**Canadian Proclamation of June 4, 1963.**—Established a 12-mile exclusive fisheries zone along the whole of Canada's coastline as of mid-May 1964, and implemented the straight baseline system as the basis from which Canada's territorial sea and fisheries zone shall be measured. See *Straight Baselines.*

**Cardinal Points.**—North, south, east, west.

**Case or Controversy.**—Stems from the provision in Art. III, sec. 2, of the Constitution, which limits the scope of federal judicial power to "cases" and "controversies." Interpreted to mean that there must be a bona fide dispute between opposing parties before a Federal court will accept the dispute for adjudication. "Cases" have been held to be broader in scope and to apply to civil and criminal suits, whereas "controversies" are confined to civil suits only.

**Catalog of Nautical Charts.**—Lists nautical charts, auxiliary maps, and related publications of the Coast Survey and includes references to publications of other federal agencies. This is supplemented monthly by a revised list of charts titled "Dates of Latest Editions," which brings the user's attention to new charts, new editions, and discontinued charts.

**Central Meridian.**—The meridian in a polyconic projection that is central to the survey sheet and about which the projection is constructed. It is represented by a straight line and distances on it are true to scale. See *Polyconic Projection.*

**Certified Copy.**—A copy of a document or record, signed and certified as a true copy by the officer in whose custody the original is entrusted.

**Certify.**—To testify in writing; to make known or establish as a fact. See *Certified Copy.*

**Certiorari.**—A writ or order by an appellate court which directs a lower court to send up the record of a pending cause for review. See *Writ of Error.*

**Chain.**—The legal unit of linear measure for the survey of the public lands of the United States, and all measurements are made in miles, chains, and links. A chain equals 100 links, or 66 feet, and 80 chains equals 1 statute mile, or 5,280 feet. All areas are expressed in acres, an acre being equal to 10 square chains.

**Chamizal Arbitration.**—An arbitration between the United States and Mexico in 1910 over the movement southward of the Rio Grande into Mexican territory. The question was whether the river boundary under the treaties of 1848 and 1853 was a fixed or a shifting one. The International Boundary Commission held it to be a shifting one because the subsequent conduct of the parties and their formal conventions were "wholly incompatible with the existence of a fixed line boundary." See *Fixed Riparian Boundary.*

**Chart Classification.**—Categories of charts based on scale and special purpose.

**Chart Datum** (also called Sounding Datum).—The tidal datum used on nautical charts for referencing the soundings (depth units). See *Tidal Datums.*

**Checks and Balances.**—A term applied to the American tripartite system by which each branch of government exercises a certain restraint on the other two. The veto power of the President and the power of Congress to override a veto, and the power of the Supreme Court to hold unconstitutional acts of Congress and acts of the President are examples of how this system works in practice. See *Tripartite System.*

**Chronometer.**—A portable timekeeper with compensated balance, capable of showing time with extreme precision and accuracy.

**Chronometric Method.**—A method of determining longitude by transporting chronometers between stations whose difference in longitude was to be determined.

**Circuit Closure** (Leveling).—The amount by which the algebraic sum of the measured differences of elevation around a circuit fails to equal the theoretical closure, zero.

**Civil Law.**—The system of law that is based upon statutes and upon written codes, and has for its antecedents the Roman law, particularly the Justinian Code. It is distinguished from the common, or unwritten, law which is based upon judicial decisions and precedent. See *Common Law*.

**Clarke Spheroid of 1866.**—The spheroid used in the Bureau's work since February 1880. The semimajor axis=6,378,206.4 meters, the semiminor axis=6,356,583.8 meters, and the ellipticity=1/294.98. See *Bessel Spheroid of 1841*.

**Closed Bay.**—*See* Volume One, Appendix A.

**Closing Errors** (Leveling).—See *Circuit Closure* (Leveling).

**Closing Line.**—*See* Volume One, Appendix A.

**Coast.**—The zone of land of indefinite width (perhaps 1 to 3 miles) that extends inland from the shore to the first major change in terrain features (*see* fig. 86).

**Coastal Engineering.**—That part of engineering dealing with harbor improvement, channel development and maintenance, or shore protection.

**Coast and Geodetic Survey.**—A Bureau of the U.S. Department of Commerce created under the Act of Feb. 10, 1807, as "Survey of the Coast" which in 1845 became known as "Coast Survey" and which name was changed to "Coast and Geodetic Survey" by the Act of June 20, 1878. In this publication, the words "Bureau," "Survey," and "Coast Survey" are used interchangeably with "Coast and Geodetic Survey."

**Coast Chart No. 33** (issue of 1877).—The Coast Survey chart on which the arbitrators of 1877 laid down the boundary between Maryland and Virginia in accordance with their findings (*see* fig. 102).

**Coast Charts.**—Charts of scales 1:50,000 to 1:100,000 for inshore navigation where the course may lie inside outlying reefs and shoals, for entering or leaving bays and harbors of considerable width, and for navigating large inland waterways.

**Coastline.**—The line of contact between land and sea. In the Coast Survey, the term is considered to be synonymous with shoreline. See *Coast Line* (according to Public Law 31).

**Coast Line** (according to Public Law 31).—*See* Volume One, Appendix A.

**Coast Pilots.**—Adjuncts to the nautical charts containing information of importance to the navigator most of which cannot be shown conveniently on the charts and is not readily available elsewhere. The Coast Pilots of the Coast and Geodetic Survey comprise 8 volumes and cover the coasts of continental United States, Hawaii, the Virgin Islands, and Puerto Rico.

**Coasts.**—Usage in Act of Feb. 10, 1807, in a very broad sense to cover both land and water areas. Modern usage confines the term "coast" to a zone of land of indefinite width (perhaps 1 to 3 miles) bordering the sea; the land that extends inland from the shore. See *Act of Feb. 10, 1807*.

**Coast Survey.**—See *Coast and Geodetic Survey*.

**Coast Survey Polyconic Projection.**—Same as *Polyconic Projection*.

**Code Napoleon.**—A civil code of France, founded on the Roman law, prepared for Napoleon in 1804. Much of the civil-law system adopted by Louisiana is based on this code. See *Justinian Code*.

**Commerce Clause.**—Art. I, sec. 8, cl. 3 of the Constitution, which empowers Congress "To regulate Commerce with foreign Nations, and among the several States, and with the Indian Tribes."

**Committee of Twenty.**—A committee appointed in 1857 by the American Association for the Advancement of Science to examine into the character and progress of the Coast Survey. In 1858, the committee, consisting of leading scientists and educators, published its report entitled, "Report on the History and Progress of the American Coast Survey," in which it was highly laudatory of the management, progress, and outstanding achievements of the Survey.

**Common Law.**—The body of judicial decisions developed in England and based upon immemorial usage. It is unwritten law as opposed to statute, or written, law. The English common law forms the foundation for the system of law in the United States. See *Civil Law.*

**Compact of 1834.**—A compact between New York and New Jersey which invested the State of New York with an extraterritorial jurisdiction over all the waters of the "bay of New York."

**Comparison of Simultaneous Observations.**—A reduction process in which a short series of tide observations at a place is compared with simultaneous observations at a control tide station where tidal constants have been determined previously from a long series of observations. See *Control Tide Station, Short-Series Tide Station.*

**"Comprehending All Islands Within Twenty Leagues of Any Part of the Shores of the United States".**—A phrase used in the Treaty of 1783 with Great Britain which has been interpreted by the Supreme Court as not intended to establish United States territorial jurisdiction over all waters lying within 20 leagues of the shore.

**Concurrent Powers.**—Those powers of the National Government that are exercisable by the states in the absence of federal action, or with congressional consent. Such powers are not concurrent in the sense of equal power with the Nation; they are subordinate to the superior authority and are superseded whenever the power of Congress is exercised. State regulation of pilotage is an example of a concurrent power.

**Conformal Projection.**—A class of map projections in which the property of correct shape is preserved for geographical features, rather than correct size. The exact condition for conformality is that the scale at any point is the same in all directions; the scale may change from point to point, but at each point it is independent of the azimuth. Projections of this type are the Mercator, the transverse Mercator, and the Lambert conformal conic, the latter two being used in the State Coordinate Systems. See *Equal-Area Projection.*

**Conical Projections.**—Projections that use the cone as the developable surface for determining their elements. See *Developable Surface.*

**Constitutional Courts.**—Courts which share in the exercise of the judicial power defined in Art. III of the Constitution, and their judges are appointed for life or good behavior and can only be removed by the impeachment process. See *Legislative Courts.*

**Conterminous United States.**—The 48 States and the District of Columbia; all of the States exclusive of Alaska and Hawaii. They have common boundaries and are not separated by foreign territory or the high seas. See *Continental United States, United States.*

**Contiguous Zone.**—In international law, an area of the high seas outside and adjacent to the territorial sea of a country but not beyond 12 miles from the baseline from which the breadth of the territorial sea is measured. See *High Seas.*

**Continental Shelf.**—*See* Volume One, Appendix A.

**Continental Slope.**—*See* Volume One, Appendix A.

**Continental Terrace.**—*See* Volume One, Appendix A.

**Continental United States.**—Includes conterminous United States plus Alaska. See *Conterminous United States.*

**Contour.**—An imaginary line on the ground all points of which are at the same elevation above a specified datum surface. See *Depth Contours.*

**Control Tide Station** (formerly called Primary Tide Station).—A place at which continuous tide observations have been taken or are to be taken over a number of years to obtain basic tidal data for the locality (*see* fig. 19).

**Conventional Signs** (1911).—Promulgated by the U.S. Geographic Board; the first complete set of topographic and hydrographic symbols to be published by a government agency. See *Standard Symbols* (1928).

**Conventional Symbols.**—A system of conventions in which the character of every line and every symbol on a survey, map, or chart conveys a definite meaning. See *Earliest Published Conventional Symbols.*

**Conventional Symbols** (1860).—A pamphlet titled "Rules for Representing Certain Topographical and Hydrographical Features on the Maps and Charts of the United States Coast Survey" (*see* figs. 47 and 48).

**Convention on the Territorial Sea and the Contiguous Zone.**—*See* Volume One, Appendix A.

**Conventions on the Law of the Sea.**—The four conventions adopted at Geneva in 1958, at the United Nations Conference on the Law of the Sea. As of Mar. 9, 1964, the number of nations that had ratified or acceded to the various conventions was as follows: Convention on the Territorial Sea and the Contiguous Zone—21 nations; Convention on the Continental Shelf—21 nations; Convention on the High Seas—27 nations; and Convention on Fishing and Conservation of the Living Resources of the High Seas—14 nations. See *Optional Protocol of Signature.*

**Corrected Establishment of the Port** (also called High-Water Lunitidal Interval).—The time interval between the moon's meridian passage (upper or lower) and the following high water.

**Correction Date** (also called Hand-Correction Date).—The date printed in the lower left-hand margin on Intracoastal Waterway and Small-Craft charts, or as hand-stamped in the lower right-hand margin of standard charts. It gives the number and date of the Notice to Mariners through which the chart has been corrected by hand for changes in aids to navigation, newly discovered dangers, and important changes in channel depths. See *Notice to Mariners.*

**Correction Factor.**—A factor to be applied to measured distances on a survey sheet to take into account distortion. It is the difference between the true value on the earth and the value on the survey sheet divided by the survey value. See *Distortion of Medium.*

**Cosa Chart of 1500.**—The earliest map now extant which shows the American coast. Drawn on oxhide and in bright colors and purports to cover the entire world (*see* fig. 66).

**Cosa, Juan de la.**—Master of the flagship on the first voyage of Columbus and cartographer on the second voyage. See *Cosa Chart of 1500.*

**County of Virginia.**—That portion of the original limits of the District of Columbia on the west side of the Potomac River which Virginia ceded to the Federal Government on Dec 3, 1789 and was receded to Virginia on Sept. 7, 1846. See *Original Limits of District of Columbia.*

**County of Washington.**—That portion of the original limits of the District of Columbia lying on the east side of the Potomac River which Maryland ceded to the Federal Government on Dec. 23, 1788. See *Original Limits of District of Columbia.*

**Course.**—See *Courses and Distances.*

**Courses and Distances.**—A method of describing land; mathematical descriptions of boundary lines indicating their direction and length. A course is the direction or bearing of a line with reference to the true or magnetic meridian. See *Magnetic Meridian, True Meridian.*

**Court of Claims.**—Originally established in 1855 as a special tribunal to investigate claims against the Government and report its findings to Congress. Subsequent acts of Congress have given it the status of a court of special jurisdiction with power to hear all claims against the United States except those in the nature of tort actions. In 1953, Congress established it as a constitutional court. See *Constitutional Courts.*

**Cross Lines.**—Sounding lines that cross the main system of lines at either right angles or at an oblique angle to serve as a check on the accuracy of the work. When all soundings are reduced to the same plane of reference, the soundings on one system of lines must agree, within certain limits, with the soundings which they cross on the other system of lines.

**Curvature of the Coast.**—*See* Volume One, Appendix A.

**Cylindrical Projections.**—Projections that use the cylinder as the developable surface for determining their elements. See *Developable Surface.*

## D

**Daily Sea Level.**—Sea level derived from tidal observations extending over a period of 1 day. See *Mean Sea Level.*

**Datum.**—A reference point, line, or plane used as a basis for measurements. For a group of statistical references, the plural form is *data,* as geographic data for a list of latitudes and longitudes, but where the concept is geometrical, rather than statistical, the plural form is *datums,* as two geographic datums. See *Datum Plane, Geographic Datum.*

**Datum Correction.**—The correction (in latitude and longitude) that must be applied to the projection lines on a survey sheet or chart to bring it to a different datum. See *Distortion Factor.*

**Datum Plane.**—*See* Volume One, Appendix A.

**Day Letters.**—Letters or combination of letters, in alphabetical order, assigned each day's work, starting with the letter *A* or *a* on each hydrographic survey, and using capital letters for identifying the major survey vessel of the party and lower-case letters for the supplementary launches, a different color being assigned to each separate unit. The letters in their distinctive colors are carried in the sounding records and on the smooth sheet. See *Position Numbers, Identification Letters and Numbers.*

**Dead Reckoning.**—A method of navigation that has been used in hydrographic surveying to control the position of the survey ship beyond the range of control stations, and to supplement astronomic observations. The position is determined by applying the ship's run to the last well-determined position, using the course steered and the distance traveled by log. See *Precise Dead Reckoning.*

**Decisions of the United States Geographic Board.**—Printed quarterly. At long intervals, all decisions of the board since its establishment are published complete in one consecutive alphabetical list. See *Sixth Report of the United States Geographic Board (1933).*

**Deed.**—An instrument in writing and under seal used for transferring land from one owner to another, an essential requirement of which is that the land be fully described in order that it may be properly identified. See *Seal.*

**Deflection of the Vertical** (also called Plumb-Line Deflection and Station Error).—The difference between the observed and computed positions corresponding to the astronomic and geodetic values of a point.

**Delegated, Limited, Enumerated Powers.**—Those powers which the States chose to surrender when the Federal Government was formed and the Constitution adopted. Does not apply to powers of external sovereignty which do not depend upon the affirmative grants of the Constitution. See *National External Sovereignty.*

**Delimitation of Boundary Line.**—The definition of a boundary line as given in treaties and statutes and generally involves problems of interpretation before the line can be laid down on a map or chart. See *Demarcation of Boundary Line.*

**Demarcation of Boundary Line.**—The actual marking of the boundary line on the ground or the marking of reference points tied in to points on the boundary line by measured directions and distances. See *Delimitation of Boundary Line.*

**Demarcation of District of Columbia–Virginia Boundary Line.**—Surveyed and mapped by the Coast and Geodetic Survey, pursuant to Act of Oct. 31, 1945, using a combination of geodetic and photogrammetric methods. Boundary witness monuments were established at 15 points, on the fast land near the water's edge, by second-order triangulation and traverse, the elevation of each monument above mean high water being determined from existing Survey bench marks, and a distance and direction taken to the mean high-water mark as determined by spirit leveling.

**De Novo.**—*See* Volume One, Appendix A.

**Department of Commerce.**—Designation as of Mar. 4, 1913, when the Department of Labor was created. Coast Survey remained in Commerce. See *Department of Commerce and Labor.*

**Department of Commerce and Labor.**—Created under Act of Feb. 14, 1903, and Coast Survey transferred to it from Treasury Department on July 1, 1903. See *Department of Commerce.*

**Depth Contour Navigation.**—A method of position determination by utilizing the depth contours on the nautical chart. Consists in fitting a series of observed echo soundings to the depth contours by recording a number of soundings and simultaneous log distances and plotting them on a strip of transparent paper at the scale of the chart. The line of soundings is fitted to the depth contours by moving it so that it remains parallel to the true course steered. See *Depth Contours.*

**Depth Contours.**—Depth curves whose delineation on hydrographic surveys is based on intensive development, as exemplified by modern echo-sounding surveys. See *Depth Curves.*

**Depth Curves.**—Curves of equal depth, every point of which is at the same depth below the sounding datum (*see* fig. 56). They are shown on hydrographic surveys and nautical charts for the purpose of bringing clearly to the eye the general configuration of the bottom, and for emphasizing important navigational features, such as shoals and channels. Depth curves are comparable to land contours and the same principles are followed in their delineation. See *Depth Contours.*

**Depth Curve Symbolization.**—The symbols and colors used to identify curves of various depths on the hydrographic surveys and nautical charts.

**Depth Units.**—The units (fathoms, feet) in which the soundings are plotted on the smooth sheet or on the nautical chart. On the early surveys, two depth units were generally used on one survey, but with no uniform dividing line (*see* Registers Nos. H–1 (1837) and H–336 (1852)). Modern practice is to use one depth unit only, feet or fathoms, or the combined form of fathoms and feet to 11 fathoms on nautical charts, the foot part of the sounding being shown as a subscript.

**Dereliction.**—Same as *Reliction.*

**Descriptive Call.**—A general or directory call directing attention to the neighborhood where the specific or locative calls may be found. See *Call, Locative Call.*

**Descriptive Report.**—A written report that accompanies every topographic and hydrographic survey for the purpose of supplementing it with information that cannot be shown graphically thereon, and to direct attention to important results. Descriptive Reports were not a standard requirement in the Coast Survey until Apr. 11, 1887.

**Developable Surface.**—A curved surface that can be spread out in a plane without distortion—the cone and the cylinder, for example. See *Nondevelopable Surface.*

**Dictum.**—Same as *Obiter Dictum.*

**Director of the Coast Survey.**—See *Superintendent of the Coast Survey.*

**Discretionary Function Exception.**—One of the exceptions in the Federal Tort Claims Act for which the Government is relieved from liability if the claim is based upon the exercise or performance or the failure to exercise or perform a discretionary function or duty on the part of a federal agency or employee, whether or not the discretion involved is abused. See *Federal Tort Claims Act.*

**Disposition of the Public Domain.**—The power which Congress has under authority of Art. IV, sec. 3, cl. 2, of the Constitution "to dispose of and make all needful Rules and Regulations respecting the Territory or other Property belonging to the United States." This power has been held to be without limitation.

**Distortion Factor.**—A factor that must be applied to every distance that is to be plotted on a survey sheet in order to account for deviation from true scale. It is found by comparing the scaled distances between projection lines on the survey sheet with the corresponding values given in the tables (Special Publication No. 5), and is determined from the relationship: Tabular value minus survey value divided by tabular value. See *Datum Correction, Tables for a Polyconic Projection of Maps, Correction Factor.*

**Distortion of Medium.**—Changes in the dimensions of surveys or charts due to expansion or contraction of the paper on which the survey or chart is drawn or printed which must be accounted for in making quantitative measurements. See *Correction Factor.*

**District of Columbia–Virginia Boundary Commission.**—A commission named for the purpose of surveying and ascertaining the boundary line between the District of Columbia and the State of Virginia, under the Act of the Virginia General Assembly of Mar. 24, 1932, and the Act of Congress of Mar. 21, 1934. The Commission made its report in 1936.

**District of Columbia–Virginia Boundary Line.**—Established by the Act of Oct. 31, 1945, as the mean high-water line along the Virginia shore, except at Alexandria where it follows the established pierhead line; surveyed and marked by the Coast Survey in 1946–1948 (fig. 104). See *Demarcation of District of Columbia–Virginia Boundary Line.*

**Diurnal Inequality.**—*See* Volume One, Appendix A.

**Diurnal Range of Tide.**—See *Range of Tide.*

**Diurnal Tides.**—*See* Volume One, Appendix A.

**Dms.**—The equivalents in meters of the seconds of latitude of triangulation stations; meridional differences (fig. 37). See *Dps.*

**Dock.**—An artificial basin or inclosure, in connection with a harbor, for the reception of vessels; the slip or waterway extending between two piers or projecting wharves, or cut into the land for the reception of ships. See *Wharf, Pier.*

**Doctrine of Precedent.**—Same as *Stare Decisis.*

**Documentary Evidence.**—Evidence supplied by written instruments. Documents are either public or private.

**Dps.**—The equivalents in meters of the seconds of longitude of triangulation stations; parallel differences (fig. 37). See *Dms.*

**Drying Rock.**—*See* Volume One, Appendix A.

**Drying Shoal.**—*See* Volume One, Appendix A.

**Due North.**—May be magnetic north or true north; interpretation depends upon how the surveys in a particular state are referenced. See *True North.*

## E

**Earliest Hydrographic Survey in Bureau Archives.**—A survey of Boston Harbor by the Navy Department in 1817 (Register No. H–1961). See *First Hydrographic Survey.*

**Earliest Instructions for Hydrographic Work.**—The instructions (in manuscript form) issued around 1844. Characterized by their brevity and generality. See *First Published Instructions for Hydrographic Work.*

**Earliest Instructions for Topographic Work.**—Instructions (in manuscript form) issued around 1840 by Ferdinand Hassler, the first Superintendent of the Coast Survey. See *First Planetable Manual.*

**Earliest Published Conventional Symbols.**—Coast Survey symbols published around 1840, and dealt for the most part with bridges, roads, fences, and navigational aids (*see* fig. 46).

**Earliest Rock Symbols.**—The symbols published by the Coast Survey around 1840 (*see* fig. 46).

**Earthquake Bay.**—The bight between Point Loma and Point Fermin on the coast of California, which Kohl described in his hydrographic description of the western coast in 1857. The name was first introduced by the land expedition of Portala. See *Hydrographic Description of Western Coast.*

**Easement.**—A right, in one person, created by grant, or its equivalent, to do certain acts on or over another person's land. See *Servitude.*

**Eastern Adjustment.**—The unified adjustment of the triangulation east of the 98th meridian. See *North American 1927 Datum.*

**Echo Sounding.**—A method of measuring the depth of water by determining the time required for sound waves to travel, at a known velocity, from the survey vessel to the bottom and return.

**Ecliptic.**—The intersection of the plane of the earth's orbit with the celestial sphere.

**Edition Date.**—The date of first publication of a chart, or the date when a new edition is printed. See *New Edition.*

**Egress.**—In the law of riparian rights, the right of access to navigable water which a riparian owner enjoys. See *Ingress, Right of Access.*

**Electronic Position Indicator** (E.P.I.).—A pulse-type arcuate system utilizing the propagation of electromagnetic waves through the atmosphere for controlling offshore hydrographic surveys that were formerly controlled by Radio Acoustic Ranging, astronomic sights, and dead reckoning, and to control surveys beyond the limits of Shoran. Distances to 500 nautical miles can be measured with this system under low static conditions.

**Elevations.**—Heights of natural and artificial objects above an adopted reference plane. On nautical charts of the Coast Survey the elevations of bare rocks, bridges, landmarks, and lights are referenced to the plane of mean high water; contour and summit elevations are referenced to mean sea level, if the source for such information is referenced to this plane. All elevations are in feet.

**Ellipsoid of Revolution.**—See *Oblate Spheroid.*

**Ellipticity of the Spheroid** (also called Flattening of the Earth).—The ratio of the difference between the equatorial ($a$) and polar ($b$) radii of the earth (major and minor semiaxes of the spheroid) and its equatorial radius, or $(a-b)/a$.

**Emerging Shoreline.**—An upwarping of the earth's crust or a lowering of sea level.

**Eminent Domain.**—See *Right of Eminent Domain.*

**Enabling Act.**—As applied to admission of new states into the Union, it is an act passed by Congress empowering the people of a territory to frame a constitution and lay down certain requirements that must be met preliminary to statehood.

**Envelope Line.**—The locus of the center of a circle of fixed radius the circumference of which is always in contact with the baseline. For delimiting the territorial sea, it is a line every point of which is at a distance from the nearest point of the baseline equal to the breadth of the territorial sea (fig. 93). *See also* Volume One, Appendix A.

**Equal-Area Projection.**—A class of map projections in which the property of correct size is preserved for geographical features, rather than correct shape. On an equal-area map, a definite area, such as a square inch, represents a constant area on the sphere, no matter on what part of the map the square inch is located. See *Conformal Projection.*

**Equal Footing.**—See *Equal-Footing Clause.*

**Equal-Footing Clause.**—A clause usually included in the statutes of admission of states entering the Union subsequent to the adoption of the Constitution and provides that the new states are admitted to the Union on an equal footing with the Original States. The clause has been held to refer to political rights and to sovereignty and not designed to wipe out diversities in economic standing. It has nevertheless been held to have a direct effect on certain property rights, as, for example, ownership of the tidelands and the submerged lands under inland navigable waters. See *Inland Water Rule.*

**Equatorial Tides.**—Tides occurring when the moon is on the equator.

**Equidistant Polyconic Projection.**—Referred to in the Annual Report of the Coast Survey for 1853, and probably used for the field sheets of the Survey and perhaps some charts of the early years. By construction, equal meridian distances are intercepted everywhere between the same parallels. Not strictly a polyconic projection, the only similarity to it being the fact that the auxiliary parallels used to develop the meridians are conic developments. See *Polyconic Projection.*

**Eratosthenes.**—Greek astronomer and philosopher and librarian of Alexandria who in 240 B.C. made measurements from which he calculated the size of the earth to be about 28,000 miles in circumference based on the distance from Alexandria to Syene.

**Erosion.**—In riparian law, the gradual and imperceptible washing away of the land along the sea by natural causes. Also applied to the submergence of the land due to encroachment of the waters. See *Riparian Law.*

**Error of Closure.**—The amount by which a value of a quantity obtained by surveying operations fails to agree with another value of the same quantity held fixed from earlier determinations.

**Executive Orders.**—Orders issued by the President to implement the Constitution and the enacted statutes.

**Ex Parte.**—On one side only; by or for one party.

**Expert Witness.**—Witnesses in a cause who testify in regard to some technical or professional matter and who are permitted to give their opinion as to such matter because of their special training, skill, or familiarity with it.

**Exterior Boundaries.**—The seaward boundaries of the zones of the open sea recognized in international law—the territorial sea, the contiguous zone, the continental shelf—and the seaward boundaries of the states recognized under the Submerged Lands Act. See *Open Sea, Seaward Boundaries* (Submerged Lands Act).

**Extreme Low Water.**—As part of the tide note included on the nautical charts, it is the value of the lowest water level observed or estimated for the limits of the chart. It may be based on the lowest water level observed at a tide station over a short period or a long period, or it may be an estimated value based on the best available reports and information. It is not a recognized tidal plane and should not be confused with the lowest tide resulting primarily from astronomic causes. See *Tide Notes.*

## F

**Fair Journal.**—A smooth copy of the original sounding records and the records used to record the angles taken at shore stations—a practice followed on some of the early surveys. Very few of the fair journals are now available.

**Fast Land.**—Land inshore of the inner edge of a marsh; usually at or above the plane of mean high water.

**Fathom.**—A unit of length equal to 6 feet, and used principally as a measure of depth of water.

**Federal Board of Surveys and Maps.**—See *Board of Surveys and Maps.*

**Federalism.**—The division of political power between a central government, with authority over the entire territory of a nation, and the states, or local governments, which individually include only limited portions of the country, but which collectively cover the entire area. See *Federal-State Relationship.*

**Federal Judiciary.**—The federal system of courts provided for in the Constitution and comprising one Supreme Court and a number of inferior courts. The arrangement is hierarchical with the trial courts (district courts) at the base, the intermediate appellate courts (courts of appeals) at the middle, and the final appellate court (Supreme Court) at the top. It is the primary function of the Federal courts to enforce federal law. See *State Judiciaries.*

**Federal Power Commission.**—Created under the Federal Water Power Act of 1920 and authorized to license the construction of dams in navigable waterways under certain specified conditions. See *United States* v. *Appalachian Electric Power Co.*

**Federal-State Relationship.**—The American constitutional system under which the Federal Government is held to be one of limited, delegated, and enumerated powers, with the powers not expressly granted or necessarily implied in the Constitution held to be reserved to the States, or to the people. See *Implied Powers.*

**Federal Tort Claims Act.**—An act passed in 1946 as Title IV of the omnibus Legislative Reorganization Act by which the United States waived its sovereign immunity from suits for injury caused by the negligent act of a federal employee and permitted claims to be brought against it under certain specified conditions. See *Discretionary Function Exception.*

**Ferrel Tide Predicting Machine.**—The first tide predicting machine used by the Coast and Geodetic Survey. It was designed by William Ferrel, a mathematician in the Survey, in 1882, and was used from 1885 to 1911 for the prediction of tides. See *Tide Predicting Machine No. 2.*

**Field Engineers Bulletins, U.S. Coast and Geodetic Survey.**—A series of unofficial bulletins published at irregular intervals between 1930 and 1939 (Vols. 1 to 13), under the auspices of the field engineers of the Survey, for the dissemination of special articles, memoranda, etc., pertaining to the field and office operations of the Survey. See *Journal Coast and Geodetic Survey.*

**Field Examination.**—A report furnished by a field party of the Bureau of an examination of small details (hydrographic or topographic) for which control is available and which can be correlated with the charts. Each examination is assigned a consecutive number, each calendar year beginning a new series.

**Field Position.**—An unadjusted, geographic position of a point on the earth, computed while field work is in progress to determine the acceptability of the observations or to provide a preliminary position for other purposes. See *Adjusted Position.*

**Figure of the Earth** (also called the Geoid).—The surface which coincides with the mean surface of the oceans—the sea level surface—and which is everywhere perpendicular to the direction of the force of gravity. The true figure is quite irregular and no geometric solid exactly fits its shape. See *Spheroid.*

**Filum Acquae.**—Same as *Medium Filum Acquae.*

**Findings of the Special Master.**—*See* Volume One, Appendix A.

**First Control Tide Station** (United States).—Established in 1844 at Governor's Island, N.Y.

**First Geneva Conference.**—The United Nations Conference on the Law of the Sea held at Geneva, Feb. 24 to Apr. 27, 1958. See *Conventions on the Law of the Sea.*

**First Hydrographic Survey.**—A survey of Great South Bay, Long Island, made in 1834 by the Coast Survey (Register No. H–44). See *Earliest Hydrographic Survey in Bureau Archives.*

**First Marine Charts.**—Constructed by Marinus of Tyre during the 2d century.

**First Mercator Chart.**—Chart 52, Montauk Point to New York and Long Island Sound (scale 1:200,000), issued in Oct. 1889, by the Coast Survey.

**First-Order Leveling.**—The most exact method of determining elevations. Lines are run in both directions and the two runnings are such that in a 100-mile circuit the error of closure is on an average about 2 inches. It satisfies the requirements of the International Union of Geodesy and Geophysics for "leveling of high precision."

**First Planetable Manual.**—Published as Appendix 22 to the Annual Report of the Coast Survey for 1865. See *Earliest Instructions for Topographic Work.*

**First Published Chart of the Coast Survey.**—See *Bridgeport Harbor, Conn.*

**First Published Instructions for Hydrographic Work.**—Published around 1860 under the superintendency of A. D. Bache and consisted of 28 printed pages. See *Earliest Instructions for Hydrographic Work.*

**First Topographic Survey.**—A survey of the north shore of Great South Bay, Long Island, from Patchogue to Babylon, made in 1834 (Register No. T–1).

**First Triangulation Work.**—Executed by Ferdinand Hassler in 1816–1817 in the vicinity of New York City (*see* fig. 2).

**Fischer Level.**—An instrument designed in the Coast Survey about 1900 for use in first-order leveling. With but comparatively slight changes this has continued to be the standard instrument since that time (*see* fig. 16).

**Fixed Riparian Boundary.**—A water boundary that remains fixed regardless of changes brought about by erosion or accretion. Two riparian owners with a common water boundary may agree that the boundary as established at a given time shall remain so forever. If the language is unclear, the intent of the parties is deduced from the circumstances surrounding the establishment of the boundary. See *Shifting Riparian Boundary, United States–Canadian Boundary, Chamizal Arbitration.*

**Flats.**—A place covered with water too shallow for navigation with vessels ordinarily used for commercial purposes; the space between high- and low-water marks along the edge of an arm of the sea, a bay, tidal river, etc.

**Flattening of the Earth.**—Same as *Ellipticity of the Spheroid.*

**Florida Purchase.**—The second addition to the territory of the United States. Ceded by Spain in 1819 under a treaty which settled conflicts with Spain in West Florida and defined the boundary between the United States and the Spanish possessions in the Southwest (*see* fig. 96).

**Following the Footsteps of the Surveyor.**—An expression used to indicate true boundaries where lines and corners of a survey have been run and marked, and can be found, and reference is made in the conveyance to such lines.

**"Following the Meanderings of Said River by the Low-Water Mark."**—A basic provision in the Award of the Arbitrators of 1877 in the Maryland–Virginia boundary dispute.

**Foreign Commerce.**—Under the commerce clause of the Constitution, this has been held to apply to transportation necessitating passage through waters not under the jurisdiction of a state, even though both termini of the voyage lie within the borders of that state. See *Commerce Clause.*

**Foreshore** (according to Coastal Engineering).—That part of the shore lying between the crest of the seaward berm (or the upper limit of wave wash at high tide) and the ordinary low-water mark (fig. 86). See *Foreshore* (according to Riparian Law).

**Foreshore** (according to Riparian Law).—The strip of land between the high- and low-water marks that is alternately covered and uncovered by the flow of the tide. See *Foreshore* (according to Coastal Engineering).

**Fractional Scale.**—The scale expressed as a fraction (termed the representative fraction or "R.F." of the map) in which the numerator is unity and the denominator is the number that the unit distance must be multiplied by in order to obtain its distance on the ground in the same units, thus 1/12,000. Also used in the form 1: 12,000 and 1–12,000. Sometimes referred to as natural scale. See *Scale.*

**Fractional Section.**—In the public land surveys, a section containing appreciably less than 640 acres, usually due to the presence of a navigable body of water, or by other land which cannot properly be surveyed or disposed of as part of that section. See *Meander Lines.*

**Freedom of the Seas.**—*See* Volume One, Appendix A.

**Free Seas Doctrine.**—See *Freedom of the Seas.*

## G

**Gadsden Purchase.**—A purchase from Mexico in 1853 to settle a question as to the limits of the Mexican cession of 1848. It lies in the States of Arizona and New Mexico (*see* fig. 96).

**General Charts.**—Charts of scales 1: 100,000 to 1: 600,000 for coastwise navigation outside of outlying reefs and shoals.

**General Coastline of United States.**—Determined by using a unit measure of 30 minutes of latitude (approximately 34.5 statute miles) on charts as near the scale of 1: 1,200,000 as possible. Includes the coastline of bays and sounds to a point where the waters narrow to the width of the unit measure, the distance across at such points being included. (*See* Table 4.)

**General Instructions for Field Work.**—The form of publication used between 1908 and 1928 in which instructions for all field work of the Coast Survey were included and which superseded the separate instructions previously issued, for example, Instructions for Hydrographic Work.

**Geodesy.**—The science which treats mathematically of the figure and size of the earth.

**Geodetic Azimuth.**—An azimuth derived by computation through the triangulation.

**Geodetic Bench Mark.**—See *Bench Mark* (Geodetic).

**Geodetic Datum.**—Same as *Geographic Datum.*

**Geodetic Determination.**—The position of a point on the surface of the earth, with reference to the equator and a principal meridian, that has been computed through the network of triangles from the measured angles and distances by starting from some predetermined position of one of the triangulation stations. See *Astronomic Determination.*

**Geodetic Process.**—The process of referring all the triangulation in an extensive area (to wit, the United States) to the latitude and longitude of a single point whose position on the adopted spheroid of reference has been determined from a consideration of the astronomic and geodetic values of common points in the system. See *Deflection of the Vertical, Standard Geographic Datum.*

**Geodetic Survey.**—A survey that takes into account the shape and size of the earth, as distinguished from a plane survey in which the surface of the earth is considered as a plane. It includes the determination of latitudes and longitudes, and elevations above sea level, of numerous points throughout the country, and involves astronomic observations, measurement of base lines, and measurement of the force and direction of gravity.

**Geodimeter.**—An instrument for measuring distances by the speed of light.

**Geographical Poles.**—The north and south extremities of the earth's axis of rotation.

**Geographic Center.**—For an area on the earth it is the point on which the area would balance if it were a plate of uniform thickness; the center of gravity of the plate. For conterminous United States, it is near Lebanon, Kans., in latitude 39°50′ N., longitude 98°35′ W.; for continental United States (includes Alaska), it is in Butte County, S. Dak., in latitude 44°59′ N., longitude 103°38′ W.; and for the United States (includes Alaska and Hawaii), it is in Butte County, S. Dak., in latitude 44°58′ N., longitude 103°46′ W.

**Geographic Coordinates.**—Data defining the locations of horizontal control stations (triangulation and traverse) in terms of geographic coordinates include their latitudes and longitudes and the lengths and azimuths of the lines between contiguous stations. This system of computations takes into account the earth's curvature.

**Geographic Datum** (also called Horizontal or Geodetic Datum).—The adopted position in latitude and longitude of a single point to which the charted features of a vast region are referred. It consists of five quantities: the latitude and longitude of the point, the azimuth of a line from this point to another point to which it is tied by the triangulation, and two constants necessary to define the terrestrial spheroid See *Clarke Spheroid of 1866.*

**Geographic Dictionary of Alaska.**—One of the earlier Coast Survey studies of geographic names, by Wm. Dall and Marcus Baker, begun in 1873, and completed by Baker in 1901 while in the Geological Survey. Adopted by Board on Geographic Names and reissued as a second edition in 1906.

**Geographic Middle of a River.**—See *Medium Filum Acquae.*

**Geographic Mile.**—Same as *Nautical Mile.*

**Geographic Position.**—The position of a point on the surface of the earth expressed in terms of latitude and longitude.

**Geoid.**—Earth-shaped. See *Figure of the Earth.*

**Gibbons v. Ogden** (9 Wheat. 1).—An 1824 case and the first of a long line of decisions that established the power of the United States to regulate interstate commerce free from state infringement. An important question in this case was whether commerce includes navigation. The Supreme Court answered this in the affirmative, saying: "The mind can scarcely conceive a system for regulating commerce between nations, which shall exclude all laws concerning navigation." See *Commerce Clause.*

**Gnomonic Chart.**—A chart constructed on the gnomonic projection and often used as an adjunct for transferring a great circle to a Mercator chart. See *Gnomonic Projection.*

**Gnomonic Projection.**—A perspective map projection on a plane tangent to the surface of a sphere, the point of projection being at the center of the sphere. Great circles are represented on this projection by straight lines. See *Gnomonic Chart.*

**Gradual and Imperceptible.**—A term used to describe changes in riparian lands that bring them within the scope of the doctrine of accretion and erosion. The test of what is gradual and imperceptible has been held to be that "Though the witnesses may see, from time to time, that progress has been made, they could not perceive it while the progress was going on." See *Riparian Lands, Accretion, Erosion.*

**Grand Tides.**—Same as *Tropic Tides.*

**Grantee.**—The one to whom a grant is made.

**Graphic Method.**—A method of applying a datum correction to a survey sheet under certain conditions by means of the *dms* and *dps.* of several triangulation stations (fig. 37). See *Numerical Method, Dms., Dps.*

**Graphic Scale** (also called Linear Scale).—A line or bar on a map or chart subdivided to represent distances on the earth in various units, to wit: Nautical miles, statute miles, yards, feet, kilometers, etc.

**Great Circle** (also called Orthodromic Curve).—The shortest distance between two points on the surface of the earth. A curved line on the Mercator projection (*see* fig. 87).

**Great Diurnal Range** (Tidal).—Same as *Diurnal Range of Tide.*

**Greatest Ocean Depth.**—See *Mariana Trench.*

**Greenwich Meridian.**—The meridian of the Royal Observatory, Greenwich, England. Adopted in 1884 by a conference of nations, called by the President of the United States, as the initial or zero of longitudes for all nations.

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**Grid Azimuth.**—The azimuth of a line in a plane rectangular coordinate system. In the State Coordinate Systems, grid azimuth is reckoned from south (0°) clockwise through 360°. See *Azimuth, State Coordinate Systems.*

**Guano Act.**—The Act of Aug. 18, 1856, under which blanket authority was granted to the President to proclaim the "appurtenancy" to the United States of certain guano islands. See *Guano Islands.*

**Guano Islands.**—Islands scattered over the Pacific Ocean and Caribbean Sea, having deposits of guano suitable for use as fertilizer, which under the Guano Act could be taken possession of and occupied at the discretion of the President and be considered as appertaining to the United States, if not occupied by citizens of, or under the lawful jurisdiction of, any other government. See *Guano Act.*

**Guide Meridians.**—See *Twenty-Four-Mile Tracts.*

**Gulf.**—A tract of water within an indentation or curve of the coastline, in size between a bay and a sea—the Gulf of California, for example. See *Ocean Nomenclature.*

**Gulf Stream.**—An ocean current forming a part of the general circulatory system of the North Atlantic Ocean.

## H

**Hague Conference of 1930 for the Codification of International Law.**—*See* Volume One, Appendix A.

**Half-Tide Level** (also called Mean Tide Level).—A tidal datum midway between mean high water and mean low water.

**Hand-Correction Date.**—Same as *Correction Date.*

**Handlead and Line.**—Same as *Leadline.*

**Harbor Charts.**—Charts of scales larger than 1:50,000 for navigation in harbors, anchorage areas, and the smaller waterways.

**Harbor Line.**—The line beyond which wharves and other structures cannot be extended. See *Bulkhead Line, Pierhead Line.*

**Harmonic Analysis.**—The mathematical process by which the observed tide at a place is analyzed by breaking it down into a number of constituent tides of simple periodic forces, each having a fixed period. In this process, the sun and moon are replaced by a number of hypothetical tide-producing bodies which move in circular orbits around the earth in the plane of the equator. See *Harmonic Constituent, Harmonic Constant.*

**Harmonic Constant.**—The amplitude and epoch (the time, in angular measure, between the meridian passage of a hypothetical tide-producing body and the high water of its tide) of a harmonic constituent of the tide. See *Harmonic Constituent, Harmonic Analysis.*

**Harmonic Constituent.**—One of the harmonic elements in a mathematical expression for the tide-producing force and in corresponding formulas for the tide, each constituent representing a periodic change or variation in the relative positions of the earth, sun, and moon. See *Harmonic Analysis.*

**Harmonic Method** (Tidal).—See *Harmonic Analysis.*

**Harmonic Tide Plane.**—Same as *Indian Tide Plane.*

**Hassler, Ferdinand Rudolph.**—A Swiss geodesist and scientist of outstanding reputation who immigrated to the United States in 1805 and whose plan for a survey of the coast was accepted by President Jefferson. He later became the first Superintendent of the Survey (*see* Frontispiece).

**Hawaiian Archipelago.**—Includes all the islands of the Hawaiian group between Hawaii and Kure Island (*see* fig. 95). It does not include Palmyra Island, Johnston Island, Sand Island, and Kingman Reef. See *Territory of Hawaii.*

**Headland.**—*See* Volume One, Appendix A.

**Headland-to-Headland Line.**—The line which joins the termini at the outer headlands of an indentation of the coast that has been determined to be inland waters by the semicircular rule or on historic grounds. It marks the seaward limit of inland waters. See *Termini at Headlands, Semicircular Rule, Historic Bay.*

**High- and Low-Water Records.**—Tabulation of the times and heights of high and low waters as scaled from the tide roll at a control tide station. They provide basic data on time and height relationships including ranges, diurnal inequalities, high- and low-water datum planes, half-tide level, and mean and extreme heights. See *Control Tide Station, Tide Roll.*

**Higher Low Water.**—The higher of the two low waters of a tidal day where the tide is of the semidiurnal or mixed type. See *Lower Low Water.*

**High Seas.**—The open sea beyond and adjacent to the territorial sea, which is subject to the exclusive jurisdiction of no one nation. Littoral nations frequently exercise limited jurisdiction over portions of the high seas adjacent to their coasts for purposes of enforcing customs and other regulations. The Geneva Convention on the High Seas defines it as "all parts of the sea that are not included in the territorial sea or in the internal waters of a State." See *Territorial Sea.*

**High Water.**—The maximum height reached by a rising tide. This may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions.

**High-Water Line.**—A generalized term associated with the tidal plane of high water but not with a specific phase of high water, such as higher high water, lower high water. See *Mean High-Water Line, Mean High Water.*

**High-Water Lunitidal Interval.**—Same as *Corrected Establishment of the Port.*

**Hipparchus.**—Astronomer and mathematician who lived in the 2d century B.C. and who is credited with having invented the trigonometry and with having devised the method of dividing the earth by a system of parallels and meridians. See *Parallels, Meridians.*

**Historic Bay.**—*See* Volume One, Appendix A.

**History of Cartographic Work.**—Same as *History Sheet.*

**History Sheet** (also called History of Cartographic Work).—A record of the original compilation and subsequent corrections of every chart published by the Coast Survey. Preserves, in compact form, every detail and authority used on the chart together with the date when a correction was applied.

**Horizontal Curves.**—Same as *Depth Curves.*

**Horizontal Datum.**—See *Geographic Datum.*

**Horrebow-Talcott Method.**—A precise method of determining astronomic latitude by measuring the difference of the meridional zenith distances of two stars of known declination, one north and the other south of the zenith. Devised by Peter Horrebow in 1732 and independently by Captain Andrew Talcott of the U.S. Engineers in 1834.

**Hourly Height Records.**—Tabulations of the hourly heights of the tide as scaled from the tide roll at a control tide station. They provide data for computing mean sea level, for computing harmonic constants used in the prediction of tides, and for a compact and condensed file record for future reference and reproduction. See *Control Tide Station, Tide Roll.*

**"H" Sheets.**—See *Registry Numbers.*
heights of predicted tides. See *Tidal Datums.*

**Hydrographic Datum.**—A datum used for referencing depths of water or the

**Hydrographic Description of Western Coast.**—Prepared by Kohl in 1857 and describes the coast as the early explorers saw it, with special reference to the names they applied to the different features. There are 695 geographic names in this work among which is the name "Bahia de los Temblores" (Earthquake Bay). See *Kohl (Dr. John George), Earthquake Bay.*

**Hydrographic Manuals.**—The form of publication used since 1928 for instructions for hydrographic work. Three such manuals have been issued to date—in 1928, in 1942, and in 1960. See *General Instructions for Field Work.*

**Hydrographic Survey** (Coast and Geodetic Survey).—A record of a survey, *of a given date,* of a water area, with particular reference to the submarine relief which is shown by means of soundings (depth units) and depth contours. It is the authority for all data below the plane of high water, including the names of hydrographic features (fig. 56). See *Smooth Sheet.*

**Hydrographic Surveying.**—As used in the Coast Survey, it is the process of developing upon a survey sheet all that portion of the earth's surface which lies beneath the water, including a delineation of the submerged contour lines of channels, banks, and shoals, and a collection of bottom specimens and water samples. It also includes that part of physical hydrography which takes into account tide and current phenomena, and in modern surveys embraces temperature and salinity characteristics of the water insofar as they relate to the accurate measurement of depth by echo sounding.

**Hypsograph.**—A circular instrument of the slide-rule type used to compute elevations from vertical angles and horizontal distances. Commonly used in planetable surveys.

## I

**Ibid.**—Abbreviation for *ibidem,* a Latin term meaning "in the same place," "in the same book," "on the same page," etc. As used in this publication, it indicates an immediately preceding citation with an identical page reference. See *Id.*

**Id.**—Abbreviation for *idem,* a Latin term meaning "the same." As used in this publication, it indicates an immediately preceding work but a different page reference, for example, *Id.* at 25. See *Ibid.*

**Identification Letters and Numbers.**—Letters and numbers (in color) used to identify sounding lines on a hydrographic survey sheet and correspond to those used in the sounding records. See *Position Numbers, Day Letters.*

**Implied Powers.**—Those powers which are derived from the powers expressly granted by the Constitution. They are incidental to these powers or to other implied powers and are not set forth in the Constitution. The Act of Feb. 10, 1807, which authorized a Survey of the Coast, was an exercise of an implied power growing out of the enumerated power of Congress to regulate commerce. See *Commerce Clause.*

**Improved Channels.**—Dredged channels under the jurisdiction of the Corps of Engineers, and maintained to provide an assigned controlling depth. Symbolized on the nautical charts by black, dashed lines to represent the side limits, with the controlling depth and date of ascertainment given together with a tabulation for more detailed information (*see* fig. 80).

**In Banco** (also called In Bank).—A term applied to court proceedings before the full bench.

**Inchoate Title.**—The beginning of a title; one not yet perfected into a legal title. Under the Swamp Lands Act, the legal title was perfected when the lands were identified as swamp lands by the Secretary of the Interior and a patent issued. The legal title, when acquired, then related back to the passage of the act. See *Swamp Lands Act.*

**Incorporated Territory.**—A territory where there is general applicability of the Constitution with respect to the civil and private rights of the inhabitants. See *Unincorporated Territory.*

**Independent Datum.**—A detached system of triangulation based on one or more astronomic determinations of latitude, longitude, and azimuth, but which has not been connected to the standard datum of the continental area. See *United States Standard Datum.*

**In Derogation of the Common Law.**—A statute inconsistent with the common law. See *Statutory Law.*

**Index Maps** (Control Survey Data).—A series of maps each covering 1° of latitude and 2° of longitude, at a scale of 1: 250,000, on which both horizontal and vertical control of the Coast and Geodetic Survey and the Geological Survey are shown. The maps contain all the information necessary for identifying the control stations in an area. When completed they will supersede the separate index maps formerly published by states at a scale of 1: 667,000.

**Index Maps** (Tidal Data).—A series of maps covering each coastal state which shows by symbol and numbered position the localities for which tidal bench-mark data may be obtained (fig. 23). See *Tidal Bench-Mark Data.*

**Indian Claims Commission Act.**—The Act of Aug. 13, 1946, under which Indian claims to land based upon fair and honorable dealings that are not recognized by any existing rule of law or equity may be submitted to the Commission with right of judicial review by the United States Court of Claims.

**Indian Tide Plane** (also called Harmonic Tide Plane).—A plane of reference used for a number of ports in India and used for a time in Puget Sound, Wash., and for all

Alaskan waters except at the mouth of the Yukon River. It corresponded closely to a plane 2 feet below mean lower low water. See *Present Planes of Reference.*

**Indian Towing Co. v. United States** (350 U.S. 61).—A 1955 case and one of the first maritime tort cases to come before the Supreme Court under the Federal Tort Claims Act involving the discretionary function exception of the act. The Court held that the Coast Guard did not have to undertake the lighthouse service, but once it exercised its discretion to operate a light, it was obliged to use due care to make certain the light was kept in good working order. See *Discretionary Function Exception.*

**Indicia of Navigability.**—Indications of navigability, prima facie or otherwise. All tidewater is prima facie navigable. Other indicia are whether a waterway leads from one public terminus to another; and whether a waterway by its depth, width, and location is rendered available for commerce. See *Prima Facie Evidence.*

**Indictment.**—An accusation in writing found and presented by a grand jury, charging that the person named therein has done some act, or been guilty of some omission, which, by law, is a public offense. See *Information.*

**Inferior Call.**—A call lower in the order of precedence for resolving conflicts in land descriptions. A call for course and distance is inferior to a call for a natural monument. See *Call.*

**Inferior Courts.**—Federal courts below the Supreme Court that are established by Congress under Art. III of the Constitution.

**Information.**—An accusation, in the nature of an indictment, presented by a competent public officer on his oath of office. See *Indictment.*

**Infra.**—Below, under. When used in text it refers to matter in a later part of the publication. See *Supra.*

**Infrared Photography.**—*See* Volume One, Appendix A.

**Ingress.**—In the law of riparian rights, the right of return to his land from navigable water which a riparian owner enjoys. See *Egress.*

**Initial Point.**—The origin of a system in the rectangular system of surveys of which a principal meridian and a base line constitute the axes for a given area (*see* fig. 97). There are 32 such points in conterminous United States and 5 in Alaska (in 1960). See *Principal Meridian, Base Line* (Public Lands Surveys), *Rectangular System of Surveys.*

**Inland Rules of the Road.**—The rules of navigation that are applicable to the water areas landward of the lines established by the U.S. Coast Guard. See *Rules of the Road Boundary Lines, International Rules of the Road, United States* v. *Newark Meadows Improvement Co., Act of Feb. 19, 1895.*

**Inland Water Rule.**—The doctrine laid down by the Supreme Court that the submerged lands under inland navigable waters and the tidelands belong to the states as an incident of sovereignty. The first was established in the case of *Martin* v. *Waddell,* 16 Pet. 367 (1842) and involved one of the Thirteen Original States, and the second was established in the case of *Pollard's Lessee* v. *Hagan,* 3 How. 212 (1845), and involved one of the subsequently admitted states. See *Tidelands, Equal-Footing Clause.*

**Inland Waters** (according to Sixteenth Census).—A category of waters measured in 1940 by the Bureau of the Census in accordance with adopted rules (*see* Table 2).

**Inland Waters** (also called National Waters, Interior Waters, and Internal Waters).—*See* Volume One, Appendix A.

**Inlet Migration.**—The lateral movement of an inlet in the direction of the dominant current.

**Inner Edge of Marsh.**—See *Fast Land.*

**In Personam.**—The ordinary proceeding against a particular person, as distinguished from a proceeding against a thing, such as a vessel. See *In Rem.*

**In Praesenti.**—At the present time. The Swamp Lands Act of 1850 is an example of a grant taking effect *in praesenti,* that is, on the date of passage of the act. See *Swamp Lands Act.*

**In Rem.**—A proceeding in admiralty law against the offending vessel, rather than against the owner of the vessel. See *In Personam.*

**Inshore Hydrographic Survey.**—A hydrographic survey of relatively shallow water, immediately adjacent to the shore, executed by launches and small boats using a leadline or sounding pole. On modern surveys a shoal-water echo-sounding instrument is generally used. See *Hydrographic Survey.*

**Insular Possessions.**—Areas subject to the dominion of the United States which do not have state or territorial status. The Virgin Islands and Samoa are existing examples.

**Intercardinal Points.**—Between the cardinal points; northeast, northwest, southeast, southwest. See *Cardinal Points.*

**International Boundary.**—*See* Volume One, Appendix A.

**International Committee on the Nomenclature of Ocean Bottom Features.**—*See* Volume One, Appendix A.

**International Ellipsoid of Reference.**—The spheroid adopted by the International Geodetic and Geophysical Union in 1924 (now the International Union of Geodesy and Geophysics) as the best available figure for the earth as a whole. This was based (with some slight modification) upon an investigation made in 1909 by Hayford—a geodesist in the Coast Survey—using the large triangulation net then existing in the United States, and taking into account the unequal density of the earth's crust. The semimajor axis = 6,378,388 meters, the semiminor axis = 6,356,912 meters, and the ellipticity = 1/297.0 as compared with an ellipticity of 1/296.96 determined by Hayford.

**International Hydrographic Bureau** (IHB).—A body founded in 1921 with the objective of maritime security to be achieved through the standardization of the nautical chart and related publications, the improvement of hydrographic survey practices, and in general the establishment of a close and permanent association among all hydrographic services. The Bureau is located in Monte Carlo, Principality of Monaco.

**International Law Commission.**—*See* Volume One, Appendix A.

**International Nautical Mile.**—See *Nautical Mile.*

**International River.**—A river that separates or passes through several nations between its source and its mouth at the open sea.

**International Rules of the Road.**—The rules of navigation that are applicable to the water areas seaward of the lines established by the U.S. Coast Guard. See *Rules of the*

*Road Boundary Lines, Inland Rules of the Road, United States* v. *Newark Meadows Improvement Co., Act of Feb. 19, 1895.*

**Interstate Compacts.**—Agreements between states authorized by Art. I, sec. 10, cl. 3, of the Constitution, which provides that "No State shall, without the Consent of Congress . . . enter into any Agreement or Compact with another State"; a legal device for adjusting interstate relations and interstate boundaries, the requirement of congressional consent insuring that national interests will not suffer in the process. Compacts betewen the states were a practice that existed even prior to the adoption of the Constitution. See *Maryland–Virginia Compact of 1785.*

**Intracoastal Waterway.**—An inside protected route extending through New Jersey; from Norfolk, Va., to Key West, Fla.; across Florida from St. Lucie Inlet to Fort Myers, Charlotte Harbor, Tampa Bay, and Tarpon Springs; and from Carabelle, Fla., to Brownsville, Tex. See *Intracoastal Waterway Charts.*

**Intracoastal Waterway Charts.**—Charts of scale 1: 40,000 for navigating the Intracoastal Waterway and designed especially for small-boat operators and yachtsmen. See *Intracoastal Waterway.*

**Island Shelf.**—*See* Volume One, Appendix A.

**Isostasy.**—A condition of approximate equilibrium in the outer part of the earth, such that the gravitational effect of masses extending above the surface of the geoid in continental areas is approximately counterbalanced by a deficiency of density in the material beneath those masses, while the effect of deficiency of density in ocean waters is counterbalanced by an excess of density in the material under the oceans.

**Isostatic Compensation.**—See *Isostasy.*

## J

**Journal, Coast and Geodetic Survey.**—A technical publication issued at irregular intervals and containing signed articles, memoranda, notes, etc., to reflect the progress of the Survey and to serve as a medium for the presentation of new methods and new developments in both field and office. The Journal was begun in January 1948 and was continued through October 1957 (Vols. 1 to 7) when it was superseded by the Technical Bulletins series. See *Technical Bulletins U.S. Coast and Geodetic Survey.*

**Judicial Notice.**—The act by which a court, in conducting a trial, or framing its decision, will, of its own motion, take cognizance of certain facts without proof which are regarded as established by common knowledge—the laws of the state, international law, historical events, main geographical features. In *United States* v. *Romaine,* 255 Fed. 253 (1919), it was said a court might properly take judicial notice of the official plats of the Coast and Geodetic Survey, and in the *Borax* case the Supreme Court took judicial notice of the Bureau's definition of mean high water as given in Tidal Datum Planes, Special Publication No. 135. See *Borax Consolidated, Ltd.* v. *Los Angeles.*

**Judicial Process.**—The set of legal principles that courts have developed to govern their decisions. In its broadest concept, it involves the whole field of judicial backgrounds, experiences, and philosophies by which judges interpret the law and determine its meaning when new problems and new situations arise.

**Judicial Review.**—As used in this publication, it is the power of the courts to review decisions of administrative agencies to determine whether an erroneous rule of law was applied, and whether the proceeding in which facts were adjudicated was conducted in a regular manner. See *Administrative Branch.*

**Jus Privatum.**—*See* Volume One, Appendix A.

**Jus Publicum.**—*See* Volume One, Appendix A.

**Justinian Code.**—The body of Roman law as codified by Emperor Justinian in 533 and 534 A.D., and consists of the Institutes, the Digest, and the Code; the basis for much of the present civil-law system. See *Code Napoleon.*

## K

**King Plats.**—A series of 16 maps of the central portion of the City of Washington, surveyed in 1803 at a scale of 1: 2,400 and published at the same scale.

**King's Chambers.**—*See* Volume One, Appendix A.

**Kohl Collection of Early Maps.**—A collection of maps which Kohl brought with him to this country in 1854, relating to the progress of discovery in America, and consisted of a series of portfolios of hand-copies which Kohl made from old geographical and other printed treatises and from manuscripts in European archives and libraries. In 1903, this collection was transferred from the State Department to the Library of Congress. See *Kohl (Dr. John George).*

**Kohl Collection of Maps and Names.**—Part of the study which Kohl undertook for Superintendent Bache, between 1855 and 1857, comprising historic descriptions of the Pacific, Atlantic, and Gulf coasts; and a hydrographic description of the western coast.

**Kohl, Dr. John George.**—A noted ethnographer engaged by Superintendent Bache to trace the succession of discoveries and explorations of the western coast, and to furnish a catalog of the names of headlands, capes, sounds, bays, and harbors, with the authorities.

## L

**Lambert Conformal Conic Projection.**—A conformal map projection of the conical type, on which the meridians are straight lines meeting in a common point outside the limits of the map, and the parallels are concentric arcs of circles having the common point as center. The projection with two standard parallels is the base for the State Coordinate Systems for states whose greatest extent is in an east-west direction. See *State Coordinate Systems.*

**Land Area** (according to Sixteenth Census).—As defined by the Bureau of the Census for measuring the area of the United States, it is land permanently dry, and land temporarily or partially covered by water, such as marshland; streams, sloughs, estuaries, and canals less than one-eighth of a statute mile in width; and lakes, reservoirs, and ponds of less than 40 acres in area (*see* Table 2).

**Land Ordinance of 1785.**—The ordinance under which the first public land surveys were made. This required the surveys to begin "on the river Ohio, at a point that shall be found to be due north from the western termination of a line which has been run as the southern boundary of the state of Pennsylvania." See *Point of Beginning, Rectangular System of Surveys.*

**Land Ownership.**—The right of possession or use and control of the land owned. See *Land Possession.*

**Land Ownership in the United States.**—Refers to the three categories of holdings: federal, state, and private.

**Land Possession.**—A use of the land with or without ownership. See *Land Ownership.*

**Laplace Azimuth.**—A geodetic azimuth derived from an astronomic azimuth to distinguish it from a geodetic azimuth derived by computation through the triangulation.

**Laplace Station.**—A triangulation station at which a Laplace azimuth is determined. At such station both astronomic longitude and astronomic azimuth are determined. See *Laplace Azimuth.*

**Large-Scale** (Survey or Chart).—A relative term, but generally one covering a small area on the ground. In Coast Survey usage, a scale of 1: 80,000 (1 inch on survey or chart= 80,000 inches on the ground) would be the upper limit of such classification. See *Small-Scale.*

**Las Siete Partidas.**—*See* Volume One, Appendix A.

**Latent Ambiguity.**—A hidden ambiguity. Where language used in land conveyances is clear and suggests only a single meaning, but some extrinsic fact creates a need for interpretation or choice between two or more possible meanings. See *Patent Ambiguity.*

**Lateral Boundaries.**—Side boundaries; boundaries between adjacent states extending from shore to their seaward boundaries under Public Law 31; boundaries between adjacent nations through the marginal sea and the contiguous zones. See *Public Law 31.*

**Lateral Ownership.**—The right that the owner of a parcel of land has to occupy and use it to the full extent of his boundaries.

**Lateral System.**—The system of buoyage used for marking the waters of the United States. The position of marks in this system are determined by the general direction taken by the mariner when approaching a harbor, river, estuary, or other waterway from seaward. The right or starboard side of the channel is marked by red, conical-shaped buoys with even numbers, while the left or portside is marked by black, cylindrical-shaped buoys with odd numbers, the numbers for each side increasing from seaward.

**Latitude.**—The distance (angular or linear) north or south on the earth's surface from the equator.

**Latitude Scale.**—The subdivided east and west borders of a Mercator chart into degrees and minutes; a variant of the graphic scale, since a minute of latitude is very nearly equal to a nautical mile. See *Graphic Scale.*

**Leadline.**—A line of sash cord or tiller rope to which a sounding lead is attached, and is used for measuring depths of water. The line is graduated in fathoms and feet, and the bottom of the lead is scooped out to receive tallow or soap for picking up specimens of the bottom while sounding.

**League.**—A measure of distance, varying for different times and for different countries from 2.4 to 4.6 miles. See *Marine League.*

**Ledge.**—A rocky formation connected with and fringing the shore, and generally uncovered at the sounding datum (*see* fig. 62).

**Left Bank** (River).—The bank on the left-hand side as one proceeds downstream. See *Right Bank*.

**Legal Concept of Navigability.**—The doctrine laid down by the Supreme Court in *The Daniel Ball* v. *United States*, 10 Wall. 557 (1871), to wit: "Those rivers must be regarded as public navigable rivers in law which are navigable in fact. And they are navigable in fact when they are used, or are susceptible of being used, in their ordinary condition, as highways for commerce, over which trade and travel are or may be conducted in the customary modes of trade or travel on water." See *United States* v. *Appalachian Electric Power Co.*

**Legislative Courts.**—Courts established under authority implied from provisions other than Art. III of the Constitution. Their functions are always directed toward the execution of one or more of such powers as are prescribed by Congress, independently of Art. III, and their judges hold for such term as Congress may prescribe, whether it be a fixed term of years or during good behavior. See *Constitutional Courts.*

**Legislative History of an Act.**—The history of an act through the legislative body from its inception to its final passage; includes hearings, committee reports, and floor debate. See *Legislative Intent.*

**Legislative Intent.**—When the wording of an act of Congress is subject to more than one interpretation, courts will look to the discussions and debates on the measure for a guide as to which interpretation was intended. See *Legislative History of an Act.*

**Leveling.**—The operation of determining differences of elevation between points on the surface of the earth; the determination of the elevations of points relative to some arbitrary or natural level surface called a datum.

**Leveling Classification.**—Classified as first order and second order according to allowable error of closure. See *First-Order Leveling.*

**Level Net** (also called Survey Net).—Lines of spirit leveling connected together to form a system of loops and circuits extending over an area. See *Spirit Leveling.*

**Limits of Oceans and Seas.**—A publication of the International Hydrographic Bureau (Special Publication No. 23 (1953)) consisting of text material in which the proposed limits of oceans and seas and certain gulfs, bays, and straits are described and shown on three accompanying diagrams for the convenience of national hydrographic offices for use in compiling sailing directions, notices to mariners, etc. (*see* fig. 94).

**Linear Scale.**—Same as *Graphic Scale.*

**Line of Mean High Water.**—Technically, the same as mean high-water line. In the context of the planetable surveys of the Coast and Geodetic Survey, it is the mean high-water line as near as it is possible for the topographer to determine without recourse to leveling. See *Surveyed Line.*

**Line of Ordinary Low Water.**—Same as *Mean Low-Water Line.* See *Ordinary Tides.*

**Lines of Allocation.**—Lines which are sometimes delimited through the high seas for the purpose of allocating lands without conveying sovereignty over the waters. See *United States-Russian Convention Line.*

**Link.**—0.66 foot or 1/100 chain. See *Chain.*

**List of Lights.**—Lists and describes all marine aids to navigation maintained by or under authority of the U.S. Coast Guard. Covers the Atlantic, Gulf, and Pacific coasts, and the Pacific islands in three volumes.

**Littoral.**—*See* Volume One, Appendix A.

**Littus** (or **Litus**) **Maris.**—The seashore.

**Local Mean Sea Level.**—Derived entirely from observations at a local station; the basis for the elevations of tidal bench marks. See *Mean Sea Level.*

**Local Notice to Mariners.**—A circular issued at frequent intervals by Coast Guard districts giving changes and deficiencies in aids to navigation and other information of navigational importance within the particular district. Information of a continuing nature is inserted in the weekly Notice to Mariners. See *Notice to Mariners.*

**Locative Call.**—A specific or particular call exactly locating a point or line. See *Call, Descriptive Call.*

**Longitude.**—The distance (angular or linear) east or west on the earth's surface from the meridian of Greenwich.

**Loran.**—A pulse-type, electronic, navigation system for fixing a vessel's position by measuring the time differences between the arrival times of a pair of radio pulses transmitted from two fixed stations of known geographic position, each time difference establishing a Loran line of position of the hyperbolic type. The intersection of two such lines of position locates the position of the receiving vessel. See *Loran Lines of Position.*

**Loran Lines of Position.**—Two or more charted families of hyperbolic curves for use with the Loran system of navigation, each family being shown in a distinctive color. See *Loran.*

**Louisiana Purchase.**—The territory purchased from France in 1803 (*see* fig. 96). The earliest acquisition of foreign territory by the United States.

**Lower Low Water.**—The lower of the two low waters of any tidal day where the tide is of the semidiurnal or mixed type. The single low water occurring daily during the periods when the tide is diurnal is considered to be a lower low water.

**Lowest Observed Water Level.**—Results from tide and surge, and, strictly speaking, is not a lowest observed *tide.* See *Extreme Low Water.*

**Low-Tide Elevation** (according to Geneva Convention).—A *naturally formed* area of land surrounded by and above water at low tide but submerged at high tide. See *Rock Awash.*

**Low Water.**—The minimum height reached by a falling tide. This may be due solely to the periodic tidal forces or it may have superimposed upon it the effects of prevailing meteorological conditions.

**Low-Water Area.**—The area between the high-water line and the low-water line (the sounding datum for a given area). See *Tidal Datums.*

**Low-Water Datum.**—A datum associated with the tidal plane of low water but not with a specific phase of low water, such as lower low water, higher low water. See *Tidal Datums.*

**Low-Water Line** (Hydrographic Surveys).—The curve of zero depth as established by the sounding datum of the area—mean low water for surveys along the Atlantic and Gulf coasts, and mean lower low water for surveys along the Pacific coast. In the context of tidal boundaries, *see* Volume One, Appendix A.

**Low-Water Line Survey of Louisiana Coast.**—A cooperative undertaking between the Bureau of Land Management, the State of Louisiana, and the Coast and Geodetic Survey, by which the Survey mapped the mean low-water line from aerial photographs coordinated with an accurate tidal datum. See *Map Location.*

**Low-Water Line** (Topographic Surveys).—In the context of the planetable surveys of the Coast Survey, it is the topographer's estimate of the line represented by the plane of reference for the soundings. See *Low-Water Line* (Hydrographic Surveys).

**Low-Water Lunitidal Interval.**—The time interval between the moon's meridian passage (upper or lower) and the following low water.

**Loxodromic Curve.**—Same as *Rhumb Line.*

**Lunar Method.**—A method of determining the longitude of a place from observations on the moon and its position with respect to other astronomic bodies, and from the local time of observation. One of the first methods used by the Coast Survey. The points at which the boundary between the United States and Canada along the 141st meridian crosses the Yukon and Porcupine Rivers were originally determined by lunar methods. See *Yukon Datum.*

**Luttes v. The State of Texas** (324 S.W. 2d 167).—A 1958 decision by the Supreme Court of Texas, interpreting the civil law (Spanish law) concept of seashore—in the light of modern conditions and the need for exact application—as extending to the line of mean higher high tide determined from a 19-year period. *See* Appendix D.

**Luzon Datum.**—The standard datum for the Philippine Islands established in 1911 from observations on Luzon Island, supplemented by theoretical inference and approximate results from other regions.

## M

**Magnetic Bearings.**—Those determined with a magnetic compass and related to the magnetic meridian.

**Magnetic Declination** (also called Variation).—The angle between the true meridian and the magnetic meridian, and is considered east or west according as magnetic north is east or west of true north. See *True Meridian, Magnetic Meridian.*

**Magnetic Meridian.**—The line having the direction of the magnetic needle at a given place; a vertical plane fixed by the direction taken by a perfect compass needle. See *True Meridian.*

**Magnetic Needle.**—The needle of a surveyor's compass.

**Magnetic Pole.**—The place on the earth's surface where the dip is 90°, the horizontal intensity is zero, and a compass does not show direction. The positions of the magnetic poles adopted for the 1960 isogonic charts of the world are: North magnetic pole—74°.9 N., 101°.0 W.; south magnetic pole—67°.1 S., 142°.7 E.

**Mandatory Authority.**—Authority that is binding on courts; imperative authority. Decisions of the United States Supreme Court are mandatory on all inferior Federal courts, and on all state courts in cases involving federal questions. But they are only persuasive authority in state courts on all other matters. See *Persuasive Authority.*

**Manuscript Map.**—The original drawing of a map as compiled or constructed from various data, such as ground surveys, photographs, etc.

**Map.**—A printed reproduction of a compilation resulting from one or more topographic surveys drawn to the scale of the original survey or smaller and on a definite projection. It may include some water area but basically it furnishes information relative to the land area.

**Map Location.**—The location of a point or line on a map rather than its demarcation on the ground. See *Low-Water Line Survey of Louisiana Coast.*

**Map Projection.**—The process by which a portion or all of the curved surface of the earth can be represented on a plane with the least amount of distortion; a systematic drawing of lines representing meridians and parallels on a plane surface, either for the whole earth or some portion of it.

**Marbury v. Madison** (1 Cr. 137).—An 1803 landmark case that established, by judicial interpretation, the great constitutional doctrine of the power of the Supreme Court to declare an act of Congress invalid, if it is repugnant to the Constitution.

**Marginal Sea.**—Same as *Territorial Sea.*

**Mariana Trench.**—A submarine feature in the Western Pacific where the greatest known ocean depth (36,198 feet) is located. See *Mount Everest.*

**Marine Accident File.**—A special file of nautical charts set up in the Coast Survey for use in connection with marine accident cases or wreck investigations. When information of an accident is received, three copies of the appropriate charts in force at the time are placed in this file and retained for a period of 5 years.

**Marine League.**—A measure of distance over the water; equals 3 nautical or geographic miles.

**Marine Mile.**—*See* Volume One, Appendix A.

**Maritime Boundary.**—A water boundary. See *National Boundary, International Boundary.*

**Maritime Tort.**—Civil wrongs committed on navigable waters.

**Marsh.**—A product of the shallow water of lagoons and other sheltered localities, usually resulting from the deposit of sediment on the bottom, which is built up to a point where certain kinds of vegetation can take root.

**Marsh Areas Mostly Flooded at High Water** (also called Grassy Shoals).—Marsh in the early stages of development often found contiguous to a well-defined marsh or outside the high-water line.

**Maryland–Virginia Boundary Dispute.**—A dispute between Maryland and Virginia arising out of the interpretation of the Award of the Arbitrators of 1877, insofar as it pertained to the south bank of the Potomac River between Jones and Smith Points. See *Award of the Arbitrators of 1877.*

**Maryland–Virginia Boundary Line.**—The boundary along the Potomac River as adopted by the Mathews–Nelson survey of 1927 and demarcated on the ground by the Coast Survey in 1929. See *Mathews–Nelson Survey of 1927.*

**Maryland–Virginia Compact of 1785.**—A treaty whereby Maryland, who owned the Potomac River, gave Virginia certain fishing rights in the river in return for free passage of Maryland ships through the lower Chesapeake Bay.

**Mathews–Nelson Survey of 1927.**—The map location of the Maryland–Virginia boundary along the Potomac River as laid down on six charts of the Coast Survey by geologists of both States (demarcated on the ground by the Coast Survey in 1929) in accordance with their interpretation of the Award of 1877. See *Potomac River Compact of 1958.*

**Meades Ranch.**—A triangulation station established in 1891 in central Kansas which was adopted as the basis for the United States Standard Datum. The selection was based on the fact that it was near the center of area of the United States and was common to two great arcs of triangulation extending across the country—one along the 39th parallel and the other along the 98th meridian. See *United States Standard Datum.*

**Meadow.**—The final stage in the upward growth of marsh. It is then dry all the time or substantially all the time.

**Meander Lines.**—Lines run a short distance back from navigable water within a section in order to determine the quantity of land in the fractional section. The meander line is generally not a boundary line.

**Mean Higher High Water.**—*See* Volume One, Appendix A.

**Mean Higher-High-Water Mark.**—The intersection of the tidal plane of mean higher high water with the shore. See *Mean Higher High Water, Luttes* v. *The State of Texas.*

**Mean High Tide.**—Same as *Mean High Water.*

**Mean High Water.**—The average height of the high waters over a 19-year period. All high waters are included in the average where the type of tide is either semidiurnal or mixed. Where the type of tide is predominantly diurnal, only the higher-high-water heights are included in the average on those days when the tide is semidiurnal. *See also* Volume One, Appendix A.

**Mean High-Water Line.**—The intersection of the tidal plane of mean high water with the shore. See *Mean High Water, Shore* (according to Riparian Law).

**Mean High-Water Mark.**—Same as *Mean High-Water Line.*

**Mean Lower Low Water.**—The average height of the lower low waters over a 19-year period. The tidal plane used on the Pacific coast as the datum for soundings on the hydrographic surveys and nautical charts of the Coast and Geodetic Survey. See *Lower Low Water.*

**Mean Lower-Low-Water Line.**—The intersection of the tidal plane of mean lower low water with the shore. See *Mean Lower Low Water, Shore* (according to Riparian Law).

**Mean Low Water.**—The average height of the low waters over a 19-year period. All low-water heights are included in the average where the type of tide is either semidiurnal or mixed. Where the type of tide is predominantly diurnal, only the lower-low-water heights are included in the average on those days when the tide becomes semidiurnal. See *Diurnal Tides, Mixed Tides, Semidiurnal Tides, Nineteen-Year Tidal Cycle.*

**Mean Low-Water Line.**—The intersection of the tidal plane of mean low water with the shore. See *Mean Low Water, Shore* (according to Riparian Law).

**Mean Low Water Springs.**—The average height of low waters occurring at the time of the spring tides; the plane of reference used by the Coast Survey on hydrographic surveys at the Pacific entrance to the Panama Canal. See *Spring Tides.*

**Mean of Selected Lowest Low Waters.**—A plane of reference used for soundings in Puget Sound, Wash., for a period from the late 1870's to 1897 and corresponded to a plane 3.2 feet below the plane of mean lower low water. See *Present Planes of Reference.*

**Mean of the Lowest Low Waters of Each 24 Hours.**—A plane of reference for soundings used on some of the early surveys along the Pacific coast and interpreted to be the same as mean lower low water. See *Mean Lower Low Water.*

**Mean Range of Tide.**—See *Range of Tide.*

**Mean Sea Level.**—The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings. A determination of mean sea level that has been adopted as a standard for heights is called a *sea level datum*. The sea level datum now used for the Coast and Geodetic Survey level net is officially known as the *Sea Level Datum of 1929*, the year referring to the last general adjustment of the net, and is based upon observations taken over a number of years at various tide stations along the coasts of the United States and Canada. *See Nineteen-Year Tidal Cycle.*

**Mean Tide Level.**—Same as *Half-Tide Level.*

**Mean Values.**—In tidal technology, the values obtained from averaging tidal observations at a station over a long period of time, a period of 19 years giving the best value. See *Nineteen-Year Tidal Cycle.*

**Median Line.**—*See* Volume One, Appendix A.

**Medium Filum Acquae** (also called Filum Acquae).—The geographic middle of a river supposed to divide it into two equal parts, without considering the channel or channels of the river. Identical with a median line, every point of which is equidistant from the nearest points of the baseline on the opposite shores. See *Thalweg.*

**Memorandum of Understanding, Mar. 25, 1947.**—A memorandum between the Coast and Geodetic Survey and the Geological Survey whereby the activities of the two agencies would be more closely integrated so as to avoid overlapping and duplication in survey operations, but without any change in the responsibilities of either agency.

**Mercator, Gerhard** (also called Gerhard Krämer).—Flemish mathematician and cartographer who lived in the 16th century and who devised the well-known projection which bears his name. See *Mercator Projection.*

**Mercatorial Bearing.**—The straight-line bearing on a Mercator chart that is obtained by applying a correction to a radio bearing (arc of a great circle) for convergency of the meridians.

**Mercator Projection.**—A conformal map projection upon a plane, in which the latitude and longitude lines are straight parallel lines intersecting each other at right angles, and in which the meridians of longitude are spaced equally throughout the map, based on their distance apart at the equator, and the distances between parallels are derived by a mathematical analysis, their spacing bearing an exact relationship to the spreading of the meridians along a corresponding parallel (fig. 77). See *Rhumb Line, Conformal Projection.*

**Meridian-Arc Method.**—A method of determining the dimensions of the ellipsoid by measuring (by triangulation) the linear distances between three points on a meridian and the angular distances between them from observed differences in their astronomic latitudes.

**Meridian Line.**—A north-south line from which longitudes or azimuths are reckoned. See *Azimuth.*

**Meridians.**—Imaginary planes passing through the poles and measure longitudes east or west of the principal meridian of Greenwich. See *Longitude.*

**Meridional Parts.**—The number of nautical miles by which any given latitude is distant from the equator on a Mercator projection if every degree and minute between them is lengthened proportionately to the spreading of the longitude. *See Mercator Projection.*

**Meter.**—A unit of length in the metric system of measures (a decimal system) and is equal to 39.37 inches in the United States. See *Yard.*

**Metes.**—The exact length of each line of a tract of land. See *Metes and Bounds.*

**Metes and Bounds.**—The boundary lines or limits of a tract of land. One of the oldest methods of describing land and was used to transfer lands in the Thirteen Original Colonies. Defined variously in law dictionaries as: the boundary lines of land with their terminal points and angles; the boundary lines and corners of a piece of land; and the boundary lines of lands with their terminating points or angles.

**Method of Squares.**—A method of transferring one survey to another of different scales (fig. 27). See *Radial-Line Method.*

**Mexican Cession.**—Territory included approximately within the present limits of California, Nevada, Utah, and parts of Colorado, Arizona, and New Mexico, ceded to the United States in 1848 under the Treaty of Guadalupe Hidalgo (fig. 96). See *Treaty of Guadalupe Hidalgo.*

**"Minus" Soundings.**—Soundings that reduced to heights above the sounding datum when corrected for height of tide. On the early surveys they were variously shown as underscored soundings, as minus soundings, and as red soundings. See *Tide Reducer.*

**Mixed Tides.**—*See* Volume One, Appendix A.

**Modes of Acquiring Territory.**—The United States has acquired territory principally by the following three methods: (1) by treaty, (2) by joint resolution of the two Houses of Congress, and (3) by statute.

**Monthly Lowest Low Water Datum.**—The plane determined from the average height of the lowest low waters of each month over a considerable period of time. A datum used when it is desired to have the datum so low that most low waters will be above it.

**Monthly Sea Level.**—Sea level derived from tidal observations extending over a period of 1 month. See *Mean Sea Level.*

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**Monthly, Yearly, and Cumulative Averages.**—Compilations available for each control tide station obtained from the hourly height and high- and low-water records. See *Control Tide Station.*

**Monument.**—For the purpose of deed description, any object or mark on the land which may serve to identify the location of a line constituting a part of the boundary. Objects, to be ranked as monuments, must have certain physical properties such as visibility, permanence and stability, and definite location, independent of measurements.

**Monumented Points.**—Permanently marked points on the ground whose latitudes and longitudes have been determined and which can be used as starting points for all mapping and engineering projects where geographic location is a consideration (*see* fig. 11).

**Moon Culminations.**—A method of determining longitude by observations on the moon at the time it transits the local meridian.

**Moon's Meridian Transit.**—The time the moon crosses the local meridian.

**Moon's Nodes.**—The points where the plane of the moon's orbit intersects the ecliptic. The point where the moon crosses in going from south to north is called the *ascending node,* and the point where the crossing is from north to south is called the *descending node.* References are usually made to the ascending node, which for brevity is called "the node." It takes approximately 18.6 years for the regression of the moon's nodes to complete a circuit of 360° of longitude, or a westward motion of about 19° a year. See *Ecliptic.*

**"More or Less".**—When used in connection with quantity or distance in a conveyance of land are considered words of safety or precaution, intended to cover some slight or unimportant inaccuracy. The same applies to the use of the word "about."

**Mount Everest.**—The highest known elevation (29,028 feet) located in the Himalayas on border between Tibet and Nepal. See *Mariana Trench.*

**Multiple Projection Lines.**—Several systems of latitude and longitude lines appearing on many of the early surveys of the Bureau, resulting from a change in the spheroid of reference, a change in longitude values, or a change in the horizontal datum, which caused a change in the geographic values of control points.

## N

**National Boundary.**—*See* Volume One, Appendix A.

**National External Sovereignty.**—*See* Volume One, Appendix A.

**National Reporter System.**—A series of unofficial reports of decisions of state and Federal courts begun in 1879 and now covers the entire country including a special series for the courts of record of New York (The New York Supplement). The state court decisions (appellate courts and some trial courts) are contained in the regional areas designated as Atlantic, North Eastern, South Eastern, Southern, South Western, North Western, and Pacific, followed in each instance by the word "Reporter." The federal decisions are reported in volumes designated as *Supreme Court Reporter* (for Supreme Court cases), *Federal Reporter* (for courts of appeals cases), and *Federal Supplement* (for district court cases). See *Federal Judiciary.*

**National River.**—A river that is under the sway of one nation.

**Natural Monument.**—A permanent natural object found on the land, such as a river, stream, lake, pond, ledge of rocks, or tree. See *Monument, Artificial Monument.*

**Natural Scale.**—See *Fractional Scale.*

**Nautical Almanac.**—A periodical publication of astronomical statistics useful to and designed primarily for marine navigation, particularly the *American Nautical Almanac,* published by the U.S. Naval Observatory.

**Nautical Chart.**—A printed reproduction of a compilation of data derived from topographic and hydrographic surveys and miscellaneous information for use in marine navigation. The distinction between a survey and a chart is that the first is an original record *of a given date,* whereas the second is a compilation of many surveys *of different dates.* See *Hydrographic Survey, Topographic Survey.*

**Nautical Chart Adjuncts.**—Publications issued by the Government to provide the navigator with information that is not feasible to show on the nautical chart (*see* fig. 89).

**Nautical Chart Manual.**—A manual for the cartographic engineer engaged in the construction and revision of nautical charts. Useful for establishing a charting practice as of a specific time. Several such manuals have been issued by the Coast and Geodetic Survey, the latest being the sixth (1963) edition.

**Nautical Mile** (also called Sea Mile and Geographic Mile).—A unit of distance used in marine navigation, and may be taken as equal to the length of a minute of arc along the equator or a minute of latitude on the map which is being measured. Prior to July 1, 1954, the United States nautical mile was defined as equal to 1/60 of a degree or 1/21,600 of a great circle on a sphere whose surface equals the surface of the earth. Its value calculated for the Clarke spheroid of 1866 was 1,853.248 meters, or 6,080.20 feet. On July 1, 1954, the United States adopted the international nautical mile which is 1,852.0 meters, or 6,076.10333 feet. This value was revised on July 1, 1959, to reflect the new relationship of the yard to the meter, making the new value for the international nautical mile equal to 1,852.0 meters, or 6,076.11549 international feet. See *Yard.*

**Navigability** (American Doctrine).—See *Tidal Test, Navigability Test.*

**Navigability** (English Doctrine).—First pronounced in the case of *The Royal Fishery of the Banne* (circa 1604), in which the court classified rivers as of two kinds—navigable and not navigable—and said: "Every navigable river, so high as the sea flows and ebbs in it, is a royal river . . . but in every other river not navigable . . . the terre [land] tenants on each side have an interest of common right." From this, the inference has been drawn, erroneously, that in England the only rivers that are navigable are those in which the tide ebbs and flows. See *Tidal Test.*

**Navigability Test.**—A test of navigability based upon the actual navigable capacity of a waterway rather than the extent of tidal influence. Enunciated by the Supreme Court in 1851 in *The Genesee Chief* v. *Fitzhugh,* 12 How. 443, in which it expressly overruled its former restrictive decisions based upon the tidal test of navigability. See *Tidal Test, Navigability* (English Doctrine).

**Navigable Airspace.**—Defined in the Federal Aviation Act of 1958 as "airspace above the minimum altitudes of flight prescribed by regulations issued under this Act," and includes "airspace needed to insure safety in take-off and landing of aircraft."

**Navigable Waters.**—Waters which afford a channel for useful commerce. See *Navigable Waters of the United States, Navigable Waters of a State.*

**Navigable Waters of a State.**—Navigable waterways that lie wholly within the limits of a state and have no navigable connection with any navigable waters outside the boundaries of the state. Such intrastate waters are subject to regulation and control by state laws and do not fall within the jurisdiction of Congress nor of the laws enacted by it for the preservation and protection of the navigable waters of the United States. See *Navigable Waters of the United States.*

**Navigable Waters of the United States.**—Waters which form in their ordinary condition by themselves, or by uniting with other waters, a continued highway over which commerce is or may be carried on with other states or foreign countries in the customary modes in which such commerce is conducted by water. This applies also to an artificial canal, as long as it forms a means of communication between ports and places in different states, even though the canal is wholly within the body of a state and subject to its ownership and control. See *Navigable Waters of a State.*

**Neap Tides.**—*See* Volume One, Appendix A.

**Negative Engraving** (also called Scribing).—A chart reproduction process in which the compilation manuscript is photographed on glass negatives and then coated with an emulsion pervious to light so the negative engraver has a facsimile of the manuscript. Both glass and plastic are used in this process.

**New Edition.**—A new printing of an existing chart embodying corrections that have become so extensive or of such importance to navigation as to render all previous printings obsolete, or when there is an accumulation of hand corrections of the order of 80 or more.

**New Print.**—A new issue of a chart embodying only minor corrections. Such corrections are applied to the negatives and a new printing plate made. New prints do not render previous printings of the current edition obsolete. See *New Print Date, New Edition, Hand-Correction Date.*

**New Print Date.**—The date when a new print of a chart is issued which embodies changes or corrections of a relatively minor character. The new print date is added to the right of the edition date in the lower left-hand corner of the chart. See *New Print.*

**Nine-Lens Camera.**—A specially designed aerial mapping camera for coastal photography. It takes a vertical central picture and eight oblique wing pictures, the latter requiring transformation and rectification before being used for mapping (*see* fig. 69). The transformed photographs are assembled to form one composite photograph equivalent to a photograph taken with a single wide angle lens. See *Transformation, Rectification.*

**1929 General Adjustment** (Leveling).—An adjustment of the level net of the United States to obtain the best available elevations for all bench marks so as to avoid excessive rates of correction when fitting new work to work already adjusted. In the adjustment, sea level was held fixed at 21 tide stations in the United States and 5 in Canada, and the miles of levels used were 40,000 in the United States and 20,000 in Canada.

**1927 Special Adjustment** (Leveling).—An adjustment for theoretical purposes in which only the closed circuits of spirit leveling, including water leveling in the Great

Lakes region, were adjusted without any sea-level connections being held fixed. See *1929 General Adjustment.*

**Nineteen-Year Tidal Cycle.**—The period of time generally reckoned as constituting a full tidal cycle because the more important of the periodic tidal variations due to astronomic causes will have passed through complete cycles. The longest cycle to which the tide is subject is due to a slow change in the declination of the moon which covers 18.6 years. See *Mean Low Water, Mean High Water.*

**"No Bottom" Soundings.**—Where the bottom was not reached because the general depths were too great for the method of measurement. A "no bottom" sounding at 20 fathoms meant that the 20-fathom leadline did not reach bottom and was shown on the smooth sheet variously by a line under the 20, by a line under the 20 and a dot under the line, or by a line over the 20 and a small circle over the line.

**Nondevelopable Surface.**—A curved surface that cannot be spread out in a plane without distortion—the sphere, for example. See *Developable Surface.*

**Nonharmonic Method** (Tidal).—An approximate method of tide prediction and is based on the principle that "the tide follows the moon." It makes use of the close relationship that exists between the time of tide at most places and the moon's meridian passage. See *Harmonic Analysis.*

**Normal Baseline.**—*See* Volume One, Appendix A.

**North American Datum.**—The same as United States Standard Datum. The name was changed to North American Datum early in 1913 when Canada and Mexico adopted the United States Standard Datum for their triangulation. This change in name reflected the continental character the datum had now assumed. See *United States Standard Datum.*

**North American 1927 Datum.**—The name to which the North American Datum was changed in 1927 as a result of the unified adjustment of the triangulation in the western half of the country. In the adjustment, the position (latitude and longitude) of station *Meades Ranch* was held fixed but the azimuth to station *Waldo* was reduced by 4.″88, making the present value of 75°28′09.″64. The positions of all other stations in the net were changed by varying amounts. As of 1963, all of conterminous United States and the whole of Alaska—including the offshore islands in the Bering Sea—were connected by one continuous triangulation and placed on the North American 1927 Datum. See *United States Standard Datum, North American Datum.*

**North Atlantic Coast Fisheries Arbitration of 1910.**—See Volume One, Appendix A.

**North Magnetic Pole.**—See *Magnetic Pole.*

**Northwest Ordinance of 1787.**—The ordinance which governed the Territory Northwest of the Ohio River prior to adoption of the Constitution in 1789. The provisions were reenacted on Aug. 7, 1789. See *Territory Northwest of the Ohio River.*

**Northwest Territory.**—See *Territory Northwest of the Ohio River.*

**Notice to Mariners.**—A pamphlet issued weekly by the U.S. Naval Oceanographic Office (formerly Navy Hydrographic Office) and published jointly with the U.S. Coast Guard. It contains material affecting the safety of navigation, such as changes in aids to navigation and channel depths, with which the mariner can bring his charts up to date. See *Local Notice to Mariners.*

**Numbering System for Bureau Publications.**—A system inaugurated Jan. 1, 1957, based on identification of class of subject matter covered. The entire scope of Bureau activities is divided into 13 categories, each category carrying its own range of numbered publications. The word "Special" is no longer used in the designation. General publications of Bureau-wide scope are in the "10" category, Hydrography is in the "20" category, etc. Thus, the designation for *Shore and Sea Boundaries* is "Publication 10–1," which indicates it is the first publication in the "10" category.

**Numerical Method.**—A method of applying a datum correction to a survey sheet from the differences in the numerical values of the geographic positions of triangulation stations on the two datums (fig. 36). See *Datum Correction, Graphic Method.*

**Numerical Scale.**—The scale of a survey (or chart) expressed in terms of the distance on the earth represented by one unit on the survey, e.g., "1 inch equals 20 miles," "3 inches to the mile."

## O

**Obiter Dictum** (also called Dictum).—That which is said in passing. Any statement of the law enunciated by a court merely by way of illustration, argument, analogy, or suggestion, not necessarily involved nor essential to the determination of the case in hand. Lacks the force of an adjudication, and does not fall within the doctrine of stare decisis. See *Stare Decisis.*

**Oblate Spheroid** (also called Ellipsoid of Revolution).—A sphere flattened at the poles and generated by an ellipse revolving about its minor axis; the geometric figure used as a surface of reference for the computation of geodetic surveys. In this spheroid, any section parallel to the equator is a circle, and any section through the poles is an ellipse. The lengths of the degrees of latitude increase from the equator to the poles. See *Prolate Spheroid.*

**Occultation.**—The disappearance of a heavenly body behind another body of larger apparent size. The occultation of a star by the moon furnished a method of determining longitude.

**Ocean.**—One of the greater tracts of water that covers the globe, such as the Atlantic Ocean.

**Ocean Nomenclature.**—The generic names assigned to the water areas of the world. Except for the oceans, there are no exact criteria for defining the secondary features. What is called a "gulf" in one locality may be termed a "sea" in another. In many cases, the nomenclature represents long, historic usage which has not been deemed advisable to disturb. See *Sea, Gulf, Bay* (General).

**Official Document.**—See *Public Document.*

**Offshore Wind.**—A wind blowing from the land toward the sea. See *Onshore Wind.*

**Oklahoma ex. rel. Phillips v. Guy F. Atkinson Co.** (313 U.S. 508).—A 1941 case which further broadened the navigability concept to include the non-navigable upper reaches of an entire watershed for the purpose of flood control and waterway development and the promotion of navigation downstream as constitutional objectives of Congress. Such control now extends to a program for the development of an entire watershed, and not merely to the navigable portions of streams in that watershed. See *Legal Concept of Navigability, United States* v. *Appalachian Electric Power Co.*

**Old Hawaiian Datum.**—The standard datum for the work in the main Hawaiian group between Hawaii and Kaula (*see* fig. 95).

**One-Quarter, One-Tenth Rule.**—A method of graphically determining the height of the tide at any time of the day from information found in the *Tide Tables* (*see* fig. 21).

**Onshore Wind.**—A wind blowing from the sea toward the land. See *Offshore Wind.*

**Open Bay.**—*See* Volume One, Appendix A.

**Open Sea.**—The water area of the open coast seaward of the ordinary low-water mark, or seaward of inland waters.

**Opinions and Award of Arbitrators.**—The findings of the Arbitrators of 1877 in the Maryland–Virginia boundary dispute.

**Opisometer.**—A recording device designed to measure by revolutions of a small wheel continuous linear distances on a map. Used in measuring the length of shoreline by closely following all the indentations and sinuosities of the shore.

**Optional Protocol of Signature.**—*See* Volume One, Appendix A.

**Op. Cit. Supra.**—An abbreviation for *opus citum supra* meaning "in the work cited above." Used when referring to a book previously cited to avoid repeating the full citation.

**Opus Citum Supra.**—See *Op. Cit. Supra.*

**Ordinance of 1641–1647.**—A colonial ordinance of Massachusetts under which title of the owner of land bounded by tidewater extends from high-water mark over the shore or flats to low-water mark, if not beyond 100 rods (1,650 feet) from the high-water mark.

**Ordinary High Water.**—See *Ordinary Tides, Mean High Water.*

**Ordinary High-Water Mark.**—Same as *Mean High-Water Line.* See *Ordinary Tides.*

**Ordinary High-Water Mark** (River).—Along a navigable river above the ebb and flow of the tide, the line to which high water ordinarily reaches, not the line reached in unusual floods nor by the great annual rises of the river.

**Ordinary Low Water.**—See *Ordinary Tides, Mean Low Water.*

**Ordinary Low-Water Mark.**—Same as *Mean Low-Water Line.* See *Ordinary Tides.*

**Ordinary Low-Water Mark** (River).—The usual or ordinary stage of a river when the volume of water is not increased by rains or melted snows nor diminished below such stage by long continued drought.

**Ordinary Polyconic Projection.**—Same as *Polyconic Projection.*

**Ordinary Tides.**—This term is not used in a technical sense by the Coast and Geodetic Survey, but the word "ordinary" when applied to tides may be taken as the equivalent of the word "mean." See *Borax Consolidated, Ltd.* v. *Los Angeles.*

**Oregon Territory Cession.**—The territory now occupied by the States of Idaho, Oregon, and Washington, and parts of Montana and Wyoming ceded by Great Britain in 1846 (*see* fig. 96).

**Organization and Functions of the Coast and Geodetic Survey (1960).**—A realignment of the functions of the Bureau designed to streamline and strengthen its organizational structure in order to meet the needs of modern science and technology (*see* fig. 8).

**Orientation of Planetable.**—Placing the planetable in such position that every line drawn on the survey sheet from the point which represents the position of the table on the ground to any other point on the sheet is parallel to the corresponding line in nature.

**Original Jurisdiction.**—*See* Volume One, Appendix A.

**Original Limits of District of Columbia.**—An area 10 miles square (on both sides of the Potomac River) ceded to the Federal Government by Maryland and Virginia, and the exact boundaries proclaimed by President Washington on Mar. 30, 1791. See *County of Washington, County of Virginia.*

**Original States.**—Same as *Thirteen Original States.*

**Orthodromic Curve.**—Same as *Great Circle.*

**Orthographic Projection.**—A map projection produced by straight parallel lines through points on the sphere and perpendicular to the plane of projection. See *Perspective Projection.*

**Orthometric Correction.**—The correction to elevations which takes into account the spheroidal shape of the earth and brings the elevations to their true height above mean sea level.

**Outer Continental Shelf Lands Act.**—*See* Volume One, Appendix A.

**Outer Edge of Marsh.**—The line delineated on topographic surveys as the dividing line between land and water, rather than the high-water line, for use on nautical charts of the Coast Survey. See *Surveyed Line, Apparent Shoreline.*

**Ovaloid.**—A figure of the earth with the southern hemisphere somewhat larger than the northern.

**Overflowed Lands.**—Lands which are permanently overflowed and will remain so without reclamation or drainage. The term has also been regarded as synonymous with swamp lands.

**Ownership Below the Surface.**—The right which an owner of the surface of land has to the soil or mineral deposits to the center of the earth. This ownership cannot ordinarily be interfered with, but it has also been held that the owner's title does not extend beyond a depth which he can reasonably use.

**Ownership of Airspace.**—See *Ad Coelum Doctrine.*

**Ozalid Prints.**—Photographic contact prints developed by a dry process and have a low distortion percentage. The developed print shows a colored line on a white background.

## P

**Pacific Coast Pilot of 1889.**—*See* Volume One, Appendix A.

**Panama-Colon Datum.**—An independent datum adopted in 1911 for triangulation in the Canal Zone. This work is now tied to the North American 1927 Datum.

**Panchromatic Photography.**—*See* Volume One, Appendix A.

**Pantograph.**—An instrument designed to reduce or enlarge maps or drawings to any desired scale.

**Parallels.**—Imaginary planes passing through the earth parallel to the equator and measure latitudes north or south of the equator.

**Paramount Rights.**—*See* Volume One, Appendix A.

**Parol Testimony.**—Given by word of mouth; oral. See *Statute of Frauds.*

**Patent Ambiguity.**—An ambiguity which appears on the face of the instrument and arises from the use of defective or obscure language. See *Latent Ambiguity.*

**Patent** (Land).—A document that vests in the transferee the complete legal title to the land transferred, or furnishes evidence of the transfer. A patent is necessary to pass a perfect legal title to public lands. Also issued by the state governments to transfer title to state lands.

**Per Curiam Opinion.**—*See* Volume One, Appendix A.

**Perigean Tide.**—Tides of increased range occurring monthly as the result of the moon being in perigee or nearest the earth. The perigean range is larger than the mean range where the type of tide is either semidiurnal or mixed, and is of no practical significance where the type of tide is diurnal.

**Permanent Court of Arbitration.**—*See* Volume One, Appendix A.

**Perspective Projection** (also called Geometric Projection).—A map projection produced by straight lines radiating from a selected point and passing through points on the sphere to the plane of projection (fig. 76). See *Orthographic Projection.*

**Persuasive Authority.**—Authority which may or may not be followed by the courts. A court of one rank is not bound to follow a decision of another court of the same rank. Thus, decisions of the intermediate Federal appellate courts, while binding on all lower Federal courts within its circuit, are only persuasive in other Federal appellate courts and in the lower Federal courts outside its circuit. See *Mandatory Authority.*

**Petitioner** (also called Appellant).—In appellate courts, the person who institutes an appeal. See *Respondent.*

**Petitioner-Plaintiff.**—Where the plaintiff in the lower court is the petitioner or appellant in the appellate court.

**Philippine Rehabilitation Act of 1946.**—The act which continued Coast and Geodetic Survey operations in the islands until June 30, 1950.

**Photogrammetric Survey.**—In Coast Survey usage, a survey of a portion of the land surface utilizing aerial photographs and reduced to map form by stereoscopic or other instrumental equipment. See *Topographic Survey.*

**Photographic Method.**—A method which uses photography as a means of changing the scale of one survey sheet for transfer to another survey or to a chart.

**Photolithography.**—A reproduction process that made possible the use of colors for emphasizing important navigational features on nautical charts—the coloring of buoys to correspond to their colors in the water, the accentuation of lighted aids to navigation by using a color overprint, and the use of tints for the land and the shoal-water areas.

**Photostat.**—A direct photographic process used in the Coast Survey for making copies of original surveys without the use of an intervening film or plate. The normal photostat has a black background with white detail. Photostats are limited in size to 18 by 24 inches and can include only a portion of the average topographic or hydrographic survey. See *Bromide, Positive Photostat.*

**Pier.**—A structure extending from the solid land out into the water to afford convenient passage for persons and property to and from vessels alongside the pier; a projecting wharf. See *Wharf, Dock.*

**Pierhead Line.**—The line fixing the boundaries of the fairway to which wharf or pier structures (of open construction) may be built (fig. 105). See *District of Columbia-Virginia Boundary Line, Bulkhead Line, Harbor Line.*

**Pilot.**—One who directs the movements of a vessel through pilot waters; usually, one who has demonstrated extensive knowledge of channels, aids to navigation, dangers to navigation, etc., in a particular area and is licensed for that area.

**Pilotage** (General).—Pilots at ports are regulated in conformity with the laws of the states as Congress has not legislated other than to indicate an intention to leave such regulations to the states. See *Pilotage* (Great Lakes).

**Pilotage** (Great Lakes).—Placed under federal control by the Great Lakes Pilotage Act of 1960, which is administered by the Secretary of Commerce and delegated to the Great Lakes Pilotage Administration. See *Pilotage* (General).

**Plane of Reference** (also called Sounding Datum).—The vertical plane or tidal datum to which the soundings on a hydrographic survey are reduced; the elevation of the water surface from which the depths on the survey or the nautical chart are reckoned. See *Tidal Datums.*

**Plane Rectangular Coordinates.**—The perpendicular distances (coordinates) of a point from a pair of axes which intersect at right angles, reckoned in the plane defined by those axes. See *State Coordinate Systems.*

**Planetable.**—A surveying instrument used in topographic mapping by which the surveyor plots his survey in the field directly from the observations without the necessity of keeping notes for later office plotting (*see* fig. 41). It consists essentially of a drawing board on a tripod to which the survey sheet is clamped and adjusted in the horizontal plane, an alidade (a telescope mounted on a metal, straight-edge ruler) for measuring directions and distances to salient features of the terrain, and a telemeter rod graduated for the optical measurement of distances from the observer. See *Topographic Survey, Praetorius (Johann).*

**Planetable Traverse.**—A sequence of lengths and directions of lines measured with a planetable between two stations of known positions. See *Planetable.*

**Planimeter.**—A mechanical integrator for measuring the area of a plane surface. The one most generally used in map work is the polar type.

**Planimetric Map.**—A map which presents the horizontal positions only for the features represented; distinguished from a topographic map by the omission of relief.

**Planimetric Survey.**—A survey which presents the horizontal positions only for the features represented; distinguished from a topographic map by the omission of relief.

**Plan of 1843.**—A plan of reorganization of the Survey of the Coast, formulated by a board of officers from the Survey, Navy, and Army, under authority of the Act of Mar.

3, 1843, and approved by President Tyler on Apr. 29, 1843. The plan governed the operations of the Coast Survey for more than a century until passage of the Act of Aug. 6, 1947. See *Act of Aug. 6, 1947.*

**Plat.**—In land surveying, a map, or representation on paper, of a tract of land subdivided into blocks, lots, etc., usually drawn to a scale. In the survey of the public lands, the term plat refers to the drawing which represents the particular area included in a survey, such as a township, private land claim, or mineral claim.

**Plenary Power.**—Full; entire; complete; absolute; perfect; unqualified.

**Plumb-Line Deflection.**—Same as *Deflection of the Vertical.*

**"Point of Beginning".**—A point on the west boundary of the State of Pennsylvania at the north bank of the Ohio River and is the "point of beginning" for the survey of the public lands. The point was marked by a stake on Aug. 20, 1785. See *Land Ordinance of 1785.*

**Polyconic Projection.**—A modification of the simple conic by developing each parallel of latitude as the circumference of the base of a right cone tangent to the sphere along that parallel. Its characteristics are a straight central meridian with all other meridians concave toward it, nonconcentric arcs of circles for the parallels except the equator, and nonorthogonality of intersections except near the middle portion of the projection or on maps of large scale and limited extent (*see* fig. 32). The scale along all parallels is correct as it is along the central meridian. The origin of the projection, at least in concept, is credited to Ferdinand R. Hassler, the first Superintendent of the Coast Survey, and is used for all the topographic and hydrographic surveys of the Bureau. See *Simple Conic Projection.*

**Portolano Charts.**—A type of chart which flourished toward the close of the middle ages. In place of a projection, networks of straight lines were used which radiated from common centers like the spokes of a wheel and corresponded to the points of the compass. These lines enabled the navigator to set his course at and to any point by aid of the magnetic needle. The Cosa chart of 1500 was a form of "Portolano." See *Cosa Chart of 1500.*

**Port Series.**—A series of books, published jointly by the Corps of Engineers and the Maritime Administration, which contains pilotage information for the principal ports of the United States.

**Position Angles.**—The two sextant angles observed on the survey vessel for determining its position.

**Position Numbers.**—Numbers assigned to the survey boat's positions, starting with number 1 at the beginning of each day's work and continuing consecutively to the end of the day's work. See *Day Letters, Position Angles, Identification Letters and Numbers.*

**Positive Photostat.**—A photostat in which the background is white and the detail black, as distinguished from the normal photostat which has a black background with the detail white.

**Potomac River Compact of 1958.**—Supersedes the Maryland–Virginia Compact of 1785, but makes no change in the boundary along the Potomac River as defined in the Black-Jenkins Award of 1877 and as laid out in the Mathews–Nelson Survey in 1927. See *Award of the Arbitrators of 1877.*

**Power to Acquire Territory.**—A power, recognized by all civilized States, that dominion over new territory may be acquired by discovery and occupation and by cession and conquest.

**Praetorius, Johann.**—Credited with having developed the prototype of the modern planetable in the latter part of the 16th century (fig. 68). See *Planetable.*

**Precise Dead Reckoning.**—The name given to a type of accurate dead reckoning used in depths where the survey ship could be anchored for current observations. Every known element affecting the vessel's position was carefully observed, but notwithstanding the precautions taken, there were enough indeterminable factors to make the results anything but precise. See *Dead Reckoning.*

**Precise Leveling.**—Same as *First-Order Leveling.*

**Predicted Tides.**—The expected times and heights of the tide as given in the *Tide Tables* in advance of their occurrence. See *Tide Tables.*

**Preliminary Charts.**—In early Coast Survey usage, the same as "sketches" but covered a greater area. They differed from the "finished" chart in the amount of information they furnished, showing only the shoreline and soundings and not the topography. During World War II this designation applied to charts constructed from unverified hydrographic surveys. See *Sketches.*

**Preliminary Survey.**—As used in early Coast Survey terminology, it was of higher order than reconnaissance, but did not have the detail of a complete survey. See *Reconnaissance Survey.*

**Prescription** (Land).—A right acquired in land by one who uses it adversely for a required statutory period.

**Present Planes of Reference.**—The planes of reference for soundings, in use in 1963, along the various coasts of the United States: mean low water for the Atlantic Ocean and the Gulf of Mexico; mean lower low water for the Pacific Ocean, except the Pacific entrance to the Panama Canal where it is mean low water springs; special planes for certain of the larger navigable rivers and lakes.

**Prima Facie Evidence.**—Evidence good and sufficient on its face, or which suffices for the proof of a particular fact until contradicted and overcome by other evidence.

**Primary Tide Station.**—Same as *Control Tide Station.*

**Primary Triangulation.**—See *Triangulation Classification.*

**Principal Meridian.**—A true north-south line (a meridian) extending both north and south of the initial point in the rectangular system of surveys. Together with the base line they constitute the axes of a system and the initial point the origin of that system (*see* fig. 97). Subdivisions of the public lands are referenced to their appropriate principal meridian which is designated by name or number. See *Initial Point, Base Line* (Public Lands Surveys), *Rectangular System of Surveys.*

**Principle of Equidistance.**—A principle applied in drawing a seaward boundary between two adjacent coastal nations through the territorial sea in such a manner that the sea area will be equitably divided between them. See *Median Line.*

**Private Land Ownership.**—Comprises those lands that formerly belonged to the Federal Government, to an individual state, or to a foreign government.

**Progressive Wave Theory.**—The theory that the tides of the world are due principally to the action of the tidal forces on the broad and deep waters of the "Southern Ocean" where it was assumed these forces raised two tidal waves, 180° apart in longitude, which traversed this belt of water from east to west, forced by the moon to keep step with its own motion. These waves, sweeping around the southern latitudes, were supposed to generate secondary waves in the Atlantic and Pacific Oceans, which traveled northward across the equator and into the Northern Hemisphere, impressing minor waves into all the water areas in their paths. See *Stationary Wave Theory, Southern Ocean.*

**Projection.**—The lines representing the parallels of latitude and meridians of longitude drawn on a survey sheet, map, or chart.

**Projection Constructed After Survey.**—Applies to some of the early hydrographic and topographic surveys which were executed prior to the determination of the geographic positions of the triangulation stations. Two methods are used for reconstructing a projection on such a survey sheet—a rigid one for surveys on scales smaller than 1: 10,000 (*see* fig. 38), and a graphic one for surveys on scales 1: 10,000 and larger (*see* fig. 39).

**Projector.**—An instrument by means of which the image of one survey sheet may be projected through a lens onto another survey sheet of a different scale.

**Prolate Spheroid.**—A sphere elongated through the polar axis and generated by an ellipse revolving about its major axis. In this spheroid, the lengths of the degrees of latitude decrease from the equator to the poles. See *Oblate Spheroid.*

**Proof of Navigability.**—The type of evidence that needs to be adduced as to whether a body of water is navigable or non-navigable; ordinarily a question of fact to be established by appropriate evidence, including opinions of persons who by training and experience are competent, and to be resolved by a jury. See *Navigable Waters.*

**Proportional Dividers.**—An instrument used chiefly for transferring details from one survey to another where the scales are different.

**Proportionate Shoreline Method.**—A method of dividing accretion between adjacent owners of riparian land so as to give to each proprietor a width at the new shoreline proportional to that which he had at the old shoreline before accretion took place.

**Proprietary Interest.**—*See* Volume One, Appendix A.

**Provisional Charts.**—Pertains to charts for which there is an urgent need and which are smooth-drafted for direct reproduction.

**Ptolemy, Claudius.**—Greco-Egyptian astronomer, geographer, and geometer who lived in the 2d century and who is credited with devising the conic projection. His *Geographia* represented the sum of all geographic learning of the time and served as a groundwork for future cartographers.

**Publication Note.**—The note shown in the lower center margin when a new chart is published. This carries the information that the chart was compiled and printed at Washington, D.C., by the Coast and Geodetic Survey of the U.S. Department of Commerce. When space is available, the names of the Secretary of Commerce and the Director of the Survey are also included.

**Public Document** (also called Official Document).—One that records facts which may have been inquired into or taken notice of for the benefit of the public by an agent authorized for the purpose. Applies to official letters, official maps, reports and records generally of official surveyors, and naval charts.

**Public Domain** (also called Public Lands).—The term applied to those areas of land that were turned over to the General Government by the Original States and to such other lands as were later acquired by treaty, purchase, or cession, and are disposed of under authority of Congress. The submerged lands granted to the states under Public Law 31 have been held to be part of the public domain. See *Public Law 31, Public Land States.*

**Publici Juris.**—Of public right; open to or exercisable by all persons.

**Public Lands.**—Same as *Public Domain.*

**Public Land States.**—Alabama, Alaska, Arizona, Arkansas, California, Colorado, Florida, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Ohio, Oklahoma, Oregon, South Dakota, Utah, Washington, Wisconsin, and Wyoming.

**Public Land Surveys.**—See *Rectangular System of Surveys.*

**Public Law 31.**—*See* Volume One, Appendix A.

**Public Use of Navigable Waters.**—The right of the public to the use of navigable waters, irrespective of who owns the soil below.

**Public Use of Shores.**—The rights which the public has, equal with the riparian owner, to a reasonable use of the shore of a tidal stream between high- and low-water marks. Where the shore belongs to the state, the public right extends to all lands below high-water mark not used, built on, or occupied, and include passing, fishing, bathing, hunting, and navigation.

**Published Maps** (District of Columbia–Virginia Boundary Line).—A series of seven planimetric maps (lithographic prints in black and white) at a scale of 1: 4,800, numbered consecutively from Register No. T–8600 to Register No. T–8606 inclusive (*see* fig. 104).

**Puerto Rico Datum.**—Derived from observations on Puerto Rico and the Virgin Islands and adopted in 1901 as the best geographic datum for Puerto Rico, Mona Island, Vieques, Culebra, and the Virgin Islands. This work is now tied to the North American 1927 Datum.

**Pythagoras.**—Greek philosopher who lived about 540 B.C., and who gave the first clear statement regarding the spherical shape of the earth.

## Q

**Quadrangle Maps.**—Topographic maps published by the United States Geological Survey which in general cover the same angular measure in both latitude and longitude. The usual values of the quadrangles are 7½ minutes, 15 minutes, 30 minutes, and 1 degree by 1, 2, or 3 degrees.

**Quid Pro Quo.**—Something for something; the mutual consideration which passes between parties to a contract, and which renders it valid and binding.

## R

**Radial-Line Method.**—A method of transferring one survey to another of different scale (fig. 28). See *Method of Squares.*

**Radio Acoustic Ranging (R.A.R.).**—A method of position determination in offshore hydrographic surveying which utilized underwater sound transmission and radio to determine the distance of the survey vessel from two or more known stations (*see* fig. 7). This method was discontinued during World War II and has since been superseded by electronic methods. See *Shoran, Electronic Position Indicator, Raydist.*

**Range Lines.**—True meridians 6 miles apart laid out along the base line and each standard parallel in the same way as the guide meridians are laid out (fig. 97). See *Township, Twenty-Four-Mile Tracts.*

**Range of Tide.**—The difference in height between consecutive high and low waters. The *mean range* is the difference in height between mean high water and mean low water. The *diurnal range* is the difference in height between mean higher high water and mean lower low water.

**Raydist.**—A phase-type electronic system for controlling offshore hydrographic surveys, in which the determination of distance is based on the measurement of a phase difference in two radio signals, one emanating from the survey vessel and the other from a transmitter at one of two fixed stations ashore. To obtain the distances to both ground stations, the phase difference is measured at three places—aboard ship and at each ground station.

**Reclaim** (according to Riparian Law).—To reduce marshy or swamp land to a state fit for cultivation and habitation. In a number of states, the owner of land on tide water may make use of the shore, though it belongs to the state for the purpose of reclaiming the shore to low-water mark, so long as it does not interfere with the public rights of fishing and navigation, and in so doing conforms to all regulations imposed by the state. The made land then becomes an integral part of the owner's upland and his title extends to the new high-water mark.

**Reconnaissance Charts.**—Charts based on reconnaissance surveys and published for exploratory purposes (usually on a very small scale) as a preliminary to the making of detailed surveys. See *Reconnaissance of the Western Coast of the United States.*

**Reconnaissance of the Western Coast of the United States (1853).**—A noteworthy example of a reconnaissance chart. It covers the coastline from San Diego to San Francisco at a scale of 1 : 1,200,000. See *Reconnaissance Survey.*

**Reconnaissance Survey.**—A hasty, preliminary survey of a region made to provide advance information regarding the area, which may be useful pending the execution of a more complete survey.

**Rectangular Polyconic Projection.**—A modification of the ordinary polyconic but with only a selected parallel truly divided, and meridian lines drawn through the points of division so as to cut all parallels at right angles; hence, the name rectangular polyconic (fig. 33). See *Polyconic Projection.*

**Rectangular System of Surveys.**—A system inaugurated by the Continental Congress on May 20, 1785, for the survey of the public lands of the United States. Its distinguishing characteristic is that in the main, and in all cases where practicable, its units are in rectangular form (fig. 97). See *Township.*

**Rectification.**—In photogrammetry, the process of projecting a tilted or oblique photograph onto a horizontal reference plane, the angular relation between the photograph and the plane being determined by ground measurements.

**Reduction of Soundings.**—In surveys with the leadline, the correction of the observed depths for height of tide above the plane of reference and for leadline correction (departure of leadline from true length).

**Reef.**—A rocky or coral elevation dangerous to surface navigation which may or may not uncover at the sounding datum. A rocky reef is always detached from shore; a coral reef may or may not be connected with the shore (*see* fig. 62).

**Registry Numbers.**—Numbers assigned to topographic and hydrographic surveys of the Coast Survey for identification and filing purposes. Topographic surveys (sometimes referred to as "T" sheets) are identified by the letter "T" annexed to the registry number, and hydrographic surveys (sometimes referred to as "H" sheets) by the letter "H." A complete identification of a topographic survey, including the date of survey, would be "Register No. T–52 (1838)."

**Regulations.**—Rules promulgated by executive officers or boards or commissions for the practical administration of statutes enacted by Congress or a state legislature after having laid down the general rules of action.

**Reliction** (also known as Dereliction).—The gradual and imperceptible recession of the water resulting in an uncovering of land once submerged. See *Accretion.*

**Report of Special Master.**—*See* Volume One, Appendix A.

**Representative Fraction.**—A term applied to a fractional scale where the numerator is unity. Also called the "R.F." of the map. See *Fractional Scale.*

**"R.F." of Chart or Map.** See *Representative Fraction.*

**Respondent** (also called Appellee).—In appellate courts, the party who contends against an appeal. See *Petitioner.*

**Respondent–Defendant.**—One who in the lower court was the defendant and is the respondent in the appellate court. See *Respondent.*

**Review.**—The final step in the processing of the field data of a hydrographic survey. Its purpose is to consider the survey in its broader aspects, to correlate it with all prior surveys of the Bureau covering the same area, with historical data that may have been received from other sources, and to lay the foundation for future surveys in the area because of indicated changes, inadequate development, or conflicting information. See *Basic Survey.*

**Rhumb Line** (also called Loxodromic Curve).—A continually curving line on the earth which cuts all the meridians at the same angle and always approaches the pole but theoretically never reaches it. A ship sailing a "rhumb" is on one course continuously. The rhumb line is a straight line only on the Mercator projection (fig. 87). See *Mercator Projection.*

**Right Bank** (River).—The bank on the right-hand side as one proceeds downstream. See *Left Bank.*

**Right of Access.**—A fundamental riparian right; the right which a riparian owner has of reaching navigable water, in the absence of an otherwise controlling local law limiting such right. See *Riparian Rights.*

**Right of Discovery.**—One of the powers which a sovereign nation has to acquire territory by discovery and occupation. See *Guano Act.*

**Right of Eminent Domain.**—The power which inheres in every politically organized society to condemn private property for a public use. It is vested in each of the several states, and by the fifth amendment to the Constitution it is implied that the United States possesses the power but the property cannot be taken without just compensation. See *Taking of Private Property.*

**Right-of-Way.**—Right to use or cross over the property of another.

**Ripa.**—*See* Volume One, Appendix A.

**Riparian Boundaries.**—*See* Volume One, Appendix A.

**Riparian Lands.**—In strictness, lands bordering on a river. The term "riparian" is also used as relating to the shore of the sea or other tidal water, or of a lake or other considerable body of water not having the character of a watercourse.

**Riparian Law.**—The branch of the law which deals with the rights in land bordering on a river or the sea.

**Riparian Owner.**—*See* Volume One, Appendix A.

**Riparian Rights.**—The rights of an owner of land contiguous to a navigable body of water and include principally the right of access to the water; the right to build piers, wharves, docks, and other improvements to the line of navigation; the right to reclaim land, and the right to accretions.

**River.**—A natural stream of water, of greater volume than a creek or rivulet, flowing in a more or less permanent bed or channel, between defined banks or walls, with a current which may either be continuous in one direction or affected by the ebb and flow of the tide. See *Boundary River, International River, National River.*

**River Boundaries.**—See *Boundary River, Medium Filum Acquae, Thalweg, River Boundary* (Bank).

**River Boundary** (Bank).—Where the entire river is part of the domain of one state the further bank or shore is the boundary line between the two states.

**River Boundary** (Shore).—Same as *River Boundary* (Bank).

**Rock Awash.**—In Coast Survey terminology, a rock exposed at any stage of the tide between the datum of mean high water and the sounding datum, or one just bare at these datums. For cartographic purposes, in order that the charted symbols may reflect the most probable condition of the rock as seen by the mariner, rocks the summits of which are in the zone between 1 foot above mean high water and 1 foot below the sounding datum on the Atlantic and Gulf coasts and 2 feet on the Pacific coast are shown as rocks awash (fig. 65). See *Bare Rock, Sunken Rock.*

**Rock Symbolization.**—The progressive changes in rock symbols between 1840 and 1960, as developed in the Coast Survey for use on surveys and charts (*see* fig. 64).

**Rodded Points.**—Points in a planetable survey that are located by a direction and measured distance. See *Telemeter Rod.*

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**Rule of Property.**—A settled legal principle governing ownership and disposition of real property, which courts are reluctant to change because many titles may be injuriously affected. The existence of the doctrine of the rule of property is one of the reasons why early court decisions are often cited as authority in modern cases involving land ownerships. See *Stare Decisis.*

**Rule of the Thalweg.**—In river boundaries, the rule which holds that where a navigable river separates two nations, the middle of the main channel is the boundary between them, as distinguished from the geographic middle of the river. See *Medium Filum Acquae.*

**Rules for Representing Certain Topographical and Hydrographical Features, etc. (1860).**—The first publication pertaining to the drawing and engraving of Coast Survey maps and charts. Every detail of the finished chart was covered by the rules from the symbols and dimensions for topographic features to the style and gage of lettering.

**Rules of Comparative Dignity.**—Rules for the order of precedence to be followed in resolving conflicts in land descriptions: (1) natural monuments or objects, (2) artificial marks or objects, (3) maps and plats, (4) courses and distances, and (5) recitals of quantity.

**Rules of Construction.**—Rules developed by the courts for the resolution of ambiguities in land conveyances in order to determine the intent of the parties to the conveyance.

**Rules of the Road.**—Established by the U.S. Coast Guard for preventing collisions at sea, and cover requirements for lights, sound signals, steering, and sailing. Set out in a pamphlet titled "Rules of the Road, International-Inland" (CG–169). See *Inland Rules of the Road, International Rules of the Road.*

**Rules of the Road Boundary Lines.**—Lines (descriptive or charted) established by the U.S. Coast Guard for separating areas of the sea where the Inland Rules of the Road apply from those where the International Rules apply (figs. 82–85). See *Inland Rules of the Road, International Rules of the Road, Act of Feb. 19, 1895.*

**"Rules of the Road, International-Inland".**—A pamphlet published by the U.S. Coast Guard under the designation "CG–169." See *Rules of the Road.*

## S

**Sailing Charts.**—Charts of scales 1:600,000 and smaller for planning and for fixing the mariner's position as he approaches the coast from the open ocean, or for sailing between distant coastwise ports.

**Sailing Directions.**—Publications similar in scope to the *Coast Pilots* of the Coast Survey published by hydrographic offices of the world.

**Sanding.**—An irregular dot pattern used on some of the early hydrographic surveys to accentuate the area between the high- and low-water lines (*see* Register No. H–500 (1855)).

**Scale.**—The relation that a measured distance on a survey, map, or chart bears to the corresponding actual distance on the earth—for example, if 1 inch on the survey or chart corresponds to 1,000 feet (12,000 inches) on the ground, the scale would be expressed as 1 inch = 1,000 feet. Expressed as a ratio this would be a scale of 1 : 12,000. See *Fractional Scale.*

**Scale Factor.**—A multiplier for reducing a distance obtained from a map by computation or scaling to the actual distance on the datum of the map. In the State Coordinate Systems, scale factors may be applied to grid lengths to obtain geodetic accuracy.

**Scale of a Mercator Chart.**—The variation of scale with latitude due to the characteristics of the Mercator projection (*see* fig. 77). Mercator charts are designed in two ways with respect to scale: by maintaining a uniform construction scale at a selected latitude for each chart (the 1200 series along the Atlantic and Gulf coasts on a scale of 1: 80,000), and by holding the adopted scale correct for a selected latitude of a series of charts (the 1100 series along the Atlantic and Gulf coasts based on a scale of 1: 400,000 at latitude 40°). See *Mercator Projection.*

**Scribing.**—See *Negative Engraving.*

**Sea.**—A large or considerable body of oceanic water partly or almost entirely enclosed by land, as, for example, the Bering Sea and the Mediterranean Sea. See *Ocean Nomenclature.*

**Seal.**—An impression upon wax to serve as an authentication of an instrument—a deed, for example, in land transfers. By statute in many states, a mere scroll or any other device marked on the paper, on which the conveyance is written, is sufficient, and the writing of the word "Seal" in connection with the signature is regarded as a sufficient sealing. See *Deed.*

**Sea Level Datum.**—See *Mean Sea Level.*

**Sea Level Datum of 1929.**—An adjusted datum and the basis for the level net of the United States. See *Mean Sea Level.*

**Seaward Boundaries** (Submerged Lands Act).—The seaward boundaries of the coastal states for purposes of exploring the submerged lands of the open sea—9 geographic miles (3 leagues) for Texas and for Florida in the Gulf of Mexico, and 3 geographic miles for the rest of the states. See *United States* v. *Louisiana et al.*

**Secondary Authority.**—Comprises indexes to authority, such as digests and legal encyclopedias, and textbooks, law review articles, and other treatises. These can be highly persuasive and are frequently cited in judicial decisions.

**Secondary Tides.**—Refers to those additional tides—higher low waters and lower high waters—that occur twice a month (when the moon is over the equator) in a general pattern of diurnal tides. See *Diurnal Tides.*

**Secondary Triangulation.**—See *Triangulation Classification.*

**Second-Order Leveling.**—Leveling that is run in one direction only except on lines 25 miles or more in length, when they are double run. For a 25-mile circuit, the error of closure is about 2 inches on an average. The accuracy of this class of leveling satisfies the requirements of the International Union of Geodesy and Geophysics for "leveling of precision."

**Section.**—The final subdivision in the rectangular system of surveys under the original ordinance. Each township contains 36 sections, each 1 mile square, or 640 acres. The sections are formed by straight lines, 1 mile apart, run parallel to the eastern range line of the township and by straight east-west lines, 1 mile apart, run parallel to the south township line. (*See* figs. 97 and 98.)

**Semicircular Rule.**—A geometric method, using the pattern of a semicircle, for determining when an indentation of a coast should be regarded as part of the inland waters of a country, and when it should be regarded as part of the open sea. The borderline case is a semicircle with a diameter equal to the distance between the headlands of the indentation—if the area of the indentation is equal to or greater than the area of the semicircle, the indentation is part of the inland waters; if it is less, the indentation is part of the open sea. *See also* Volume One, Appendix A.

**Semidiurnal Tides.**—*See* Volume One, Appendix A.

**S. 1109.**—A bill, introduced in the 88th Cong., 1st sess., to establish the seaward boundaries of Alabama, Mississippi, and Louisiana at 3 marine leagues into the Gulf of Mexico. See *Seaward Boundaries.*

**S. 1988.**—A bill, introduced in the 88th Cong., 1st sess., prohibiting (with certain exceptions) any foreign vessel from taking fish within the territorial waters of the United States (including the territories and possessions and the Commonwealth of Puerto Rico) or from taking any fishery resources of the continental shelf which appertain to the United States. The bill was approved by the Senate on Oct. 1, 1963, and sent to the House for action. It was signed by the President on May 20, 1964, as Public Law 88–308.

**S. Rept. 500.**—The Senate committee report on S. 1988, 88th Cong., 1st sess. See *S. 1988.*

**Servitude.**—The right in respect to land owned by one person by virtue of which it is subject to a certain use or enjoyment by another person. Frequently applied to the right which foreign vessels have to travel through the territorial sea of another country. See *Easement.*

**Seven Seas.**—Figuratively, all the waters or oceans of the world. Applied generally to the seven oceans—Arctic, Antarctic (not now considered by hydrographers as having definite boundaries), North Atlantic, South Atlantic, North Pacific, South Pacific, and Indian.

**Sextant.**—An instrument used in hydrographic surveying for measuring the horizontal angle between two objects (*see* fig. 59). It is constructed on the optical principle that when a ray of light undergoes two successive reflections in the same plane, the angle measured is actually twice the angle through which the index arm has passed. The markings on the graduated arc are therefore doubled at the time of manufacture. See *Three-Point Fix Method.*

**Sextant Fix.**—A position determined by measuring with a sextant two adjacent angles between three objects whose relative positions (latitudes and longitudes) are known. See *Three-Point Problem.*

**Shifting Boundary Theory.**—See *Shifting Riparian Boundary.*

**Shifting Riparian Boundary.**—Where the sea or an arm thereof is a boundary, changes brought about by erosion or accretion operate to change the boundary. This is sometimes referred to as the ambulatory nature of a water boundary. See *Fixed Riparian Boundary, Erosion, Accretion.*

**Shoran.**—A pulse-type electronic ranging system, originally designed for the positioning of bombing aircraft and later adapted for use in hydrographic surveying and other procedures.

**Shore** (according to Coastal Engineering).—The zone over which the line of contact between land and sea migrates; the landward limit of effective wave action. Extends from the low-water mark inshore to the base of the cliff (fig. 86). See *Shore* (according to Riparian Law).

**Shore** (according to Riparian Law).—The land between ordinary high- and low-water marks, where the common law prevails; the land over which the daily tides ebb and flow (*Borax Consolidated, Ltd.* v. *Los Angeles*, 296 U.S. 10, 22–23 (1935)). The civil-law concept of shore has been interpreted as extending to the line of mean higher high tide (*Luttes* v. *State of Texas*, 324 S.W. 2d 167, 191 (1958)). See *Tidelands, Ordinary Tides.*

**Shore Development Cycle.**—The progressive changes in the shore from the time when the water first assumes its level and rests against the new shore to the time when it has brought its boundaries into harmony with its movements.

**Shore Lands.**—Same as *Tidelands.*

**Shoreline.**—The line of contact between the land and a body of water. On Coast and Geodetic Survey nautical charts and surveys the shoreline approximates the mean high-water line. In Coast Survey usage the term is considered synonymous with "coastline." See *Mean High-Water Line.*

**Shore Processes.**—The forces of nature, such as winds, waves, tides, and currents, that contribute to the development of a shore. See *Shore* (according to Coastal Engineering).

**Short-Series Tide Station.**—A station established as a necessary part of a hydrographic survey operation to provide data for determining the reference datum and for reducing the soundings to that datum. The results from such stations are brought to 19-year means by comparisons with simultaneous observations at suitable control stations where mean values are available from long-series records. See *Comparison of Simultaneous Observations, Mean Values.*

**Simple Conic Projection.**—A map projection which utilizes as the medium of projection a right cone tangent to the sphere at the middle latitude (the standard parallel) of the area to be mapped. Its characteristics are straight meridians and concentric arcs of circles for parallels, the two intersecting at right angles. The scale of the projection is true along the standard parallel and along all meridians but not along the parallels above and below the standard parallel, which makes the projection unsuitable for areas with considerable north-south extent.

**Sixth Report of the United States Geographic Board (1933).**—The latest complete, published report of the board and covers decisions between 1890 and 1932, in one consecutive alphabetical list.

**Sketches.**—In early Coast Survey usage, charts based on reconnaissance or regular surveys but covering a very limited area and published as soon as possible after the surveys were made. They were engraved by the apprentices in the Survey and served as subjects for practice. See *Preliminary Charts.*

**Small-Craft Charts.**—A series of charts begun in 1959 (at scales 1: 40,000 and 1: 80,000) and designed for maximum usefulness to the yachtsman and the small-boat operator in the active coastal boating areas of the country. They contain information in tabular and pictorial form not included on the standard charts.

**Small-Scale** (Survey or Chart).—A relative term, but generally one covering a large area on the ground. In Coast Survey usage, a scale of 1: 100,000 (1 inch on survey or chart = 100,000 inches on the ground) or smaller would fall in this classification. See *Large-Scale.*

**Smooth Sheet.**—The name given to the hydrographic survey when reduced to plot form (*see* fig. 56). Essentially, it is a record of the soundings taken during the field survey but contains other data necessary for a proper interpretation of the survey, such as depth curves, bottom characteristics, names of geographic features, and control stations. After verification and review, it becomes the official permanent record of the field survey, and subsequent reference to the original sounding records is seldom necessary except for some special investigation. Corresponds to what was termed in the early instructions for hydrographic work as "finished" hydrographic sheet. See *Hydrographic Survey.*

**Sofar.**—A signaling system for distress calls at sea which utilizes the existence of certain depth layers where the combined factors of temperature and pressure cause a velocity inversion, resulting in a channeling effect that conserves energy and sends the sound signals over great distances to be picked up by shore listening stations.

**Sounding Datum.**—See *Plane of Reference.*

**Sounding-Line Crossings.**—The intersection of two systems of sounding lines at which the depths must agree within specified limits. See *Cross Lines.*

**Sounding Pole.**—A graduated pole with a disk on the lower end, to prevent it sinking into muddy bottom, for sounding in shoal depths.

**Sounding Records.**—Bound record books in which all of the data taken on a hydrographic survey are entered, and become part of the permanent records of the Bureau. A typical sounding record of a launch hydrographic survey using an echo sounder and three-point fix control contains the following data: position numbers, times of taking the soundings, uncorrected soundings, corrections to be applied, reduced soundings, boat's headings by compass, position control data, and pertinent remarks (*see* fig. 61).

**Soundings.**—The depths obtained on a hydrographic survey—uncorrected when first recorded in the sounding record but corrected for tide and other factors when plotted on the smooth sheet. See *Sounding Records, Tide Reducer.*

**Southeast Alaska Datum.**—An independent datum established toward the end of 1901 by joining together nine different groups of triangulation to form one continuous scheme on one datum. Applied to all triangulation in Alaska between Dixon Entrance and Mount St. Elias. Although all the triangulation is now computed on the North American 1927 Datum, many of the hydrographic and topographic surveys in this area are still on the old datum. See *North American 1927 Datum.*

**Southern Ocean.**—The Antarctic facies of the Atlantic, Indian, and Pacific Oceans which some consider as a Southern Ocean. See *Progressive Wave Theory.*

**South Magnetic Pole.**—See *Magnetic Pole.*

**Sovereign States.**—States whose subjects or citizens are in the habit of obedience to them, and which are not themselves subject to any other State in any respect. After the American Revolution the Thirteen Original Colonies became sovereign States. With the adoption of the Constitution and the formation of the Federal Government, the latter succeeded only to such rights as the States chose to surrender. See *National External Sovereignty*.

**Specialized Symbolization.**—Used in photogrammetric mapping and nautical charting of the Laguna Madre area in Texas and similar areas elsewhere where very little of an astronomic tide exists and the variation in water level is due primarily to meteorological conditions (*see* Part 2, 452).

**Special Master.**—*See* Volume One, Appendix A.

**Specimens of Topographical Drawing (1879 and 1883).**—A series of 16 lithographed plates, with contours in color, of topographic features most prevalent along the coasts of the United States to serve as guides for the office draftsmen who were to ink the planetable surveys. The plates were published in the Annual Report for 1883.

**Specimen Topographic Symbols (1865).**—A specimen sheet of conventional symbols accompanying the first comprehensive treatise on the planetable included in the Annual Report of the Coast Survey for 1865 (*see* figs. 49 and 50).

**Spherical Excess.**—The amount by which the sum of the three angles of a triangle on a sphere exceeds 180°.

**Spheroid.**—In general, any figure differing but little from a sphere. In geodesy, a mathematical figure closely approaching the geoid in form and size, and used as a surface of reference for geodetic surveys. See *Oblate Spheroid, Prolate Spheroid, Figure of the Earth*.

**Spirit Leveling.**—The determination of elevations of points with respect to each other, or with respect to a common vertical datum, by means of an instrument using a spirit level to establish a horizontal line of sight.

**Spring Range** (Tidal).—The average semidiurnal range occurring semimonthly as a result of the moon being new or full. It is larger than the mean range where the type of tide is either semidiurnal or mixed, and is of no practical significance where the type of tide is diurnal. See *Spring Tides*.

**Spring Tides.**— *See* Volume One, Appendix A.

**Stadia.**—The plural form of stadium, a Greek measure of length somewhat greater than 600 feet.

**Stadia Rod.**—See *Telemeter Rod*.

**Standard.**—A copy of a new edition or a new chart on which is indicated in outline form all new information, except aids to navigation, to be applied to the chart before printing. See *New Edition, Standards File*.

**Standard Disk.**—A metal tablet, about 3½ inches in diameter, which may be set in a concrete monument, rock outcrop, or building, and used as a station marker. The type of station (triangulation, bench mark, etc.) is inscribed on the surface of the disk together with the designation of the particular station (*see* figs. 11 and 17).

**Standard Geographic Datum.**—The best theoretical value (latitude, longitude, and azimuth) for a point on the adopted spheroid of reference to which all other points in the triangulation net are tied.

**Standard Parallels.**—See *Twenty-Four Mile Tracts.*

**Standards File.**—A file begun about 1908 by means of which a record is kept of all incoming charting information. The file consists of a complete set of the published charts. See *Standard.*

**Standards Symbols (1928).**—Included in the Topographic Manual of 1928 (Special Publication No. 144) and based on the symbols published by the Board of Surveys and Maps in 1925 (*see* figs. 53, 54, and 55).

**Stare Decisis** (also called the Doctrine of Precedent).—Literally, to stand by decided matters, or let the decision stand. The doctrine of stare decisis is a creation of the common-law system of jurisprudence and is based on the theory that the principle underlying the decision in one case should control decisions in like cases in the same court or in lower courts within the same jurisdiction. *See also* Volume One, Appendix A.

**State Coordinate Systems.**—The plane rectangular coordinate systems established by the Coast and Geodetic Survey, beginning in 1933, in which the unit of area is, in general, the state, and which are used for defining positions of control stations in terms of plane rectangular ($X$ and $Y$) coordinates. Each state is covered by one or more zones, over each of which is placed a grid imposed upon a conformal map projection, the relationship between the two being established by mathematical analysis. See *Lambert Conformal Conic Projection, Transverse Mercator Projection.*

**State Judiciaries.**—The state systems of courts established to settle suits arising under the state constitutions or under the laws enacted by the state legislatures. The arrangement is hierarchical with trial courts at the base, intermediate appellate courts at the middle, and final appellate courts at the top. See *Federal Judiciary.*

**State of Hawaii.**—Includes all the islands of the Territory of Hawaii except Palmyra Island. See *Territory of Hawaii.*

**State Plane Coordinates.**—Data defining the locations of horizontal control stations (triangulation and traverse) in terms of State Plane Coordinates include their plane coordinates and the plane or grid azimuth to an azimuth mark. See *State Coordinate Systems.*

**State Waters** (according to Sixteenth Census).—Waters (coastal and Great Lakes) adjacent to the states (other than inland) which, under rules adopted by the Bureau of the Census, were used in setting the outer limits of the United States for purposes of measuring the area for the Sixteenth Census in 1940 (*see* Table 3).

**Stationary Wave Theory.**—A theory of tidal phenomena evolved at the beginning of this century, replacing the older progressive wave theory which considered the tide as a single world phenomenon. The new theory substitutes the idea of regional oscillating basins, each with its own natural period, and their responses to the tide-producing forces imposed by the sun and moon, as the origin of the dominant tide in each basin. The resulting tide in the basin will depend on the relation between the natural and the imposed periods. The tide-producing force consists principally of two parts, a semidiurnal force with a period approximating a half day and a diurnal force with a period of a whole day.

Although the tidal movement as a whole is somewhat complicated by the overlapping of oscillating basins, the theory is consistent with observational data. See *Progressive Wave Theory, Tide-Producing Force.*

**Station Error.**—Same as *Deflection of the Vertical.*

**Station Pointer.**—Same as *Three-Arm Protractor.*

**Statute Mile.**—5,280 feet, 1,609.3 meters, or 80 chains. See *Chain.*

**Statute of Frauds.**—A celebrated English statute, enacted in 1677, and adopted in nearly all of the states, which prohibits any suit being brought on certain classes of contracts or engagements unless there is a note or memorandum in writing signed by the party to be charged or by his authorized agent. See *Parol Testimony.*

**Statutory Law.**—The enacted law, including written constitutions and treaties. In relation to the common law, statutes may declare or supplement, or they may supersede.

**Stereoplanigraph.**—An advanced stereoscopic plotting instrument, utilizing full-size diapositives (contact prints from the aerial film onto $\frac{3}{16}$-inch glass plates).

**Storm High Water.**—The highest level to which the sea rises during a storm and usually marked by a line of debris high up on the beach. Should not be confused with the mean high-water line or with the spring high-water line.

**Straight Baselines.**—*See* Volume One, Appendix A.

**Submarine Relief.**—The formation of the sea bottom as developed by depth contours on hydrographic surveys and nautical charts (fig. 74). See *Depth Contours.*

**Submarine Valley** (also called Seavalley).—*See* Volume One, Appendix A.

**Submerged Lands Act.**—*See* Volume One, Appendix A.

**Submerging Shoreline.**—A downwarping of the earth's crust or a raising of sea level.

**Summer Solstice.**—That instant at which the sun reaches the point of maximum northerly declination, about June 21.

**Sunken Rock.**—In Coast Survey terminology, a rock covered at the sounding datum that is a potential danger to navigation. For cartographic purposes, it is a rock whose summit is below the lower limit of the zone for a rock awash (fig. 65). See *Rock Awash.*

**Superintendent of the Coast Survey.**—The title of the directing head of the Survey until changed by the Act of June 5, 1920, to "Director."

**Superior Call.**—A call higher in the order of precedence for resolving conflicts in land descriptions. A call for a natural monument is superior to a call for a course and distance. See *Call.*

**Supplementary Adjustments** (Leveling).—Adjustments of elevations of bench marks made after the 1929 General Adjustment, as a result of the rapid expansion of the level net and because of movements of bench marks in some areas, in order to fit the new work to the old. These elevations are characterized as "Standard elevations based on the 1929 General Adjustment through the medium of the ______ Supplementary Adjustment." See *1929 General Adjustment.*

**Supra.**—Above. The word when used in a book has reference to a previous part of the book—for example, a reference in note 12 to note 6 would be given as "*supra* note 6." See *Infra.*

**Supreme Court of the United States.**—The highest court of the land, and the court of last resort in the federal and state judiciaries. Its jurisdiction is essentially appellate, but it has irrevocable original jurisdiction in cases affecting ambassadors, public ministers, and consuls, or cases in which a state is a party. See *Original Jurisdiction, Appellate Jurisdiction.*

**Survey.**—The result of the field operation, as distinguished from map or chart which results from a compilation. See *Hydrographic Survey.*

**Surveyed Line.**—Refers to the high-water line which the Coast Survey topographer delineated on his planetable survey from the physical appearance of the beach and a knowledge of the tide in an area. See *Line of Mean High Water.*

**Survey Index** (Photogrammetric).—Printed sheets showing the areas covered, scales, and dates of aerial photographs upon which the surveys are based for photogrammetric surveys. Classification of the surveys (planimetric, shorelines, topographic) is indicated by color. See *Survey Indexes* (Topographic and Hydrographic).

**Survey Indexes** (Topographic and Hydrographic).—Printed sheets showing the dates, areas covered, and scales of planetable and hydrographic surveys along the Atlantic, Gulf, and Pacific coasts (exclusive of Alaska and Hawaii). See *Survey Index* (Photogrammetric).

**Survey of the Coast.**—See *Coast and Geodetic Survey.*

**Swamp and Overflowed Lands.**—Lands that are wet and unfit for cultivation. See *Swamp Lands, Overflowed Lands.*

**Swamp Lands.**—Lands that require drainage to fit them for cultivation. The term has also been regarded as synonymous with overflowed lands.

**Swamp Lands Act.**—The Act of Sept. 28, 1850, by which Congress granted to the public-land states then in the Union all the swamp and overflowed lands within the state which the Government owned for the purpose of aiding in reclamation. See *Swamp and Overflowed Lands, Public Land States.*

**Symbolization of Aids on Nautical Charts.**—The symbols and colors by which buoys and lighted aids to navigation are represented on the charts.

**Symbolization on Nautical Charts.**—The symbols and abbreviations used for the topographic and hydrographic features on the nautical charts of the Coast Survey—the high-water line, the low-water line, shoal areas, rocks and wrecks, aids to navigation, etc. *See* Appendix F.

**Systems of Sounding Lines.**—The predetermined lines that the survey vessel is to follow for the best development of the depth contours in an area (*see* fig. 57).

## T

**Tables for a Polyconic Projection of Maps** (Special Publication No. 5, U.S. Coast and Geodetic Survey).—Contain the true lengths in meters of meridional arcs and arcs of the parallels, as they appear on the Clarke spheroid of 1866, for use in the construction of projections, together with the *X* and *Y* coordinates for plotting the intersection of parallels and meridians in constructing a polyconic projection. The tables are based on the legal value of the meter in the United States which is 39.3700 inches and corresponds to 1 meter = 3.2808333 feet and 1 foot = 0.3048006 meter.

**Taking of Private Property.**—An important element in the doctrine of eminent domain. Any interference with ownership, enjoyment, or the value of private property is usually considered a "taking" that falls within the fifth amendment. See *Right of Eminent Domain.*

**Technical Bulletins, U.S. Coast and Geodetic Survey.**—A series of technical papers published at irregular intervals for the dissemination of the results of research and operational studies (in field and office) pertaining to the activities of the Coast Survey. The series was begun in January 1958, superseding The Journal, and as of January 1964, 23 such bulletins had been issued. See *Journal Coast and Geodetic Survey.*

**Telegraphic Method.**—A method of determining the longitude of a place by the telegraphic exchange of time signals with a station of known longitude. First used by the Coast Survey on Oct. 10, 1846, 2 years after Morse flashed his first telegraphic message. Superseded by the radio method in 1922.

**Telemeter Rod.**—Part of the planetable equipment for the indirect measurement of distances by means of the telescopic alidade. The rod is graduated so that the number of divisions intercepted between two horizontal wires in the eyepiece of the alidade are equal to the number of units in the distance between the observer and the rod (*see* figs. 40 and 41).

**Ten-Mile Rule.**—*See* Volume One, Appendix A.

**Termini at Headlands.**—The points on shore (the low-water mark in the international law of the sea) between which the closing line at indentations is drawn to mark the seaward limits of inland waters. See *Closing Line, Headland-to-Headland Line, Inland Waters.*

**Territorial Limits.**—The seaward limits of a littoral nation over which it has exclusive jurisdiction. See *Territorial Sea.*

**Territorial Sea** (also called Marginal Sea, Adjacent Sea, Marine Belt, Maritime Belt, and 3-Mile Limit).—The water area bordering a nation over which it has exclusive jurisdiction, except for the right of innocent passage of foreign vessels. It is a creation of international law, although no agreement has thus far been reached by the international community regarding its width. It extends seaward from the low-water mark along a straight coast and from the seaward limits of inland waters where there are embayments. The United States has traditionally claimed 3 nautical miles as its width and has not recognized the claims of other countries to a wider belt.

**Territorial Waters.**—Includes the territorial sea (marginal sea) and the inland waters of a country (lakes, rivers, bays, etc.). Sometimes used as synonymous with Territorial Sea.

**Territory Northwest of the Ohio River.**—The territory bounded on the west by the Mississippi River and a line running north from its source to the international boundary, on the north by the boundary line between the United States and the British possessions, on the east by the Pennsylvania and New York State lines, and on the south by the Ohio River. It was made up of claims of Virginia, Connecticut, and Massachusetts, and comprised an area of approximately 278,000 square miles. From this territory were formed the States of Ohio, Indiana, Illinois, Michigan, and Wisconsin, that part of Minnesota east of the Mississippi River, and the northwest corner of Pennsylvania.

**Territory of Hawaii.**—Includes the islands of the Hawaiian Archipelago (except the Midway Islands) and Palmyra Island (fig. 95). See *Hawaiian Archipelago, State of Hawaii.*

**Tertiary Triangulation.**—See *Triangulation Classification.*

**Texas Accession.**—Republic of Texas admitted as a State in 1845. Part of this territory was purchased by the United States in 1850, and is now included in the States of Kansas, Colorado, New Mexico, Oklahoma, and Wyoming (*see* fig. 96).

**Thalweg.**—The "downway," meaning the course taken by boats going downstream in a river. See *Rule of the Thalweg.*

**The Genesee Chief v. Fitzhugh** (12 How. 443).—An 1851 leading case on navigability in which the Supreme Court overruled its former decisions based on the tidal test of navigability and adopted the test of the actual navigable capacity of a waterway. See *Navigability Test.*

**Theodolite.**—A precision surveying instrument consisting of an alidade with telescope, mounted on an accurately graduated circle, equipped with necessary levels and reading devices. Sometimes, the alidade carries a graduated vertical circle.

**The Trust Territory.**—Islands in the Western Pacific (Caroline, Marshall, and Mariana (except Guam)), formerly under Japanese mandate, placed under the administration of the United States through an agreement with the United Nations following World War II.

**Thirteen Original Colonies.**—See *Thirteen Original States.*

**Thirteen Original States.**—*See* Volume One, Appendix A.

**Three-Arm Protractor** (also called Station Pointer).—An instrument (metal or plastic) for plotting sextant fixes in hydrographic surveying (*see* fig. 60). It consists of a graduated circle with a fixed center arm and right and left movable arms pivoted at its center so that the extension of each fiducial edge always passes through the precise center of the graduated circle. The observed left angle is set with the left arm and the right angle with the right arm, and each fiducial edge is made to pass through the corresponding control station on the survey sheet. The center of the protractor marks the position of the survey boat. See *Three-Point Fix Method.*

**Three-Mile Limit.**—See *Territorial Sea.*

**Three-Point Fix Method.**—One of the principal methods used on inshore hydrographic surveys for establishing the position of the survey boat. It involves the measurement with sextants of two angles between three known stations, the middle station being common to both angles, and plotting the boat's position graphically with a three-arm protractor. See *Three-Point Problem, Sextant, Three-Arm Protractor.*

**Three-Point Problem.**—The determination of the horizontal position of a point of observation from the known positions of three other points. In planetable surveying, the position of the planetable is determined by a graphic solution of the three-point problem. See *Orientation of Planetable.*

**Tidal Bench Mark.**—See *Bench Mark* (Tidal).

**Tidal Bench-Mark Data.**—Compilations published separately for each tide station in loose leaf form. These data include descriptions of all bench marks and their elevations above the basic hydrographic datum for the area, the date and length of the tidal series on which the bench-mark elevations are based, and a table showing the relation between the basic datum and other tidal datums in use—mean higher high water, mean high water, half-tide level, mean low water, and mean lower low water. In addition, heights of observed or estimated highest and lowest water levels in relation to the basic datum are included with their dates of occurrence.

**Tidal Boundary.**—A boundary of land determined by the course of the tide and tied in with a specific phase of the tide—for example, mean high water. See *Mean High-Water Line, Mean Low-Water Line.*

**Tidal Characteristics.**—Primarily refers to the type of tide in a locality, that is, whether it is diurnal, semidiurnal, or mixed, for purposes of reducing short-period observations to mean values. In considering the characteristics at a particular place, they would include the range and the time. See *Type of Tide, Range of Tide.*

**Tidal Corrections.**—Corrections given in the *Tide Tables* which the mariner uses in conjunction with the nautical chart to determine the depth of water at a specified time and place. See *Tide Reducer.*

**Tidal Current Charts.**—Publications consisting of a set of 12 charts for each waterway which depict the direction and velocity of the current for each hour of the tidal cycle. Eight waterways are presently covered by these publications.

**Tidal Current Tables.**—Tables issued annually in advance of the year for which they are prepared, and give daily predictions of the times of slack water and the times and velocities of the strength of flood and ebb currents for a number of waterways, together with differences for obtaining predictions at numerous other places.

**Tidal Datums.**—Vertical datums defined by a phase of the tide—for example, high water—and used as a reference plane for heights on land and depths in the sea, and in the demarcation of waterfront boundaries. The Coast and Geodetic Survey level net is based on the datum of mean sea level, but in its hydrographic work, including soundings on charts and tidal predictions, a low-water datum is used—mean low water for the Atlantic and Gulf coasts and mean lower low water for the Pacific coast. For defining tidal boundaries, mean high water and mean low water are used. See *Mean Sea Level.*

**Tidal Difference.**—Difference in time or height of a high or low water at a subordinate station and at a reference station for which predictions are given in the *Tide Tables*. The difference applied according to sign to the prediction at the reference station gives the corresponding time or height for the subordinate station. See *Tide Tables.*

**Tidal Planes.**—See *Tidal Datums.*

**Tidal Shoreline of United States** (Detailed).—Determined by using a recording measure on the largest scale maps and charts available. Shoreline of bays, sounds, and other bodies of water are included to the head of tidewater, or to a point where such waters narrow to a width of 100 feet. Both shores of a stream are measured if over 200 yards wide, but streams between 30 yards and 200 yards in width are measured as a single line through the middle of the stream. (*See* Table 4.)

**Tidal Shoreline of United States** (General).—Determined by using a unit measure of 3 statute miles on charts of 1 : 200,000 and 1 : 400,000 scale when available. The shoreline of islands is included, and of bays, sounds, and other bodies of water to a point where the waters narrow to a width of 3 statute miles, the distance across at such points being included. (*See* Table 4.)

**Tidal Test.**—A test of navigability based upon the presence of tidal influence in a waterway. First enunciated by Chancellor Kent, of the New York Supreme Court, who ruled in the early case of *Palmer* v. *Mulligan,* 3 Caines 307 (1805), that according to the common law of England only tidal streams were navigable waterways. See *Navigability* (English Doctrine), *Navigability Test.*

**Tide.**—The periodic rising and falling of the waters of the earth that result mainly from the gravitational attraction of the moon and sun acting upon the rotating earth. See *Tide-Producing Force.*

**Tidelands.**—The land that is covered and uncovered by the daily rise and fall of the tide. More specifically, it is the zone between the mean high-water line and the mean low-water line along a coast, and is commonly known as the "shore" or "beach." Referred to in legal decisions as between ordinary high-water mark and ordinary low-water mark. Tidelands presuppose a high-water line as the upper boundary. See *Ordinary Tides, Borax Consolidated, Ltd.* v. *Los Angeles.*

**Tide Notes.**—Notes included on the nautical charts which give information on the mean range or the diurnal range of the tide, mean tide level, and extreme low water at key places on the chart (*see* figs. 78 and 79). Formerly, the notes also furnished information for tide predicting purposes when used in conjunction with the Nautical Almanac. See *Extreme Low Water.*

**Tide Predicting Machine No. 2.**—An instrument designed in the Coast and Geodetic Survey for tide prediction by mechanically summing the harmonic constituents of which the tide is composed (*see* fig. 22). The machine was put in operation in 1912. See *Ferrel Tide Predicting Machine.*

**Tide Prediction.**—The mathematical process by which the times and heights of the tide are determined in advance from the harmonic constituents at a place. See *Harmonic Analysis, Harmonic Constituent.*

**Tide-Producing Force.**—That part of the gravitational attraction of a heavenly body which is effective in producing the tides on earth. The sun and moon are the principal astronomic bodies that have a tide-producing effect. The force varies approximately as the mass of the attracting body and inversely as the cube of its distance. The tide-producing force exerted by the sun is a little less than one-half that of the moon. See *Tide.*

**Tide Reducer.**—The correction that must be applied to a recorded sounding for the height of the tide above or below the plane of reference at the time of sounding. See *Plane of Reference.*

**Tide Roll.**—A roll of plain paper used with a standard automatic gage for recording the rise and fall of the tide. Each roll generally contains the record for a calendar month.

**Tide Staff.**—A tide gage consisting of a vertical graduated staff from which the height of the tide can be read directly. See *Automatic Tide Gage.*

**Tide Tables.**—Tables which give the predicted times and heights of high and low water for every day in the year for a number of reference stations, and tidal differences and constants by which additional predictions can be obtained for numerous other places. From these values it is possible to interpolate by a simple procedure the height of the tide at any hour of the day (*see* fig. 21). The coasts of the United States are covered in two volumes: East Coast, North and South America; and West Coast, North and South America. See *Tide Prediction, Tidal Difference, One-Quarter One-Tenth Rule.*

**Tidewaters.**—Waters subject to the rise and fall of the tide. Sometimes used synonymously with tidelands, but would be better to limit tidewaters to areas always covered with water. The amount of tide is immaterial. See *Tidelands.*

**Tier Lines.**—True parallels 6 miles apart which join corners on the principal meridian, guide meridians, and range lines (fig. 97). See *Township.*

**Tinted Areas.**—Those areas on the nautical chart that are symbolized by a flat color to indicate the nature of the area, such as buff for the land area, blue for the water area considered to be within the danger curve for a particular chart, and yellow-green for marsh areas and for low-water areas. See *Low-Water Area.*

**Topographical Conference of 1892.**—A conference convened in the Coast Survey for studying the state of the science and art of topography and looking toward improvement and standardization of the methods of survey and representation of the results. The conference adopted a set of conventional symbols, cancelling or modifying previous ones and adding some new ones (*see* figs. 51 and 52).

**Topographic Survey** (Coast and Geodetic Survey).—A record of a survey, *of a given date,* of the natural features and the culture of a portion of the land surface and their delineation by means of conventional symbols. As used in this publication, it is the *original field survey sheet* and is the authority for the high-water line and all information inshore of that line including geographic names of topographic features (fig. 44). See *Photogrammetric Survey, Registry Numbers.*

**Tort.**—A private or civil wrong or injury independent of contract. See *Federal Tort Claims Act, Maritime Tort.*

**Township.**—The unit of survey in the rectangular system, normally a quadrangle approximately 6 miles on a side with boundaries conforming to meridians and parallels, located with reference to the initial point of a principal meridian and base line. Townships are numbered consecutively as Township 1 North (T1N), Township 1 South (T1S), etc., north and south of the base line, and east and west of the principal meridian as Range 1 West (R1W), Range 1 East (R1E), etc., to the limit of the system controlled by an initial point. (*See* fig. 97.)

**Township Plats.**—Plats prepared by the Bureau of Land Management of the Department of the Interior showing the results of the public land surveys. Plats are generally drawn to a scale of 1 : 31,680, but scales of 1 : 15,840, or larger, may be used. The sheet size is always 19 by 24 inches, regardless of the scale.

**Tracing-Paper Method.**—A method of transferring one survey to another where small differences in scale exist due to distortion.

**Transcontinental Arc of Triangulation.**—The arc of triangulation along the 39th parallel that was completed in 1899 and which connected the various detached systems into one continuous triangulation. Its completion laid the foundation for establishing a single geographic datum for the whole country. See *Independent Datum, United States Standard Datum.*

**Transformation.**—In photogrammetry, the special process of rectifying the oblique images from a multiple-lens camera to equivalent vertical images by projection into a plane perpendicular to the camera axis. See *Rectification.*

**Transverse Mercator Projection.**—A conformal map projection in which the normal Mercator projection is rotated (transversed) 90° in azimuth, the central meridian corresponding to the line which represents the equator on the normal Mercator. The characteristics as to scale are identical to those of the normal Mercator, except that the scale is dependent on distances east or west of the meridian instead of north or south of the equator. The projection is used as the base for the State Coordinate Systems for states whose greatest extent is in a north-south direction. See *State Coordinate Systems, Mercator Projection.*

**Treaty of 1818.**—*See* Volume One, Appendix A.

**Treaty of Guadalupe Hidalgo.**—The peace treaty signed Feb. 2, 1848, at the close of the Mexican War, and proclaimed July 4, 1848. See *Mexican Cession.*

**Treaty of Paris.**—See *Treaty of Sept. 3, 1783.*

**Treaty of Sept. 3, 1783** (also called Treaty of Paris).—The treaty by which Great Britain recognized the independence of the United States.

**Triangulation.**—A method of surveying in which the stations are points on the ground at the vertices of a chain or network of triangles, whose angles are observed instrumentally and whose sides are derived by computation from selected triangle sides called base lines, the lengths of which are obtained from direct measurement on the ground. See *Trilateration, Basic Geodetic Networks of the Country.*

**Triangulation Classification.**—First-order, second-order, and third-order triangulation, according to the closure of the triangles. In first-order work, the average closure (variation from 180°) is not in excess of 1 second; in second-order work it does not exceed 3 seconds; and in third-order it does not exceed 5 seconds. For the basic first-order work, the computed length through the network must agree with the measured base within 1 part in 50,000, as a minimum, and averages about 1 in 75,000, or better. First-, second-, and third-order triangulation were prior to 1921 called primary, secondary, and tertiary triangulation, respectively.

**Triangulation Mark.**—A bronze disk set in the ground to identify a point whose latitude and longitude have been determined by triangulation. See *Triangulation.*

**Tributary Waterway.**—Any body of water that flows into a larger body—a creek in relation to a river, a river in relation to a bay, a bay in relation to the open sea (*see* fig. 92).

**Trilateration.**—A method of extending horizontal control where the sides of triangles are measured rather than the angles as in triangulation. See *Triangulation.*

**Tripartite System.**—A system in which the exercise of legislative, executive, and judicial powers are vested in separate and independent branches. A characteristic of the federal and state governments.

**Tropic Tides.**—Tides occurring semimonthly when the effect of the moon's maximum declination is greatest. At these times there is a tendency for an increase in the diurnal range.

**True Bay.**—*See* Volume One, Appendix A.

**True Bearings.**—Those related to the true meridian. See *True Meridian.*

**True Meridian.**—The line that passes through a given place and the geographical poles; the observer's plane that passes through the earth's axis of rotation. See *Magnetic Meridian.*

**True North.**—Geographic or astronomic north; coincides with the true meridian. See *Due North.*

**"T" Sheets.**—See *Registry Numbers.*

**Twenty-Four-Mile Rule.**—The rule adopted by the First Geneva Conference in 1958 as the closing line for bays in place of the former Ten-Mile Rule. See *Ten-Mile Rule, Closing Line.*

**Twenty-Four-Mile Tracts.**—The largest unit in the rectangular system of surveys. Each area, controlled by a principal meridian and a base line, is divided into tracts by means of standard parallels or correction lines (true parallels of latitude) located at intervals of 24 miles to the north and south of the base line and by means of guide meridians (true meridians) spaced at intervals of 24 miles east and west of the principal meridian. Because of the convergence of the meridians, the distance between the guide meridians is 24 miles only at the starting points; at all other points, the distance is less by the amount of the convergence. (*See* fig. 97.)

**Type of Tide.**—The characteristic form of the tide, with special reference to the relation of the diurnal and semidiurnal waves. Tides are usually classified as diurnal, semidiurnal, and mixed, but there are no sharply defined limits separating the groups.

## U

**Unalaska Datum.**—An independent datum in Alaska used along the south coast of the Alaska Peninsula from Cape Kuyuyukak to Umnak Island.

**Unilateral Action.**—*See* Volume One, Appendix A.

**Unincorporated Territory.**—A territory where there is no general applicability of the Constitution with respect to the civil and private rights of the inhabitants, and where Congress, in legislating for such territory, is bound by but few of the limitations which apply in the case of incorporated territories. See *Incorporated Territory.*

**United Nations Conferences on the Law of the Sea.**—*See* Volume One, Appendix A.

**United States.**—Includes continental United States plus Hawaii. See *Continental United States.*

**United States Board on Geographic Names.**—Created by President Harrison on Sept. 4, 1890, for the purpose of standardizing usage in regard to geographic nomenclature in the executive departments of the Government, particularly on the maps and charts issued by the various agencies. See *United States Geographic Board.*

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**United States–Canadian Boundary.**—Held to be a fixed boundary because the Treaty of Apr. 11, 1908, between the United States and Great Britain contained the following statement: "The line so defined and laid down shall be taken and deemed to be the international boundary." See *Fixed Riparian Boundary.*

**United States Geographic Board.**—Established on Aug. 10, 1906, by President Roosevelt as an enlargement of the duties of the United States Board on Geographic Names to include advisory powers concerning, among other things, the unification of symbols and conventions used on maps. See *United States Board on Geographic Names.*

**United States Reports.**—The official reports of the decisions of the Supreme Court and are printed by the Government. Prior to 1882, the volumes of these reports were designated by the name of the official reporter and a number. Later a serial number was added which carries through to the present time.

**United States–Russian Convention Line.**—A charted line of allocation in the Bering Sea and Bering Strait marking the western limit of the territories ceded to the United States by Russia under the convention of Mar. 30, 1867. See *Lines of Allocation.*

**United States Standard Datum.**—The first standard geographic (geodetic) datum adopted by the Coast and Geodetic Survey for all the triangulation in the United States. It was adopted on Mar. 13, 1901, and is defined by station *Meades Ranch,* whose position on the Clarke spheroid of 1866 is: Latitude $39°13'26''.686$, longitude $98°32'30''.506$, and azimuth to station *Waldo* $75°28'14''.52$. See *Transcontinental Arc of Triangulation, North American 1927 Datum.*

**United States v. Alaska** (Civil Action No. A–51–63).—A case pending in Mar. 1964 in the District Court of Alaska for the purpose of confirming title of the United States to certain submerged lands in Yakutat Bay.

**United States v. Appalachian Electric Power Co.** (311 U.S. 377).—A 1940 case which reaffirmed the doctrine of *The Daniel Ball* v. *United States,* 10 Wall. 557 (1871), but extended the legal concept of navigability to include waterways that may be made available for navigation through future reasonable improvements. See *Legal Concept of Navigability.*

**United States v. California** (332 U.S. 19).—*See* Volume One, Appendix A.

**United States v. Causby** (328 U.S. 256).—A 1946 case in which the Supreme Court rejected the *ad coelum* doctrine of unlimited ownership of the airspace above a landowner's property as having no place in the modern air age. However, if the flights of government aircraft are so low and so frequent as to be a direct and immediate interference with the enjoyment and use of the land, then there is a "taking of private property" under the fifth amendment for which there must be compensation. See *Taking of Private Property.*

**United States v. Louisiana et al.** (363 U.S. 1).—*See* Volume One, Appendix A.

**United States v. Muniz and Winston** (374 U.S. 150).—A 1963 case and the most recent pronouncement by the Supreme Court on the scope and construction of the Federal Tort Claims Act. By a unanimous vote, the Court refused to read into the act an implied exception which would have barred federal prisoners from recovery for the negligent conduct of prison employees.

**United States v. Newark Meadows Improvement Co.** (173 Fed. 426).—A 1909 case which held that the lines established by the U.S. Coast Guard to separate the areas where the Inland Rules of the Road apply from those where the International Rules apply have no application other than the purpose of determining what rules of navigation are to be followed. They do not define the limits of inland waters. See *Inland Rules of the Road, International Rules of the Road, Act of Feb. 19, 1895.*

**Unrecoverable Station.**—A triangulation station that cannot be found and cannot be included in the triangulation to connect it with a new datum. Sometimes referred to as a "lost" station.

**Upland.**—Land above mean high-water mark and subject to private ownership, as distinguished from tidelands, the ownership of which is prima facie in the state but also subject to divestment under state statutes. See *Tidelands.*

## V

**Valdez Datum.**—An independent datum used in Alaska for the work on the south coast of Alaska from Controller Bay in the vicinity of Cape St. Elias to Wide Bay on the Alaska Peninsula, and for the triangulation around Kodiak Island.

**Variation.**—See *Magnetic Declination.*

**Velocity of Sound in Sea Water.**—A function of the temperature, salinity, and depth of the water through which the sound wave passes. See *Echo Sounding.*

**Verification.**—The process by which the hydrographic survey undergoes in effect a complete check of the field observations and of the accuracy of the smooth plotting. It deals primarily with a specific survey and its accompanying records, and with correlating it to other contemporary surveys—the hydrographic surveys which adjoin it, and the contemporary planetable or photogrammetric survey. See *Review.*

**Vertical Control.**—See *Leveling.*

## W

**Waterfront Boundaries.**—See *Riparian Boundaries.*

**Water Leveling.**—A method of obtaining relative elevations by observing heights with respect to the surface of a body of still water, such as a lake. The relative elevations of objects along its shores are obtained by taking the differences of their heights with respect to the surface of the water.

**Western Adjustment.**—The unified adjustment made in 1927 of the triangulation west of the 98th meridian. See *North American 1927 Datum.*

**Wharf.**—An artificial landing place for the purpose of loading or unloading goods. It may be built out from the upland and form an extension thereof or it may be made on the land at the water's edge. See *Dock, Pier.*

**Wharfing Out.**—The right to construct and maintain a wharf, dock, or pier from riparian land to the navigable portion of adjoining waters, subject to the general rules imposed by the legislature. The right of access includes the right to wharf out to deep water. See *Right of Access.*

**Wire Drag.**—An apparatus, developed in the Coast and Geodetic Survey, for surveying rocky areas where the normal sounding methods are insufficient to ensure the discovery of all existing obstructions, pinnacle rocks, etc. The drag consists of a horizontal wire which is towed through the water and which will catch on any obstruction rising above the depth at which it is set.

**Wire-Dragged Areas.**—Areas in Alaska that have been covered to a safe depth with the wire drag, but which have not been adequately sounded. Symbolized on the nautical charts by a bright green tint. See *Wire Drag.*

**Witness Monument.**—A marked point established on firm ground at a measured distance and direction from a boundary line which may be so situated that it cannot be permanently marked. The Maryland-Virginia boundary line which followed the low-water mark on the Virginia side of the Potomac River was demarcated by establishing 58 boundary witness monuments above the high-water line and their geographic positions determined, points on the low-water line (the boundary) being determined by measured distances and directions.

**Wrecks.**—Charted wrecks are of two kinds: *Stranded wreck,* where any portion of the hull is above the chart datum; and *sunken wreck,* where the hull is below the chart datum or where the masts only are visible. For symbolization, *see* fig. 81.

**Writ of Error.**—A writ or order issued from a court of appellate jurisdiction directing the judge or judges of a court of record to send to the appellate court the record of an action in which a final judgment has been entered, in order that examination may be made of certain errors alleged to have been committed, and that judgment may be reversed, corrected, or affirmed. See *Certiorari.*

**Writ of Mandamus.**—An order issued from a court of competent jurisdiction directing the performance of a particular act.

## Y

**Yard.**—A fundamental unit of length in the English system of measurement. The metric equivalent prior to July 1, 1959, was 1 yard = 0.91440183 meter. On that date the value was changed to 1 yard = 0.9144 meter. This change will not apply to any data expressed in feet derived from and published as a result of geodetic surveys within the United States until such time as the basic geodetic survey networks are readjusted. See *Nautical Mile.*

**Youth, Maturity, Old Age** (Shore Development).—Stages in the development of a shoreline.

**Yukon Datum.**—An independent datum used for the triangulation along the 141st meridian, the boundary between Canada and Alaska, and covers the area from Mount St. Elias to the Arctic Ocean. It is based on one astronomic station near the crossing of the 141st meridian and the Yukon River. The Yukon Datum will remain the official datum for treaty purposes for the 141st meridian work, even though the connection to the North American 1927 Datum changed the geographic positions of the boundary monuments.

## Z

**"Zero" Soundings.**—Soundings that reduce to heights above the sounding datum but are shown on the smooth sheet as zero soundings, regardless of height—a practice followed prior to 1860. See *"Minus" Soundings*.

**Zone** (State Coordinate Systems).—The unit into which states are divided in the State Coordinate Systems in order to avoid too great an error being introduced when passing from geographic to plane coordinates. A new origin is used for each zone. To maintain an accuracy of 1 part in 10,000, a single zone may not exceed 158 miles in a north-south direction on the Lambert projection and in an east-west direction on the transverse Mercator before a new origin is required. See *State Coordinate Systems.*

## APPENDIX B

# Bibliography of Technical and Legal Sources Cited

*(In the following bibliography, books and journals are identified by capitals and small capitals, and articles are identified by italics. This follows the form used in the text.)*


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## APPENDIX C

# Selected Statutes Pertaining to the Coast and Geodetic Survey

### *Act of February 10, 1807 (2 Stat. 413).*

AN ACT

To provide for surveying the coasts of the United States.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the President of the United States shall be, and he is hereby authorized and requested, to cause a survey to be taken of the coasts of the United States, in which shall be designated the islands and shoals, with the roads or places of anchorage, within twenty leagues of any part of the shores of the United States; and also the respective courses and distances between the principal capes, or head lands, together with such other matters as he may deem proper for completing an accurate chart of every part of the coasts within the extent aforesaid.

SEC. 2. *And be it further enacted,* That it shall be lawful for the President of the United States to cause such examinations and observations to be made, with respect to St. George's bank, and any other bank or shoal and the soundings and currents beyond the distance aforesaid to the Gulf Stream, as in his opinion may be especially subservient to the commercial interests of the United States.

SEC. 3. *And be it further enacted,* That the President of the United States shall be, and he is hereby authorized and requested, for any of the purposes aforesaid, to cause proper and intelligent persons to be employed, and also such of the public vessels in actual service, as he may judge expedient, and to give such instructions for regulating their conduct as to him may appear proper, according to the tenor of this act.

SEC. 4. *And be it further enacted,* That for carrying this act into effect there shall be, and hereby is appropriated, a sum not exceeding fifty thousand dollars, to be paid out of any monies in the treasury, not otherwise appropriated.

APPROVED, *February 10, 1807.*

## *Act of July 10, 1832 (4 Stat. 570).*

AN ACT

To carry into effect the act to provide for a survey of the coast of the United States [Act of February 10, 1807].

*Be it enacted by the Senate and House of Representatives of the United States of America, in Congress assembled,* That for carrying into effect the act, entitled "An act to provide for surveying the coasts of the United States," approved on the tenth day of February, one thousand eight hundred and seven, there shall be, and hereby is, appropriated, a sum not exceeding twenty thousand dollars, to be paid out of any money in the treasury not otherwise appropriated; and the said act is hereby revived, and shall be deemed to provide for the survey of the coasts of Florida, in the same manner as if the same had been named therein.

SEC. 2. *And be it further enacted,* That the President of the United States be, and he is hereby authorized, in and about the execution of the said act, to use all maps, charts, books, instruments, and apparatus, which now, or hereafter may belong to the United States, and employ all persons in the land or naval service of the United States, and such astronomers and other persons as he shall deem proper: *Provided,* That nothing in this act, or the act hereby revived, shall be construed to authorize the construction or maintenance of a permanent astronomical observatory.

APPROVED, *July 10, 1832.*

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## *Act of March 3, 1843 (5 Stat. 630, 640).*

AN ACT

Making appropriations for the civil and diplomatic expenses of Government for the fiscal year ending the thirtieth day of June, eighteen hundred and forty-four.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums be, and hereby are, appropriated to the objects hereinafter expressed, for the fiscal year ending on the thirtieth of June, one thousand eight hundred and forty four, to be paid out of any unappropriated money in the treasury, namely:

* * * * * * *

For survey of the coast of the United States, including compensation of superintendent and assistants, one hundred thousand dollars: *Provided,* That this, and all other appropriations hereafter to be made for this work, shall, until otherwise provided by law, be expended in accordance with a plan of reorganizing the mode of executing the survey, to be submitted to the President of the United States by a board of officers which shall be organized by him, to consist of the present superintendent, his two principal assistants, and the two naval officers now in charge of the hydrographical parties, and four from among the principal officers of the corps of topographical engineers; none of whom shall receive any additional compensation whatever for this service, and who shall sit as soon as organized. And the President of the United States shall adopt and carry into effect the plan of said board, as agreed upon by a majority of its members; and the plan of said board shall cause to be employed as many officers of the army and navy of the United States as will be compatible with the successful prosecution of the work; the officers of the navy to be employed on the hydrographical parts, and the officers of the army on the topographical parts of the work; and no officer of the army or navy shall hereafter receive any extra pay out of this, or any future appropriations for surveys.

* * * * * * *

APPROVED, *March 3, 1843.*

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## *Act of June 3, 1844 (5 Stat. 660).*

AN ACT

Directing a disposition of maps and charts of the Survey of the Coast.

*Be it it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of the Treasury be, and he is hereby, authorized to dispose of the maps and charts of the survey of the coast of the United States at such prices and under such regulations as may from time to time be fixed by the said Secretary; and that a number of copies of each sheet, not to exceed three hundred, be presented to such foreign governments, and departments of our own government, and literary and scientific associations as the Secretary of the Treasury may direct.

APPROVED, *June 3, 1844.*

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## *Act of March 3, 1871 (16 Stat. 495, 508).*

AN ACT

Making Appropriations for sundry civil Expenses of the Government for the fiscal Year ending June thirty, eighteen hundred and seventy-two, and for other Purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums be, and the same are hereby, appropriated, for the objects hereinafter expressed, for the fiscal year ending the thirtieth June, eighteen hundred and seventy-two viz.:—

* * * * * * *

For extending the triangulation of the coast survey so as to form a geodetic connection between the Atlantic and Pacific coasts of the United States, including compensation of civilians engaged in the work, fifteen thousand dollars: *Provided,* That the triangulation shall determine points in each State of the Union which shall make requisite provisions for its own topographical and geological surveys.

* * * * * * *

APPROVED *March 3, 1871.*

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## *Act of June 20, 1878 (20 Stat. 206, 215).*

AN ACT

Making appropriations for sundry civil expenses of the government for the fiscal year ending June thirtieth, eighteen hundred and seventy-nine, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the following sums be, and the same are hereby, appropriated for the objects hereinafter expressed for the fiscal year ending June thirtieth, eighteen hundred and seventy-nine, namely:

* * * * * * *

### COAST AND GEODETIC SURVEY

Survey of the Atlantic and Gulf coasts: For every purpose and object necessary for and incident to the continuation of the survey of the Atlantic and Gulf coasts of the United States, the Mississippi, and other rivers, to the head of ship-navigation or tidal influence; soundings, deep-sea temperatures, dredgings, and current-observations along the above-named coasts, and in the Gulf of Mexico and the Gulf Stream, including its entrance into the Gulf of Mexico and east end of the Carribean Sea; the triangulation toward the Western coast and furnishing points for State surveys; the preparation and publication of charts, the Coast Pilot, and other results of the work, with the purchase of materials therefor, including compensation of civilians engaged in the work, three hundred thousand dollars.

Survey of the Western (Pacific) coasts: For every purpose and object necessary for and incident to the continuation of the survey of the Pacific coasts of the United States, including the resurvey of San Pablo Bay and Suisun Bay, California, the Columbia and other rivers, to the head of ship-navigation or tidal influence; soundings, deep-sea temperatures, dredgings, and current-observations along and in the branch of the Japan Stream flowing off the above-named coasts, with observations of other currents along the same coasts; the triangulation toward the eastern coast, and furnishing points for State surveys; the preparation and publication of charts, the Coast Pilot, and other results of the work, with the purchase of materials therefor, including compensation of civilians engaged in the work, one hundred and eighty thousand dollars.

* * * * * * *

APPROVED *June 20, 1878.*

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## *Act of May 22, 1917 (40 Stat. 84, 87).*

AN ACT

To temporarily increase the commissioned and warrant and enlisted strength of the Navy and Marine Corps, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the authorized enlisted strength of the active list of the Navy is hereby temporarily increased from eighty-seven thousand to one hundred and fifty thousand, including four thousand additional apprentice seamen.

* * * * * * *

SEC. 16. That the President is hereby authorized, whenever in his judgment a sufficient national emergency exists, to transfer to the service and jurisdiction of the War Department, or of the Navy Department, such vessels, equipment, stations, and personnel of the Coast and Geodetic Survey as he may deem to the best interest of the country, and after such transfer all expenses connected therewith shall be defrayed out of the appropriations for the department to which transfer is made: *Provided,* That such vessels, equipment, stations, and personnel shall be returned to the Coast and Geodetic Survey when such national emergency ceases, in the opinion of the President, and nothing in this Act shall be construed as transferring the Coast and Geodetic Survey or any of its functions from the Department of Commerce except in time of national emergency and to the extent herein provided: *Provided further,* That any of the personnel of the Coast and Geodetic Survey who may be transferred as herein provided shall, while under the jurisdiction of the War Department or Navy Department, have proper military status and shall be subject to the laws, regulations, and orders for the government of the Army or Navy, as the case may be, in so far as the same may be applicable to persons whose retention permanently in the military service of the United States is not contemplated by law: *And provided further,* That the President is authorized to appoint, by and with the advice and consent of the Senate, the field officers of the Coast and Geodetic Survey, who are now officially designated assistants and aids, as follows: Officers now designated assistants and receiving a salary of $2,000 or more per annum shall be appointed hydrographic and geodetic engineers; officers now designated assistants and receiving a salary of $1,200 or greater but less than $2,000 per annum shall be appointed junior hydrographic and geodetic engineers; officers now designated aids shall be appointed aids: *Provided,* That no person shall be appointed aid or shall be promoted from aid to junior hydrographic and geodetic engineer or from junior hydrographic and geodetic engineer to hydrographic and geodetic engineer until after passing a satisfactory mental and physical examination conducted in accordance with regulations prescribed by the Secretary of Commerce, except that the President is authorized to nominate for confirmation the assistants and aids in the service on the date of the passage of this Act.

Nothing in this Act shall reduce the total amount of pay and allowances they were receiving at the time of transfer. While actually employed in active service under direct orders of the War Department or of the Navy Department members of the Coast and Geodetic Survey shall receive the benefit of all provisions of laws relating to disability incurred in line of duty or loss of life.

When serving with the Army or Navy the relative rank shall be as follows:

Hydrographic and geodetic engineers receiving $4,000 or more shall rank with and after colonels in the Army and captains in the Navy.

Hydrographic and geodetic engineers receiving $3,000 or more but less than $4,000 shall rank with and after lieutenant colonels in the Army and commanders in the Navy.

Hydrographic and geodetic engineers receiving $2,500 or more but less than $3,000 shall rank with and after majors in the Army and lieutenant commanders in the Navy.

Hydrographic and geodetic engineers receiving $2,000 or more but less than $2,500 shall rank with and after captains in the Army and lieutenants in the Navy.

Junior hydrographic and geodetic engineers shall rank with and after first lieutenants in the Army and lieutenants (junior grade) in the Navy.

Aids shall rank with and after second lieutenants in the Army and ensigns in the Navy.

And nothing in this Act shall be construed to affect or alter their rates of pay and allowances when not assigned to military duty as hereinbefore mentioned.

The Secretary of War, the Secretary of the Navy, and the Secretary of Commerce shall jointly prescribe regulations governing the duties to be performed by the Coast and Geodetic Survey in time of war, and for the cooperation of that service with the War and Navy Departments in time of peace in preparation for its duties in war, which regulations shall not be effective unless approved by each of the said Secretaries, and included therein may be rules and regulations for making reports and communications between the officers or bureaus of the War and Navy Departments and the Coast and Geodetic Survey.

*      *      *      *      *      *      *

APPROVED, *May 22, 1917.*

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## *Act of August 6, 1947 (61 Stat. 787).*

AN ACT

To define the functions and duties of the Coast and Geodetic Survey, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That, to provide charts and related information for the safe navigation of marine and air commerce, and to provide basic data for engineering and scientific purposes and for other commercial and industrial needs, the Director of the Coast and Geodetic Survey, hereinafter referred to as the Director, under direction of the Secretary of Commerce, is authorized to conduct the following activities in the United States, its Territories, and possessions:

(1) Hydrographic and topographic surveys of coastal water and land areas (including surveys of offlying islands, banks, shoals, and other offshore areas);

(2) Hydrographic and topographic surveys of lakes, rivers, reservoirs, and other inland waters not otherwise provided for by statute;

(3) Tide and current observations;

(4) Geodetic-control surveys;

(5) Field surveys for aeronautical charts;

(6) Geomagnetic, seismological, gravity, and related geophysical measurements and investigations, and observations for the determination of variation in latitude and longitude.

SEC. 2. In order that full public benefit may be derived from the operations of the Coast and Geodetic Survey by the dissemination of data resulting from the activities herein authorized and of related data from other sources, the Director is authorized to conduct the following activities:

(1) Analysis and prediction of tide and current data;

(2) Processing and publication of data, information, compilations, and reports;

(3) Compilation and printing of aeronautical charts of the United States, its Territories, and possessions; and, in addition, the compilation and printing of such aeronautical charts covering international airways as are required primarily by United States civil aviation;

(4) Compilation and printing of nautical charts of the United States, its Territories, and possessions;

(5) Distribution of aeronautical charts and related navigational publications required by United States civil aviation;

(6) Distribution of nautical charts and related navigational publications for the United States, its Territories, and possessions.

SEC. 3. To provide for the orderly collection of geomagnetic data from domestic and foreign sources, and to assure that such data shall be readily available to Government and private agencies and individuals, the Coast and Geodetic Survey is hereby designated as the central depository of the United States Government for geomagnetic data, and the Director is authorized to collect, correlate, and disseminate such data.

SEC. 4. To improve the efficiency of the Coast and Geodetic Survey and to increase engineering and scientific knowledge, the Director is authorized to conduct developmental work for the improvement of surveying and cartographic methods, instruments, and equipments; and to conduct investigations and research in geophysical sciences (including geodesy, oceanography, seismology, and geomagnetism).

SEC. 5, The Director is authorized to enter into cooperative agreements with, and to receive and expend funds made available by, any State or subdivision thereof, or any public or private organization, or individual, for surveys or investigations authorized herein, or for performing related surveying and mapping activities, including special-purpose maps, and for the preparation and publication of the results thereof.

SEC. 6. The Director is authorized to contract with qualified organizations for the performance of any part of the authorized functions of the Coast and Geodetic Survey when he deems such procedure to be in the public interests.

SEC. 7. The Secretary of Commerce is hereby authorized to accept and utilize gifts or bequests of money and other real or personal property for the purpose of aiding or facilitating the work of the Coast and Geodetic Survey and such gifts and bequests and the income therefrom shall be exempt from Federal taxes.

SEC. 8. The President is authorized to cause to be employed such of the public vessels as he deems it expedient to employ, and to give such instructions for regulating their conduct as he deems proper in order to carry out the provisions of this Act.

SEC. 9. There are hereby authorized to be appropriated such funds as may be necessary to acquire, construct, maintain, and operate ships, stations, equipment, and facilities and for such other expenditures, including personal services at the seat of government and elsewhere and including the erection of temporary observatory buildings and lease of sites therefor, as may be necessary for the conduct of the activities herein authorized.

SEC. 10. The following statutes are hereby repealed:

(1) The Act of January 31, 1925 (ch. 121, 43 Stat. 802; 33 U.S.C. 866).

(2) Section 4681 of the Revised Statutes (33 U.S.C. 881).

(3) Section 4682 of the Revised Statutes (33 U.S.C. 882).

(4) Section 4683 of the Revised Statutes (33 U.S.C. 883).

(5) Section 4684 of the Revised Statutes (33 U.S.C. 883).

(6) Section 4686 of the Revised Statutes (33 U.S.C. 885).

APPROVED *August 6, 1947.*

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## *Act of April 5, 1960 (74 Stat. 16).*

AN ACT

To remove geographical limitations on activities of the Coast and Geodetic Survey, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the first section of the Act entitled "An Act to define the functions and duties of the Coast and Geodetic Survey, and for other purposes", approved August 6, 1947 (33 U.S.C., sec. 883a), is amended—

(1) by striking out "in the United States, its Territories, and possessions";

(2) by striking out "of coastal water and land areas (including survey of offlying islands, banks, shoals, and other offshore areas)"; and

(3) by striking out all of paragraph (2), and by renumbering paragraphs (3), (4), (5), and (6) as (2), (3), (4), and (5) respectively.

APPROVED *April 5, 1960.*

APPENDIX D

# Selected Cases Dealing With Tidal Boundaries

*(The following three cases were selected for inclusion in this Appendix because of their impact on the law of tidal boundaries in this country: The first,* Attorney-General *v.* Chambers, *is a leading English case in which the word "ordinary," as applied to tides, was first construed as meaning the medium tides between the springs and the neaps; the second,* Borax Consolidated, Ltd. *v.* Los Angeles, *established for the Federal courts the common law concept of "ordinary high-water mark" as "the mean high-tide line"; and the third,* Luttes *v.* The State of Texas, *established the civil (Spanish) law concept of "seashore" as extending to the line of "mean higher high tide.")*

## ATTORNEY-GENERAL *v.* CHAMBERS

### Before the Lord Chancellor Lord CRANWORTH, assisted by Mr. Baron ALDERSON and Mr. Justice MAULE 4 De G. M. & G. 206 (1854)

In this case an information was filed by the Attorney-General against the owners and lessees of a district abutting on and extending along the sea-shore of the parish of Llanelly, in the county of Carmarthen. The information alleged that by the royal prerogative the sea-shore, and the soil of all arms and creeks of the sea, and of all public ports and havens round this kingdom as far as the sea flows and reflows between high and low water mark, and the soil of the navigable rivers of this kingdom, and all mines and minerals lying under the sea, sea-shore, arms and creeks of the sea, and all profits arising from the shore and soil belonged to her Majesty, and have at all times belonged to her and her royal predecessors, kings and queens of this realm. The information stated that there were very valuable and extensive veins, seams or strata of coal and culm lying under that part of the parish of Llanelly which was contiguous to the sea-shore, and particularly under the land belonging to the defendant David Lewis, called or known by the name of Old Castle Farm, and that such veins, seams, or strata of coal and culm continued and extended also under the contiguous sea-shore below the line of high-water mark and under the sea.

The information charged that the sea-shore, which was vested in her Majesty by virtue of her prerogative, extended landwards as far as high-water mark at ordinary monthly spring-tides, or at all events far beyond high-water mark at neap-tides, and up to the medium line of high-water mark between neap and spring tides. The information charged that encroachments had been made by the defendants on the shore by means of embankments; and that valuable coal mines were worked under that part of the shore that lay to the seaward of high water mark at ordinary neap-tides before the sea was excluded by the embankment.

The information prayed that the right of her Majesty to the sea-shore of the parish of Llanelly below high-water mark might be established; that the leaves or licenses to embank, or build, or dig, or raise coal from the said sea-shore might be declared null void, and delivered up to be cancelled, and that the boundary or mark to which the sea flowed at high ordinary tides upon the shore of the parish of Llanelly, adjoining the lands in the occupation or possession of the defendant D. Lewis, before the embankments were erected, and also those portions of the works or mines from which coal or culm were gotten, which lay under land belonging to her Majesty, might be ascertained and distinguished, and that the nuisances arising from the erection of the works might be abated.

Answers were put in by the several defendants, controverting the right asserted by the Crown, and submitting that at the utmost the Crown's right did not extend landwards beyond the line of high-water mark of ordinary neap-tides, and did not embrace any alluvium of gradual formation.

The cause originally came on to be heard before the Master of the Rolls, and on the 21st January, 1852, his Honor directed certain issues to be tried between the Crown and Lord Cawdor, and Mr. Chambers (two of the defendants and principal owners of the shore); no issue, however, was directed as between the Crown and the defendant D. Lewis, who was also an owner, the Attorney-General having been of opinion that the issues between the Crown and the two principal defendants should be first disposed of. The issues came on to be tried on a trial at bar before a jury at the Queen's Bench, sitting *in banco* on the 19th February, 1854, when a verdict by agreement was entered for the Crown. The Act 15 & 16 Vict. c. 86, having in the mean time passed (by the 62d section of which a Court of Equity is empowered to determine the legal rights of parties without directing a trial at law), and the question, so far as regarded the rights of the defendant Lewis, being still undecided, it was arranged that the cause should be set down on further directions, to be heard by consent of the Lord Chancellor, before his Lordship in the first instance, assisted by two of the Judges of the Courts of Common Law. His Lordship having accordingly invited the attendance of Mr. Baron Alderson and Mr. Justice Maule to assist in the determination of the question, those learned Judges now attended.

The following passages from Lord Chief Justice Hale's Treatise De Jure Maris (Hargrave's Tracts 12, 25, 26) were much commented upon in the argument, and by the learned Judges and Lord Chancellor, and are here inserted for the convenience of reference:—

> "The shore is that ground that is between the ordinary high-water and low-water mark. This doth *prima facie* and of common right belong to the King, both in the shore of the sea, and the shore of the arms of the sea.
>
> "And herein there will be these things examinable,—
>
> "1st. What shall be said the shore or *littus maris?*
>
> "2d. What shall be said an arm or creek of the sea?
>
> "3d. What evidence there is of the King's propriety thereof.
>
> "I. For the first of these it is certain that that which the sea overflows, either at high spring-tides, or extraordinary tides, comes not as to this purpose under the denomination of *littus maris;* and consequently the King's title is not of that large extent, but only to land that is usually overflowed at ordinary tides. And so I have known it ruled in the Exchequer Chamber in the case of Vanhaesdanke, on prosecution by information against Mr. Whiting, about 12 Car. 1, for lands in the county of Norfolk, and accordingly ruled, 15 Car. B. R., Sir Edward Heron's case and Pasch, 17 Car. 2, *in Scaccario* upon evidence between the Lady Wansford's lessee and Stephens, in an

*ejectione firmae* for the town of Cowes, in the Isle of Wight. That therefore I call the shore that is between the common high-water and low-water mark, and no more.

*　*　*　*　*　*　*

"There seems to be three sorts of shores or *littora marina* according to the various tides (Hargrave's Tracts 25); viz.,—

"(1st) The high spring-tides, which are the fluxes of the sea at those tides that happen at the two equinoctials; and certainly this doth not *de jure communi* belong to the Crown. For such spring-tides many times overflow ancient meadows and salt marshes, which yet unquestionably belong to the subject. And this is admitted of all hands.

"(2d) The spring-tides which happen twice every month, at full and change of the moon, and the shore in question, is by some opinion not denominated by these tides neither, but the land overflowed with these fluxes ordinarily belong to the subject *prima facie,* unless the King hath a prescription to the contrary. And the reason seems to be, because for the most part the lands covered by these fluxes are dry and maniorable; for at other tides the sea doth not cover them, and therefore touching these shores, some hold that common right speaks for the subject, unless there be an usage to entitle the Crown; for this is not properly *littus maris.* And therefore it hath been held that where the King makes his title to land as *littus maris,* or *parcella littoris marini,* it is not sufficient for him to make it appear to be overflowed at spring-tides of this kind, P. 8, Car. 1, *in Camera Scaccarii,* in the case of Vanhaesdanke for lands in Norfolk; and so I have heard it was held, P. 15, Car. B. R., Sir Edward Heron's case, and Tr. 17, Car. 2, in the case of the Lady Wandesford, for a town called the Cowes, in the Isle of Wight, *in Scaccario.*

"(3d) Ordinary tides or neap-tides, which happen between the full and change of the moon; and this is that which is properly *littus maris,* sometimes called *marettum,* sometimes *warettum.* And touching this kind of shore, viz., that which is covered by the ordinary flux of the sea, is the business of our present inquiry."

*The Solicitor-General, Mr. James,* and *Mr. Hansen,* for the Crown.—By the feudal law all the real property of this country was vested in the Crown, and the sea-shore appertaining to the sovereign commences with that portion of the shore where the interests of the public may be said to begin; and therefore the rights of the adjacent freeholders are bounded not merely by the ordinary flux and reflux of the tide, but the Crown for the benefit of the public has a right to all the intervening space between the highest and the ordinary high-water mark; for though the soil of the sea between high and low water mark may be parcel of the manor of a subject, *Constable's Case* (5 Rep. 107 *a*), yet, as Lord HALE, in his Treatise De Jure Maris, says, p. 22 this "*jus privatum* that is acquired to the subject either by patent or prescription must not prejudice the *jus publicum* where with public rivers or arms of the sea are affected for public use." Mr. Justice BAYLEY, in the case of *Scratton* v. *Brown* (4 B. & C. 485, 495), observes, "The property in such land *prima facie* is in the Crown," and it is quite clear that if the sea encroach upon the land of a subject gradually, the land thereby covered by water belongs to the Crown; in *The Matter of the Hull and Selby Railway* (5 M. & W. 327), *Rex* v. *Lord Yarborough* (3 B. & C. 91; S. C., 2 Bligh, N. S. 147). The limit to which the Crown would be entitled by the rule of the civil law will give us more than we claim; by that law the shore is defined to be so far as the greatest winter tides do run.

[ALDERSON, B., referred to the observations of HOLROYD, J., in the case of *Blundell* v. *Catteral* (5 B. & A. 268, 292), as to the variance between the common law and civil law in regard to maritime rights, showing that the civil law was not any guide in such matters.]

With reference to the word "ordinary," that must be intended to comprehend such phenomena as are of the most constant recurrence, and the word itself is just as applicable to spring as neap tides (Anon., Dyer, 326*b*).

They referred to *Berry* v. *Holden* (3 Dun. & Bell. 205), *Attorney-General* v. *Burridge* (10 Price 350), and *Attorney-General* v. *Parmeter* (10 Price 378), Lord Stair's Institutes, Vol. II. p. 190. They also relied upon the observations attributed to Lord BROUGHAM in the case of *Smith* v. *The Earl of Stair* (6 Bell. Ap. Ca. 847), indicating a preference for the former of the opinions which is to be found in p. 12 of the Treatise De Jure Maris.

*Mr. R. Palmer, Mr. Goldsmid,* and *Mr. Mellish,* for Mr. Lewis.—We submit that the neap-line best fulfils the definition of "ordinary" high-water mark, inasmuch as that line would include land covered every day in the year by the sea. Lord HALE, defining the shore to be that space usually overflowed at ordinary tides, p. 26, excludes all spring-tides. On this principle PARKE, J., says, in the case of *Lowe* v. *Govett* (3 B. & Ad. 863, 871), "In the absence of proof to the contrary, the presumption as to such land (meaning land above the ordinary high-water mark) is in favour of the adjoining proprietor." The only case in which the Crown was held to be entitled is *Attorney-General* v. *Parmeter* (10 Price 378); but that was the case of a nuisance, and there the parties were claiming under the Crown, and the decision was that the grant was bad.

If the right of conservancy is attributed to the Crown to the extent asserted by the information, the consequence will be directly repugnant to the doctrine laid down by Lord HALE, in p. 26 of the Treatise De Jure Maris, and would include lands which, by reason of their being uncovered for the greatest part of the year are dry and maniorable.

*Mr. Roupell* and *Mr. Dickinson* appeared for Messrs. Sims, Williams, & Co., lessees under Mr. Lewis.

*Mr. James,* in reply.—In *Lowe* v. *Govett* the Crown was not a party; and even granting the presumption in favour of the adjacent proprietors, still this will not deprive the Crown of the right here asserted, nor dispense with the obligations of protecting the interests of the public for the purposes of navigation.

At the conclusion of the argument the learned Judges desired time to consider the question which had been submitted to them; and on the 8th July, 1854, Mr. Baron ALDERSON, on behalf of Mr. Justice MAULE and himself, delivered the following joint opinion:—

MY LORD CHANCELLOR.—In this case, on which your Lordship has requested the assistance of my brother MAULE and myself, I am now to deliver our joint opinion on the only question argued before us. That question, as I understand it, is this: What, in the absence of all evidence of particular usage, is the limit of the title of the Crown to the sea-shore? The Crown is clearly in such a case, according to all the authorities, entitled to the *littus maris* as well as to the soil of the sea itself adjoining the coasts of England. What then, according to the authorities in our law, is the extent of this *littus maris?*

This, in the absence of any grant, or usage from which a grant may be presumed, is according to the civil law defined as the part of the shore bounded by the extreme limit to which the highest natural tides extend, "Quatenus hybernus fluctus maximus excurrit," i.e., the highest natural tide; for according to Lord STAIR's exposition, the definition does not include the highest actual tides, for these may be produced by peculiarities of wind or other temporary or accidental circumstances, concurring with the flow produced by the action of the sun and moon upon the ocean.

But this definition (even thus expounded by the authorities) of the civil law is clearly not the rule of the common law of England.

Mr. Justice HOLROYD, no mean authority, in his very elaborate judgment in the case of *Blundell* v. *Catterall* (5 B. & A. 268, 290), mentions this as one of the instances in which the common law differs from the civil law, and says that it is clear that according to our law it is not the limit of the highest tides of the year, but the limit reached by the highest ordinary tides of the sea, which is the limit of the shore belonging *prima facie* to the Crown. What, then, are these "highest ordinary tides"? Now we know that in fact the tides of each day, nay, even each of the tides of each day, differ in some degree as to the limit which they reach. There are the spring-tides at the equinox, the highest of all. These clearly are excluded in terms by Lord HALE, both in p. 12 and in p. 26 of his Treatise De Jure Maris. For though in one sense these are ordinary, i.e. according to the usual order of nature, and not caused by accidents of the winds and the like, yet they do not ordinarily happen but only at two periods of the year. These, then, are not the tides contemplated by the common law, for they are not "ordinary tides," not being "of common occurrence." This may perhaps apply to the spring tides of each month, exclusive of the equinoctial tides; and indeed, if the case were without distinct authority on this point, that is the conclusion at which we might have arrived. But then we have Lord HALE's authority, p. 26, De Jure Maris, who says, "Ordinary tides or neap-tides which happen between the full and change of the moon" are the limit of "that which is properly called *littus maris,"* and he excludes the spring-tides of the month, assigning as the reason that the "lands covered with these fluxes are for the most part of the year dry and maniorable," i.e., not reached by the tides. And to the same effect is the case of *Lowe* v. *Govett* (3 B. & Ad. 863), which excludes these monthly spring-tides also.

But we think that Lord HALE's reason may guide us to the proper limit. What are then the lands which for the most part of the year are reached and covered by the tides? The same reason that excludes the highest tides of the month (which happen at the springs) excludes the lowest high tides (which happen at the neaps), for the highest or spring-tides and the lowest high tides (those at the neaps) happen as often as each other. The medium tides, therefore, of each quarter of the tidal period afford a criterion which we think may be best adopted. It is true of the limit of the shore reached by these tides that it is more frequently reached and covered by the tide than left uncovered by it. For about three days it is exceeded, and for about three days it is left short, and on one day it is reached. This point of the shore therefore is about four days in every week, i.e., for the most part of the year, reached and covered by the tides. And as some not indeed perfectly accurate construction, but approximate, must be given to the words "highest ordinary tides" used by Mr. Justice HOLROYD, we think, after fully considering it, that this best fulfils the rules and the reasons for it given in our books.

We therefore beg to advise your Lordship that, in our opinion, the average of these medium tides in each quarter of a lunar revolution during the year gives the limit, in the absence of all usage, to the rights of the Crown on the sea-shore.

THE LORD CHANCELLOR.—The question for decision is, what is the extent of the right of the Crown to the sea-shore? Its right to the *littus maris* is not disputed. But what is the *littus?* Is it so much as is covered by ordinary spring-tides, or is it something less? The rule of the civil law was, "Est autem littus maris quatenus hybernus fluctus maximus excurrit." This is certainly not the doctrine of our law. All the authorities concur in the conclusion that the right is confined to what is covered by "ordinary" tides, whatever be the right interpretation of that word. By "hybernus fluctus maximus" is clearly meant extraordinary high tides, though, speaking with physical accuracy, the winter tide is not in general the highest.

Land covered only by these extraordinary tides is not what is meant by the sea-shore; such tides may be the result of wind, or other causes independent of what ordinarily regulates flux and reflux. Setting aside these accidental tides, the question is, What is the meaning of ordinary? It is evidently a word of doubtful import. In one sense, the highest equinoctial spring tides are "ordinary;" i.e., they occur in the natural order of things. But this is evidently not the sense in which the word ordinary is used when designating the extent of the Crown's right to the shore. Treatise De Jure Maris, pp. 12, 25.

Disregarding, then, extreme tides, we next come to the ordinary spring-tides, i.e., the spring-tides of each lunar month. No doubt, speaking scientifically, they probably all differ; but practically this may be disregarded. Lord HALE gives no absolutely decided opinion; but he evidently leans very strongly against the right to the land covered only by spring-tides (Treatise De Jure Maris, p. 26), and refers to decisions which support his views. Then he describes ordinary tides as if synonymous with neap-tides.

This leaves the question very much at large, and there is very little of modern authority. In *Blundell* v. *Catterall* (5 B. & A. 268), Mr. Justice HOLROYD says, by the common law, i.e., the shore, is confined to the flux and reflux of the sea at ordinary tides, meaning the land covered by such flux and reflux.

Still the question remains, What are ordinary tides? The nearest approach to direct authority is *Lowe* v. *Govett* (3 B. & Ad. 863). There certain recesses on the coast, covered by the high water of ordinary spring-tides, but not by the medium tides between spring and neap tides, were held not to pass under an Act vesting in a company an arm of the sea daily overflowed by it. Lord TENTERDEN held that these recesses were not ordinarily overflowed by the sea, which shows clearly that he did not consider the overflowing by ordinary spring-tides to be what is meant by ordinarily overflowing; and both Mr. Justice LITTLEDALE and Mr. Justice (now Baron) PARKE concur in saying that the recesses in question were above ordinary high-water mark, clearly showing their opinion to be that what is meant by ordinary high-water mark is not so high as the limit of high water at ordinary spring-tides.

There is, in truth, no further authority to guide us; for the question did not arise in either of the cases of *Attorney-General* v. *Burridge* (10 Price 350), or *Attorney-General* v. *Parmeter* (10 Price 378), as to the buildings at Portsmouth.

In this state of things, we can only look to the principle of the rule which gives the shore to the Crown. That principle I take to be that it is land not capable of ordinary cultivation or occupation, and so is in the nature of unappropriated soil. Lord HALE gives as his reason for thinking that lands only covered by the high spring-tides do not belong to the Crown, that such lands are for the most part dry and maniorable; and taking this passage as the only authority at all capable of guiding us, the reasonable conclusion is, that the Crown's right is limited to land which is for the most part not dry or maniorable.

The learned Judges whose assistance I had in this very obscure question point out that the limit indicating such land is the line of the medium high tide between the springs and the neaps. All land below that line is more often than not covered at high water, and so may justly be said, in the language of Lord HALE, to be covered by the ordinary flux of the sea. This cannot be said of any land above that line; and I therefore concur with the able opinion of the Judges, whose valuable assistance I had, in thinking that medium line must be treated as bounding the right of the Crown.

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## BORAX CONSOLIDATED, LTD. ET AL. *v.* LOS ANGELES

### In the Supreme Court of the United States

### 296 U.S. 10 (1935)

MR. CHIEF JUSTICE HUGHES delivered the opinion of the Court.

The City of Los Angeles brought this suit to quiet title to land claimed to be tideland of Mormon Island situated in the inner bay of San Pedro now known as Los Angeles Harbor. The City asserted title under a legislative grant by the State. Stats. Cal. 1911, p. 1256; 1917, p. 159.[1] Petitioners claimed under a preemption patent issued by the United States on December 30, 1881, to one William Banning. The District Court entered a decree, upon findings, dismissing the complaint upon the merits and adjudging that petitioner, Borax Consolidated, Limited, was the owner in fee simple and entitled to the possession of the property. 5 F. Supp. 281. The Circuit Court of Appeals reversed the decree. 74 F. (2d) 901. Because of the importance of the questions presented, and of an asserted conflict with decisions of this Court, we granted certiorari, June 3, 1935.

In May, 1880, one W. H. Norway, a Deputy Surveyor, acting under a contract with the Surveyor General of the United States for California, made a survey of Mormon Island. The surveyor's field notes and the corresponding plat of the island were approved by the Surveyor General and were returned to the Commissioner of the General Land Office. The latter, having found the survey to be correct, authorized the filing of the plat. The land which the patent to Banning purported to convey was described by reference to that plat as follows: "Lot numbered one, of section eight, in township five south, of range thirteen west of San Bernardino Meridian, in California, containing eighteen acres, and eighty-eight hundredths of an acre, according to the Official Plat of the Survey of the said Lands, returned to the General Land Office by the Surveyor General."

The District Court found that the boundaries of "lot one," as thus conveyed, were those shown by the plat and field notes of the survey; that all the lands described in the complaint were embraced within that lot; and that no portion of the lot was or had been

1. The Act of 1911 (Stats. 1911, c. 656, p. 1256) provided: "There is hereby granted to the city of Los Angeles, a municipal corporation of the State of California, and to its successors, all the right, title and interest of the State of California, held by said state by virtue of its sovereignty, in and to all tide lands and submerged lands, whether filled or unfilled, within the present boundaries of said city, and situated below the line of mean high tide of the Pacific ocean, or of any harbor, estuary, bay or inlet within said boundaries, to be forever held by said city, and by its successors, in trust for the uses and purposes, and upon the express conditions following, to wit:" The conditions which followed are not material here.

The granting clause above quoted is the same in the Act of 1917 (Stats. 1917, p. 159).

tideland or situated below the line of mean high tide of the Pacific Ocean or of Los Angeles Harbor. The District Court held that the complaint was a collateral, and hence unwarranted, attack upon the survey, the plat and the patent; that the action of the General Land Office involved determinations of questions of fact which were within its jurisdiction and were specially committed to it by law for decision; and that its determinations, including that of the correctness of the survey, were final and were binding upon the State of California and the City of Los Angeles, as well as upon the United States.

The Circuit Court of Appeals disagreed with this view as to the conclusiveness of the survey and the patent. The court held that the Federal Government had neither the power nor the intention to convey tideland to Banning, and that his rights were limited to the upland. The court also regarded the lines shown on the plat as being meander lines and the boundary line of the land conveyed as the shore line of Mormon Island. The court declined to pass upon petitioners' claim of estoppel *in pais* and by judgment, upon the ground that the question was not presented to or considered by the trial court, and was also of the opinion that the various questions raised as to the failure of the City to allege and prove the boundary line of the island were important only from the standpoint of the new trial which the court directed. 74 F. (2d) p. 904. For the guidance of the trial court the Court of Appeals laid down the following rule: The "mean high tide line" was to be taken as the boundary between the land conveyed and the tideland belonging to the State of California, and in the interest of certainty the court directed that "an average for 18.6 years should be determined as near as possible by observation or calculation." *Id.*, pp. 906, 907.

Petitioners contest these rulings of the Court of Appeals. With respect to the ascertainment of the shore line, they insist that the court erred in taking the "mean high tide line" and in rejecting "neap tides" as the criterion for ordinary high water mark.

1. The controversy is limited by settled principles governing the title to tidelands. The soils under tidewaters within the original States were reserved to them respectively, and the States since admitted to the Union have the same sovereignty and jurisdiction in relation to such lands within their borders as the original States possessed. *Martin* v. *Waddell*, 16 Pet. 367, 410; *Pollard* v. *Hagan*, 3 How. 212, 229, 230; *Goodtitle* v. *Kibbe*, 9 How. 471, 478; *Weber* v. *Harbor Commissioners*, 18 Wall. 57, 65, 66; *Shively* v. *Bowlby*, 152 U.S. 1, 15, 26. This doctrine applies to tidelands in California. *Weber* v. *Harbor Commissioners, supra; Shively* v. *Bowlby, supra*, pp. 29, 30; *United States* v. *Mission Rock Co.*, 189 U.S. 391, 404, 405. Upon the acquisition of the territory from Mexico, the United States acquired the title to tidelands equally with the title to upland, but held the former only in trust for the future States that might be erected out of that territory. *Knight* v. *United States Land Assn.*, 142 U.S. 161, 183. There is the established qualification that this principle is not applicable to lands which had previously been granted by Mexico to other parties or subjected to trusts which required a different disposition,—a limitation resulting from the duty resting upon the United States under the treaty of Guadalupe Hidalgo (9 Stat. 922), and also under principles of international law, to protect all rights of property which had emanated from the Mexican Government prior to the treaty. *San Francisco* v. *LeRoy*, 138 U.S. 656, 671; *Knight* v. *United States Land Assn., supra; Shively* v. *Bowlby, supra*. That limitation is not applicable here, as it is not contended that Mormon Island was included in any earlier grant. See *DeGuyer* v. *Banning*, 167 U.S. 723.

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It follows that if the land in question was tideland, the title passed to California at the time of her admission to the Union in 1850. That the Federal Government had no power to convey tidelands, which had thus vested in a State, was early determined. *Pollard* v. *Hagan, supra; Goodtitle* v. *Kibbe, supra.* In those cases, involving tidelands in Alabama, the plaintiffs claimed title under an inchoate Spanish grant of 1809, an Act of Congress confirming that title, passed July 2, 1836, and a patent from the United States, dated March 15, 1837. The Court held that the lands, found to be tidelands, had passed to Alabama at the time of her admission to the Union in 1819, that the Spanish grant had been ineffective, and that the confirming Act of Congress and the patent conveyed no title. The Court said that "The right of the United States to the public lands, and the power of Congress to make all needful rules for the sale and disposition thereof, conferred no power to grant to the plaintiffs the land in controversy." *Pollard* v. *Hagan, supra.* See also *Shively* v. *Bowlby, supra,* at pp. 27, 28; *Mobile Transportation Co.* v. *Mobile,* 187 U.S. 479, 490; *Donnelly* v. *United States,* 228 U.S. 243, 260–261.

2. As to the land in suit, petitioners contend that the General Land Office had authority to determine the location of the boundary beween upland and tideland and did determine it through the survey in 1880 and the consequent patent to Banning, and that this determination is conclusive against collateral attack; in short, that the land in controversy has been determined by competent authority not to be tideland and that the question is not open to reexamination. Petitioners thus invoke the rule that "the power to make and correct surveys belongs to the political department of the government and that, whilst the lands are subject to the supervision of the General Land Office, the decisions of that bureau in all such cases, like that of other special tribunals upon matters within their exclusive jurisdiction, are unassailable by the courts, except by a direct proceeding." R.S., §§ 453, 2395–2398, 2478; 43 U.S.C. 2, 751–753, 1201. *Cragin* v. *Powell,* 128 U.S. 691, 698, 699; *Heath* v. *Wallace,* 138 U.S. 573, 585; *Knight* v. *United States Land Assn., supra; Stoneroad* v. *Stoneroad,* 158 U.S. 240, 250, 252; *Russell* v. *Maxwell Land Grant Co.,* 158 U.S. 253, 256; *United States* v. *Coronado Beach Co.,* 255 U.S. 472, 487, 488.

But this rule proceeds upon the assumption that the matter determined is within the jurisdiction of the Land Department. *Cragin* v. *Powell, supra.* So far as pertinent here, the jurisdiction of the Land Department extended only to "the public lands of the United States." The patent to Banning was issued under the preemption laws, which expressly related to lands "belonging to the United States." R.S. 2257, 2259. Obviously these laws had no application to lands which belonged to the States. Specifically, the term "public lands" did not include tidelands. *Mann* v. *Tacoma Land Co.,* 153 U.S. 273, 284. "The words 'public lands' are habitually used in our legislation to describe such as are subject to sale or other disposal under general laws." *Newhall* v. *Sanger,* 92 U.S. 761, 763; *Barker* v. *Harvey,* 181 U.S. 481, 490; *Union Pacific R. Co.* v. *Harris,* 215 U.S. 386, 388.

The question before us is not as to the general authority of the Land Department to make surveys, but as to its authority to make a survey, as a basis for a patent, which would preclude the State or its grantee from showing in an appropriate judicial proceeding that the survey was inaccurate and hence that the patent embraced land which the United States had no power to convey. Petitioners' argument in substance is that while the United States was powerless as against the State to pass title to tidelands in the absence of a survey (*Pollard* v. *Hagan, supra*), the question whether or not the land was tideland would be foreclosed by a departmental survey, although erroneous. This contention encounters the principle that the question of jurisdiction, that is, of the competency of the Department to act upon the subject matter, is always one for judicial determination. "Of course," said the Court in *Smelting Co.* v. *Kemp*, 104 U.S. 636, 641, "when we speak of the conclusive presumptions attending a patent for lands, we assume that it was issued in a case where the department had jurisdiction to act and execute it; that is to say, in a case where the lands belong to the United States, and provision had been made by law for their sale. If they never were public property, or had previously been disposed of, or if Congress had made no provision for their sale, or had reserved them, the department would have no jurisdiction to transfer them, and its attempted conveyance of them would be inoperative and void, no matter with what seeming regularity the forms of law may have been observed." The Court added that questions of that sort "may be considered by a court of law"; for in such cases "the objection to the patent reaches beyond the action of the special tribunal, and goes to the existence of a subject upon which it was competent to act." *Id.* See, also, *Polk* v. *Wendall,* 9 Cranch 87, 99; *Moore* v. *Robbins,* 96 U.S. 530, 533; *Wright* v. *Roseberry,* 121 U.S. 488, 519; *Doolan* v. *Carr,* 125 U.S. 618, 625; *Hardin* v. *Jordan,* 140 U.S. 371, 401; *Crowell* v. *Benson,* 285 U.S. 22, 58, 59. Here, the question goes to the existence of the subject upon which the Land Department was competent to act. Was it upland, which the United States could patent, or tideland, which it could not? Such a controversy as to title is appropriately one for judicial decision upon evidence, and we find no ground for the conclusion that it has been committed to the determination of administrative officers.

Petitioners urge a distinction in that at the time of the survey no private right in the property had yet attached and the question lay between the Federal Government and the State of California. But the distinction is immaterial. If tideland, the title of the State was complete on admission to the Union. No transfer to private parties was necessary to perfect or assure that title and no power of disposition remained with the United States.

To support their contention as to the conclusiveness of the survey and patent, petitioners largely rely upon our decision in *Knight* v. *United States Land Assn., supra.* But that decision is not in point, as it related to land which, albeit tideland, had been the subject of a Mexican grant made prior to statehood. What had there been done by the Federal Government was found to be in pursuance of the duty of the United States, imposed by the treaty of Guadalupe Hidalgo and the principles of international law, to protect the rights of property which had previously been created by the Mexican Government. The contest related to land in Mission Creek, an estuary of the bay of San Francisco. The plaintiffs claimed under a tideland grant from the State. The defendant's claim rested upon the title of the City of San Francisco as successor to the Mexican pueblo of that name. Following the procedure prescribed by statute with respect to the confirmation of such titles (Acts of March 3, 1851, 9 Stat. 631; July 1, 1864, 13 Stat. 332), the City had obtained a confirmatory decree from the United States Circuit Court in May, 1865. The statutes required that such a decree should be followed by a survey under the supervision of the General Land Office, and patent was to issue to the successful claimant when such survey had been finally approved. *Id.* Accordingly, after the decree in favor of the City, a survey was made, which was approved by the Surveyor General and the Commissioner of the General Land Office. The line of that survey ran along the line of ordinary high water mark of the bay of San Francisco, but in the case of the estuary followed the tideline up the creek end, crossing over, ran down on the other side. The City objected to that method, insisting that the line should have crossed the mouth of the estuary, and, on appeal, that contention was sustained by the Secretary of the Interior. A second survey was made pursuant to that decision and a patent was issued. 142 U.S. pp. 162–172. The plaintiffs contended that the first survey was correct and the second unauthorized. Reviewing that branch of the case, the Court decided that the Secretary of the Interior had power to set aside the first survey and direct another, and that the departmental action in that particular was unassailable. But that conclusion was not sufficient to meet the plaintiffs' claim under the state grant, unless it could be held that title to the land had not passed to the State. Upon that question the court found that the case of *San Francisco* v. *LeRoy,* 138 U.S. 656, 670, 672, was "directly in point," as the Court had there decided that "if there were any tide lands within the pueblo the power and duty of the United States under the treaty to protect the claims of the City of San Francisco as successor to the pueblo were superior to any subsequently acquired rights of California." 142 U.S. pp. 183–185. In discharge of that duty, provision had been made by Congress for the investigation and confirmation of the property rights of pueblos equally with those of individuals. The rights of the pueblo "were dependent upon Mexican laws, and when Mexico established those laws she was the owner of tide lands as well as uplands, and could have placed the boundaries of her pueblos wherever she thought proper." It was for the United States to ascertain those boundaries when fixing the limits of the claim of the City as successor to the pueblo. *Id.,* pp. 186, 187. The obligation of protection was "political in its character, to be performed in such manner and on such terms as the United States might direct." Accordingly, Congress had established a special tribunal to consider claims derived from Mexico, had authorized determinations by the court upon appeal, and "had designated the officers who should in all cases survey and measure off the land when the validity of the claim presented was finally determined." *Id.,* pp. 202, 203. The survey upon which the patent rested in the *Knight* case was thus made pursuant to the authority reserved to the United States to enable it to discharge its international duty with respect to land which, although tideland, had not passed to the State. See *Shively* v. *Bowlby, supra,* pp. 30, 31; *United States* v. *Coronado Beach Co., supra.*

The distinguishing features of the instant case are apparent. No prior Mexican grant is here involved. We conclude that the State was not bound by the survey and patent, and that its grantee was entitled to show, if it could, that the land in question was tideland.

In this view it is not necessary to consider whether the lines designated in the plat of the Norway survey as "meander" lines were intended as boundaries.

3. As the District Court fell into a fundamental error in treating the survey and patent as conclusive, it was not incumbent upon the Court of Appeals to review the evidence and decide whether it showed, or failed to show, that the land in question was tideland. The court remanded the cause for a new trial in which the issues as to the boundary between upland and tideland, and as to the defenses urged by petitioners, are to be determined. In that disposition of the case we find no error.

4. There remains for our consideration, however, the ruling of the Court of Appeals in instructing the District Court to ascertain as the boundary "the mean high tide line" and in thus rejecting the line of "neap tides."

Petitioners claim under a federal patent which, according to the plat, purported to convey land bordering on the Pacific Ocean. There is no question that the United

States was free to convey the upland, and the patent affords no ground for holding that it did not convey all the title that the United States had in the premises. The question as to the extent of this federal grant, that is, as to the limit of the land conveyed, or the boundary between the upland and the tideland, is necessarily a federal question. It is a question which concerns the validity and effect of an act done by the United States; it involves the ascertainment of the essential basis of a right asserted under federal law. *Packer* v. *Bird,* 137 U.S. 661, 669, 670; *Brewer-Elliott Oil Co.* v. *United States,* 260 U.S. 77, 87; *United States* v. *Holt Bank,* 270 U.S. 49, 55, 56; *United States* v. *Utah,* 283 U.S. 64, 75. Rights and interests in the tideland, which is subject to the sovereignty of the State, are matters of local law. *Barney* v. *Keokuk,* 94 U.S. 324, 338; *Shively* v. *Bowlby, supra,* p. 40; *Hardin* v. *Jordan,* 140 U.S. 371, 382; *Port of Seattle* v. *Oregon & Washington R. Co.,* 255 U.S. 56, 63.

The tideland extends to the high water mark. *Hardin* v. *Jordan, supra; Shively* v. *Bowlby, supra; McGilvra* v. *Ross,* 215 U.S. 70, 79. This does not mean, as petitioners contend, a physical mark made upon the ground by the waters; it means the line of high water as determined by the course of the tides. By the civil law, the shore extends as far as the highest waves reach in winter. Inst. lib. 2, tit. 1, § 3; Dig. lib. 50, tit. 16, § 112. But by the common law, the shore "is confined to the flux and reflux of the sea at ordinary tides." *Blundell* v. *Catterall,* 5 B. & A. 268, 292. It is the land "between ordinary high and low-water mark, the land over which the daily tides ebb and flow. When, therefore, the sea, or a bay, is named as a boundary, the line of ordinary high-water mark is always intended where the common law prevails." *United States* v. *Pacheco,* 2 Wall. 587, 590.

The range of the tide at any given place varies from day to day, and the question is, how is the line of "ordinary" high water to be determined? The range of the tide at times of new moon and full moon "is greater than the average," as "high water then rises higher and low water falls lower than usual." The tides at such times are called "spring tides." When the moon is in its first and third quarters, "the tide does not rise as high nor fall as low as on the average." At such times the tides are known as "neap tides." "Tidal Datum Planes," U.S. Coast and Geodetic Survey, Special Publication No. 135, p. 3.[2] The view that "neap tides" should be taken as the ordinary tides had its origin in the statement of Lord Hale. *De Jure Maris,* cap. VI; Hall on the Sea Shore, p. 10, App. XXIII, XXIV. In his classification, there are "three sorts of shores, or *littora marina,* according to the various tides," (1) "The high spring tides, which are the fluxes of the sea at those tides that happen at the two equinoxials"; (2) "The spring tides, which happen twice every month at full and change of the moon"; and (3) "Ordinary tides, or nepe tides, which happen between the full and change of

2. See "The Tide," H. A. Marmer, Assistant Chief, Division of Tides and Currents, U.S. Coast and Geodetic Survey, pp. 9, 10. "There is generally an interval of one or two days between full moon or new moon and the greatest range of the tide. And a like interval is found between the first and third quarters of the moon and the smallest tides." *Id.,* p. 11.

The origin of the terms spring and neap tides "is probably due to the fact that as the moon leaves the meridian of the sun in her orbital round the earth and approaches the quarters the tides begin to 'fall off' or are 'nipped,' and neap tides ensue. As she leaves the quarters for the meridian they begin to 'lift,' or 'come on,' or 'spring up,' and when the meridian is reached spring tides ensue." "A Practical Manual of Tides and Waves," W. H. Wheeler, p. 49.

the moon." The last kind of shore, said Lord Hale, "is that which is properly *littus maris.*" He thus excluded the "spring tides" of the month, assigning as the reason that "for the most part the lands covered with these fluxes are dry and maniorable," that is, not reached by the tides.

The subject was thoroughly considered in the case of *Attorney General* v. *Chambers,* 4 DeG. M. & G. 206. In that case Lord Chancellor Cranworth invited Mr. Baron Alderson and Mr. Justice Maule to assist in the determination of the question as to "the extent of the right of the Crown to the seashore." Those judges gave as their opinion that the average of the "medium tides in each quarter of a lunar revolution during the year" fixed the limit of the shore. Adverting to the statement of Lord Hale, they thought that the reason he gave would be a guide to the proper determination. "What," they asked, are "the lands which for the most part of the year are reached and covered by the tides?" They found that the same reason that excluded the highest tides of the month, the spring tides, also excluded the lowest high tides, the neaps, for "the highest or spring-tides and the lowest high tides (those at the neaps) happen as often as each other." Accordingly, the judges thought that "the medium tides of each quarter of the tidal period" afforded the best criterion. They said: "It is true of the limit of the shore reached by these tides that it is more frequently reached and covered by the tide than left uncovered by it. For about three days it is exceeded, and for about three days it is left short, and on one day it is reached. This point of the shore therefore is about four days in every week, i.e. for the most part of the year, reached and covered by the tides." *Id.*, p. 214.

Having received this opinion, the Lord Chancellor stated his own. He thought that the authorities had left the question "very much at large." Looking at "the principle of the rule which gives the shore to the Crown," and finding that principle to be that "it is land not capable of ordinary cultivation or occupation, and so is in the nature of unappropriated soil," the Lord Chancellor thus stated his conclusion: "Lord Hale gives as his reason for thinking that lands only covered by the high spring-tides do not belong to the Crown, that such lands are for the most part dry and maniorable; and taking this passage as the only authority at all capable of guiding us, the reasonable conclusion is that the Crown's right is limited to land which is for the most part not dry or maniorable. The learned Judges whose assistance I had in this very obscure question point out that the limit indicating such land is the line of the medium high tide between the springs and the neaps. All land below that line is more often than not covered at high water, and so may justly be said, in the language of Lord Hale, to be covered by the ordinary flux of the sea. This cannot be said of any land above that line." The Lord Chancellor therefore concurred with the opinion of the judges "in thinking that the medium line must be treated as bounding the right of the Crown." *Id.*, p. 217.[3]

This conclusion appears to have been approved in Massachusetts. *Commonwealth* v. *Roxbury,* 9 Gray 451, 483; *East Boston Co.* v. *Commonwealth,* 203 Mass. 68, 72; 89 N.E. 236. See, also, *New Jersey Zinc Co.* v. *Morris Canal Co.,* 44 N.J. Eq. 398, 401; 15 Atl. 227; Gould on Waters, p. 62.

3. See, also *Tracey Elliott* v. *Earl of Morley,* Ch. Div. 51 Sol. Journal (1907), 625.

In California, the Acts of 1911 and 1917, upon which the City of Los Angeles bases its claim, grant the "tidelands and submerged lands" situated "below the line of mean high tide of the Pacific Ocean."[4] Petitioners urge that "ordinary high water mark" has been defined by the state court as referring to the line of the neap tides.[5] We find it unnecessary to review the cases cited or to attempt to determine whether they record a final judgment as to the construction of the state statute, which, of course, is a question for the state courts.

In determining the limit of the federal grant, we perceive no justification for taking neap high tides, or the mean of those tides, as the boundary between upland and tideland, and for thus excluding from the shore the land which is actually covered by the tides most of the time. In order to include the land that is thus covered, it is necessary to take the mean high tide line which, as the Court of Appeals said, is neither the spring tide nor the neap tide, but a mean of all the high tides.

In view of the definition of the mean high tide, as given by the United States Coast and Geodetic Survey,[6] that "Mean high water at any place is the average height of all the high waters at that place over a considerable period of time," and the further observation that "from theoretical considerations of an astronomical character" there should be "a periodic variation in the rise of water above sea level having a period of 18.6 years,"[7] the Court of Appeals directed that in order to ascertain the mean high tide line with requisite certainty in fixing the boundary of valuable tidelands, such as those here in question appear to be, "an average of 18.6 years should be determined as near as possible." We find no error in that instruction.

The decree of the Court of Appeals is

*Affirmed.*

Mr. Justice McReynolds is of opinion that *Knight* v. *United States Land Assn.*, 142 U.S. 161, is controlling and that the decree of the District Court should be affirmed.

4. See Note 1.

5. See *Teschemacher* v. *Thompson*, 18 Cal. 11, 21; *Ward* v. *Mulford*, 32 Cal. 365, 373; *Eichelberger* v. *Mills Land & Water Co.*, 9 Cal. App. 628, 639; 100 Pac. 117; *Forgeus* v. *County of Santa Cruz*, 24 Cal. App. 193, 195; 140 Pac. 1092; *F. A. Hihn Co.* v. *City of Santa Cruz*, 170 Cal. 436, 442; 150 Pac. 62; *Oakland* v. *Wood Lumber Co.*, 211 Cal. 16, 23; 292 Pac. 1076; *Otey* v. *Carmel Sanitary District*, 219 Cal. 310, 313; 26 P. (2d) 308. In a number of cases the state court has referred to the limit of the shore as the "ordinary" high water mark. See *Wright* v. *Seymour*, 69 Cal. 122, 126; 10 Pac. 323; *Long Beach Co.* v. *Richardson*, 70 Cal. 206; 11 Pac. 695; *Oakland* v. *Oakland Water Front Co.*, 118 Cal. 160, 183; 50 Pac. 277; *Pacific Whaling Co.* v. *Packers' Association*, 138 Cal. 632, 635, 636; 72 Pac. 161; *People* v. *California Fish Co.*, 166 Cal. 576, 584; 138 Pac. 79. See, also, *Strand Improvement Co.* v. *Long Beach*, 173 Cal. 765, 770; 161 Pac. 975; *Miller & Lux* v. *Secara*, 193 Cal. 755, 761, 762; 227 Pac. 171.

6. "Tidal Datum Planes," Special Publication No. 135, p. 76.

7. *Id.* p. 81.

## LUTTES ET AL. *v.* THE STATE OF TEXAS

(Excerpts)

In the Supreme Court of Texas

324 S.W. 2d 167 (1958)

GARWOOD, Justice.

The ultimate issue in this dispute between the State of Texas (defendant below, by consent, and respondent here) and the plaintiffs, Luttes et al. (our petitioners) is the title to some 3,400 acres of mud flats or former sea bottom in Cameron County lying along, and alleged to be accretions to, the mainland or westerly edge of the long, narrow lagoon known as Laguna Madre, about fifteen or twenty miles north of Port Isabel and the mouth of the Rio Grande River, and about fifteen miles south of Port Mansfield on the Laguna. The Laguna, of course, lies between the mainland on the west and, on the east, the long, narrow, sandy island called Padre, the eastwardly side of which latter is the shore of the Gulf of Mexico.

The flats abut to the west upon a line of the upland or mainland characterized by a steep angle of elevation, although the altitude of the land along this line is hardly enough to justify the name "bluff line" which the parties call it. This line was the original easterly boundary of the now admittedly valid 1829 grant of lands on the mainland from the Mexican State of Tamaulipas to Manuel de la Garza Sosa, to whose rights the petitioners-plaintiff have succeeded. The grant, known as Potrero de Buena Vista, stipulated as its easterly or seaward boundary the westerly "shore" of the Laguna.

In a trial to the court and upon elaborate fact findings by the trial judge, judgment went for the State and was affirmed by the Waco Court of Civil Appeals upon transfer. 289 S.W. 2d 357.

The property claim of the State in the premises is, of course, that of successor (since 1836) to the Mexican nation or state, which latter, prior to the grant, admittedly owned the bottoms and shores of public waters such as the Laguna, as well as the upland granted. At the date of the grant, and, indeed, for well over half a century thereafter, the area in suit was always covered by the waters of the Laguna and thus admittedly did not pass to the grantee at the time of the grant nor thereafter, unless at some time about the first quarter of the present century. Accordingly, had this suit occurred some half century sooner than it did, the result would admittedly have favored the State.

However, since some obscure date in the past, the area has been progressively rising in relation to the Laguna waters, with the result that it is now from 0.25 feet to 1 foot above mean sea level, in greater part above the line of "mean high tide" (as hereinafter explained) and covered by the waters, not as a regular daily, weekly or even monthly matter, but only at irregular intervals and in irregular amounts, although, from the rather meager record in this behalf, it cannot be said that the presence of sea water in substantial quantity is rare.

The petitioners-plaintiff say that under the evidence and applicable principles of law, the land has become, since some forty years ago, a part of the upland as distinguished from sea bottom or seashore and, having become such by a *genuine* process of accretion to the earlier upland, the title to it has accordingly passed from the State to them as upland owners. On the other hand, the respondent-defendant State contends: first, that, although the area in dispute may have long since ceased to be mere sea bottom, it is, nevertheless, not upland or fast land, but seashore, as the latter term is defined by the Mexican (Spanish) law, which was admittedly in force at the date of the grant and thus controls thereafter the effect of the grant; that accordingly the area still belongs to the State, as admittedly it does if it is properly seashore. In the same connection, the State asserts that by the governing Mexican (Spanish) law, the landward or upper line of the "shore" is not the line of "mean high tide" (or "mean high water"; see "Tide and Current Glossary", Special Publication No. 228; Revised (1949) Ed., U.S. Dept. of Com., Coast & Geodetic Survey, p. 23), which applies only in respect of grants made by Texas after she adopted the common law in 1840, but a higher or more landward line. We are not certain as to the State's view of just what this line is in terms of practical determination, but the contention seems to be that it is either the highest—most landward—line reached by the waters on any one occasion that can be proved or perhaps the average of single highest annual lines for such years as to which proof is available. Storm high waters are admittedly not to be taken into consideration.

* * * * * * *

Going back to the matter of sea water levels, there has never been any permanent measuring device ("tide gauge") at the particular area, the two nearest ones being each some 15 miles away in opposite directions, to wit, the tide gauge of the United States Government operated at Port Isabel since April, 1954 and a similar apparatus at Port Mansfield operated by the Humble Oil & Refining Company since June, 1947. These gauges reflect the changes in the water levels at all times, regardless of the cause of the change, and in such manner that the levels so determined with reference to mean sea level can be, as they were, accurately correlated with the corresponding levels of the flats in controversy.

Properly speaking the term "tide" means the regular and predictable perpendicular daily rise (or rises) and fall (or falls) of the waters as a result of astronomical forces, to wit, the gravitational pull of the sun and moon (mostly the latter) upon the earth. See Tide and Current Glossary, supra. The levels reached by tides vary from day to day and as between all other fixed periods of time, however long, and also as between different geographical areas. But water levels are also influenced by weather conditions, such as wind, temperature and atmospheric pressures, as well as by other factors not connected with astronomical forces and, of course, by combinations of all or part of the former. Thus water level changes, whether produced by astronomical or nonastronomical forces or by combination between the former and the latter are reflected by the tide gauges, which record the different levels attained, although they do not, as to any given level or reading, purport to record the cause as astronomical, nonastronomical or both.

As found by the trial court, and admitted by the parties to the suit, there is in the Laguna Madre relatively little tide in the true sense, although there are undoubtedly substantial and frequent, but irregular, variations in water levels during each day or longer period due to the influence of nonastronomical forces and conditions, sometimes in combination with astronomical tide conditions in the Gulf of Mexico. One of the factors causing, or substantially contributing to, higher water levels in the general area in suit is the presence of northerly winds in the period from early Fall to Spring, although, on the other hand, there have been recent instances of sea water overrunning the flats in midsummer. There is also present, and due in at least some part to astronomical forces, a progressive, slow rise over the years of the general ("mean") sea level at an average rate of about 0.02 feet per year.

Thus, while on any one day we have the single variation between a highest level to a lowest, we have also the variation from what was the highest (or lowest) on that day and what is the highest (or lowest) on the next day. Similarly if we take the highest (or lowest) single instance that occurred in an entire year, it will ordinarily be different from a corresponding instance of the next or preceding year. And, of course, when we speak in general terms of the "highest water" *for* a given period longer than two days, we may mean that highest level of a particular day which is also higher than that reached on any other day of the period, or we may mean, perhaps, the sum of all the daily highs of the period (e.g., 365 in number for a year) divided by the number of days of the period (e.g., 365 in number for a year). If we mean the latter, such an average figure will necessarily be lower than the one highest annual level above mentioned. Moreover, the average figure, while it will vary from a similar average figure for a comparable period before or after that in question, will vary less than the single high of one such period varies from another, averages being always lower than a single highest as well as higher than a single lowest.

In the instant case, the trial court, either as a primary or secondary basis of his conclusion that the area in dispute was still "shore", under the Mexican (Spanish) law, took the one highest reading of the Humble gauge at Port Mansfield for each of the four years of gauge operation, added these four individual footage readings and divided the total by four, the result being a footage of 2.24 feet above mean sea level, or more than high enough to inundate the area in dispute. A similar result (2.64 feet) followed his similar calculation based on the ten-year Port Isabel gauge. (On account of the reference to the supposedly higher tides or waters *of winter* occurring in some statements as to the Mexican (Spanish) law of the seashore, it is interesting to note at this point that similar readings, and similar calculations therefrom by the trial judge, but using only the one highest reading during the *winter* of each year, produced substantially lower figures (1.56 feet, Humble, and 2.03 feet, Port Isabel) than those first above mentioned, although still high enough to inundate the flats.)

On the other hand, if the court had based his averages, not on the single highest reading of each year, i.e., one reading per year, but on day by day highest readings, i.e., 365 of them for one year, 1,460 for four years, 3,650 for ten years—adding them all together and dividing by the corresponding number of days, the resultant levels would have been much lower than those above mentioned upon which he actually relied and would have been, by and large, lower than the level of the flats. This is demonstrated by the court's own and uncontested findings to the effect that "mean high tide" or "mean high water" at the Humble gauge was only 0.416 feet above mean sea level and at the Port Isabel gauge only 0.56 feet, these levels being somewhat lower than the levels prevailing over most of the disputed area, especially at the perimeter thereof.

The terms last mentioned, as employed by the court and as universally understood, mean an average of all the daily highest readings over a long period. The proper period is one of approximately 19 years, since within such a period the astronomic forces affecting the water level go through a complete cycle. In localities in which tide gauge readings for so long a period are not available the accepted practice for determining "mean high tide" or "mean high water" is to take the daily local tide gauge readings for such periods as they are available, provided it is not less than one year, and correct them by comparison with the nearest gauge which affords a record for 19 years, the corrected result being a substantially accurate approximation of true mean high tide at the locality in question over the 19-year cycle. See Tidal Datum Planes, U.S. Dept. of Com., Coast and Geod. Survey, Special Publication No. 135, Rev. Ed. (1951) p. 86 et seq.; Borax Consolidated v. City of Los Angeles, 296 U.S. 10, 56 S. Ct. 23, 80 L. Ed. 9.

Thus the difference between this "mean high tide", found by the court to be but about half a foot above mean sea level, and the much higher figure of about two and a half feet upon which he relied and which he found to represent the "highest" water levels (excluding storm conditions) is but a difference between the number of different highest water readings taken and averaged out in each instance. This difference of method, although both methods involve to lesser or greater degree an average or mean of highest levels, was undoubtedly intended by the court to reflect his view of the difference between the Anglo-American law concept of "shore" (as the area below the line of "mean high tide", "mean high water" or "ordinary high tide") and the alleged Mexican (Spanish) law concept (as, generally speaking, the area below the "highest" reach of the waters, limited only to the extent that such level be not due to storm type conditions).

As above indicated, and as more fully reflected in the opinion of the Court of Civil Appeals (289 S.W. 2d 357, 361 et seq.), the trial court made elaborate findings of fact, including amendments following his review of his original findings at the behest of the petitioners-plaintiff. These findings and his corresponding conclusions of law largely favored the contentions of the respondent-defendant State as heretofore outlined.

As to whether the area in dispute is or is not "shore", as distinguished from upland or fast land, there was evidence introduced by both sides, including some expert testimony. However, the petitioners-plaintiff are, in our opinion, correct in saying that this particular question, as now presented to us, is really a question or questions of law, to wit: (a) Was it error for the courts below to apply the Mexican (Spanish) law, as distinguished from the common law, and (b) if not, was the Mexican (Spanish) law yet correctly interpreted and applied with regard to the instant situation? If the views of the courts below on (a) and (b) are correct, the judgment below must be affirmed, regardless of the questions concerning accretion, because such fact findings as are relevant to the "shore" phase of the case are admittedly not without support in the evidence. Such findings, of course, include some that, on this aspect of the case, are conceivably the basis of ultimate rulings in favor of the petitioners-plaintiff, such as the mentioned finding that "mean high tide (or water)" as determined by the two mentioned tide gauges is lower than the level of the bulk of the area in controversy.

* * * * * * *

We granted the writ of error largely in the hope of being able to eliminate the confusion that appears to exist at the Bar and otherwise as to what, in details of practical application to cases like the present, is the correct definition of the shore—the matter being obviously one of considerable public importance. We shall accordingly discuss that question first.

We harbor no doubt that the Mexican (Spanish) law, whatever it may be, in effect at the date of the grant, is what must furnish the applicable rule, and that such is the effect of every decision, observation or assumption that has ever been made by this Court on the subject, including those of as recent date as Rudder v. Ponder, 156 Tex. 185, 293 S.W. 2d

736; Giles v. Basore, 154 Tex. 366, 278 S.W. 2d 830, and State v. Balli, 144 Tex. 195, 190 S.W. 2d 71. We consider Humble Oil & Refining Co. v. Sun Oil Co., 5 Cir., 190 F. 2d 191, 191 F. 2d 705, certiorari denied 342 U.S. 920, 72 S. Ct. 367, 96 L. Ed. 687, as being to the same effect. Any confusion that may exist by reason of a previously somewhat unstudied use of the broad term "civil" law in texts and decisions, as distinguished from the applicable Mexican (Spanish) law, is confusion only as to what effect is to be given to the Roman law of Justinian's time in interpreting the vague terms of the Mexican (Spanish) law of several centuries later for application to the very practical question of fixing a line on the ground today.

* * * * * * *

All this is not to deny, however, that since State v. Balli, and as a result thereof, a particular line, actually marked on the Laguna side of Padre Island, and which may actually be the line of mean high tide, is now the boundary of a large portion of the total shores of Laguna, that is, of the portion of such shores that was involved in the Balli case. Accordingly, should a line different from that of mean high tide be the result of the instant case, conceivably although not certainly, different kinds of boundaries will, as a matter of fact, prevail on the different sides of the Laguna.

There is, indeed, much to be said on principle for the thesis of substantial identity between the two rules in question in the light of modern conditions. The Mexican (Spanish) law provision, infra, with which we are mostly concerned, being written in the middle ages under circumstances vastly and variedly different from those under which we must now give it an exact application, a court can have no vast confidence in its own deductions, however "educated", as to the intent of the ancient Spanish law writers derivable from their few and quite general words, somewhat different in form from present day Spanish and conceivably different in meaning to their authors from what their formal modern counterpart would mean even to modern Spanish jurists. Nor can we rely with great confidence upon translations and interpretations made centuries later—often by non-Spaniards, whose expertness in the language and subject matter must largely be assumed from the fact that they presumed to write a tract or book about it or, being judges, had to write a judicial decision based on such relatively meagre knowledge as is, and has been, available. The inadequacy of all language, however wise and learned the source, is notorious when it comes to be applied to particular facts and conditions of a later and quite different age, which doubtless were not clearly contemplated by the authors.

The basic definition, of course, is that of the celebrated body of Spanish law known as *Las Siete Partidas,* which was evidently written in the 13th century and promulgated some three centuries later, and of which the critical portion of Partida 3, Title 28, Law 4 (from the so-called Lopez edition published at that time under governmental auspices at Salamanca) reads as follows:

> "* * * e todo aquel lugar es llamado ribera de la mar quanto se cubre el agua della, quanto mas crece en todo el ano, quier en tiempo del inuierno o del verano."

A rather literal translation of this ancient Spanish and 16th century printing thereof, according to our own modern ideas of what it says, is:

> "* * * and all that place is called shore of the sea insomuch as it is covered by the water of the latter, however most it grows in all the year, be it in time of winter or of summer."

The word "crece" (third person, singular, of the present tense of the intransitive verb "crecer", meaning, no doubt, to grow, increase, augment itself, expand or swell) does not seem of itself necessarily to imply either astronomical tide on the one hand or waves or "swells" on the other, although it is not necessarily inconsistent with either. At least in modern usage, and as far back as the first half of the eighteenth century, the related noun "creciente" sometimes means "rise of the water of the sea by effect of the tide (marea)". On the other hand, another related noun, "crecida", means a freshet, or sudden rise of a stream. See Diccionario de la Lengua Castellana by the Royal Spanish Academy (edition published during first half of the 18th century); also Vol. 1, p. 404, Diccionario Hispanico Universal, S.A. Horta de Impresiones y Ediciones, Barcelona; Velasquez, a New Pronouncing Dictionary of the Spanish and English Languages (1947).

* * * * * * *

Rather obviously the original language does not define the upper line of the shore as the highest water levels of winter, whatever may have been stated to the contrary in some of our earlier opinions and in administrative pronouncements. Unless the sense has changed drastically with the centuries, it is inconsistent with such a construction in that it lays no more emphasis on winter than on summer.

Now whether the language confines the shore to that area regularly covered and uncovered by "tide" in the astronomical sense or permits it to be that highest "swell", wave or rise that may occur at this or that one particular hour or minute from whatever force other than storm conditions, the phrase, "in all the year" (en todo el ano), undoubtedly leaves a question as to *what year* is meant. Does it mean the last calendar year expiring before the litigation or other effort to fix the boundary on the ground, or some earlier year with a higher water level, or the kind of average of single highest annual levels over several years, on which the trial court alternatively relied in the instant case, or does it mean that where the *daily* highest levels over a period of years are of record and in evidence, these hundreds or thousands of highest levels should be averaged, and the average taken to be "however most it grows *in all the year*"?

Pretermitting for the moment the matter of interpretive authority, we think the language of the *partidas* of itself permits, and common sense suggests, a line based on a long term average of daily highest water levels, rather than a line based on some theory of occasional or sporadic highest waters. Indeed, such appears to us to be consistent with one of the primary arguments of the State itself to the effect that the true line should be one evidenced by more or less permanent markings on the ground of the kind ordinarily associated with the upper line of a shore. Whatever the aspect of the ground in the instant case, ordinarily a "shore line" is one characteristic of regular and frequent coverage by the sea, which in turn is much more closely related to an average of daily highest waters than to one, or an average of merely a few, highest annual readings.

While obviously the word, "average", or its equivalent, "mean", does not occur, both are suggested by the language as a whole, as the learned trial judge evidently recognized.

No particular year being indicated as that from which the so-called highest tide or water "in all the year" is to be taken, the inference is that a condition regularly prevailing over a number of years is what was intended, and this in turn suggests a mean taken over such a period. If, for example, the single highest water for each of the five years immediately prior to the litigation were in no instance higher than one foot above mean sea level, but were somehow shown to be three feet in one particular year long prior to the latest five years, it would hardly appear within the reasonable intendment of the law that we should forget the later years and fix the line at three feet according to the one more remote year. Conversely if the single highest reading for the year just preceding the trial were two feet, while those for each of nine or more years preceding the latest were not over one foot, it would seem unreasonable to require fixing the line at the two-foot level of the latest year, disregarding the lower "highest" levels of all the preceding years. And if we are to use some kind of "mean", as evidently we should, what is there in principle, or in the words of the basic law itself, to require such an average to be that of single highest annual readings for each of the several years in question, rather than one of daily highest readings for all of the days of such years? Both are averages of *highest water readings*. The only difference lies in the number of highest readings averaged.

The reference in the law to winter and summer does not necessarily require that some single highest water of which proof may be available shall determine the line. It appears simply to take care of a situation in which, by reason of a pronounced difference between seasonal levels, the area in question may over the years be regularly inundated, for example, each summer but only in summer. It has no significance in a situation such as the present in which such inundation as occurs is evidently irregular and with little regard for either summer or winter. It accordingly does not exclude the possibility of basing a line on an average of daily highest levels over a continuous and long period.

Obviously the greater the number of highest water readings averaged, the nearer we come to a figure, or level, which, applied to the ground as a line, will reflect a more regular and permanent shore characteristic than any other. The line will be the one at which the sea most regularly "stops with the shore", and, generally speaking, it will be the line at which the physical features commonly associated with the upper line of the shore most conspicuously appear. Thus it will normally be a more visible line, however it may be under the evidence of the instant case.

Of course, if the "highest" levels were substantially the same on every day, then there would be no such thing as a "single highest water", and thus "mean high water" would necessarily be the test under the Mexican (Spanish) law even as it is under the Anglo-American law. Actually, so far as real "tide" goes, that is the situation in the Laguna, since, as the trial court found, any astronomically inspired changes in levels are insignificant, and the variations are due to meteorological forces such as wind and air density. But these latter variations are quite substantial, both as between different periods of time and between different places with differing exposures to meteorological forces. The finding that the average of single annual highest water over periods of several years was several times as high as "mean high tide (water)" shows that the meteorologically inspired levels on which the former was based were quite extreme or exceptional with reference to the highest waters occurring from day to day. Thus should we base the line, as did the court, on these few exceptional levels, we are likely to have a line of shore which is not shore in the commonly accepted sense of being *regularly* covered and uncovered by water. It is difficult to believe that the ancient writers of the *partidas* had in mind a shore which was different from the commonly accepted idea thereof. One thinks of shore more in terms of the water's edge than in terms of land which is only occasionally and irregularly inundated.

There are, moreover, sundry practical considerations presented in applying the ancient law to modern Texas, which the ancient writers, had they thought of them, would probably have considered relevant to a sound interpretation of their own words.

As before indicated, we believe it essential, as the learned trial judge seemed to suspect it might be, to proceed on the basis of averages over a period of years, whether the basis of the average be only a single highest reading for each of the years concerned or the vastly larger number of daily highest readings. This, in turn, necessitates the use of tide gauges in practically every case. Any proof of even the single highest annual levels from sources other than tide gauges will ordinarily be as unreliable as it will be difficult, and proof as to day by day highest levels would be impossible. At the same time, we know that the number of tide gauges along the hundreds of miles of Texas coast, much of which is remote from population centers, is relatively insignificant, while the number which has been operated as much as a year is smaller still. Obviously in a locality where there is no tide gauge that has been in existence for a good many years, there will be little reliable evidence of the various single highest annual levels upon which to base an average for all those years. So, in such instances, we would either have to rely upon the quite scarce and unreliable evidence from sources other than tide gauges or take the equally unreliable alternative of abandoning the system of averages altogether in favor of accepting proof of one or two instances of highest levels, which some eyewitness might claim to remember, as proof of what is the shore. Both alternatives seem undesirable.

A third and much more reliable alternative, however, is that of following the system of "mean high tide (water)", which in effect is but the average of highest water of each day rather than each year. If that rule is adopted, we can have, by installing a tide gauge for as little as one year near the area in question, the benefit of 365 highest readings upon which to base an average, that is, upon which to determine "mean high tide (water)" at that point for that one year. This mean level will obviously vary less from a corresponding level for earlier (or later) years than would a single highest annual level for one year vary from the respective highest annual levels of other years. Indeed, as before stated, upon the further and quite simple step of correction against the nearest tide gauge which has been in operation for the full 19-year tidal cycle, the one-year "mean high tide (water)" figure of the local gauge will reflect with reasonably close exactness the "mean high tide (water)" for the whole 19-year cycle. In other words, so far as most of the Texas coast is concerned, the only reliable way in which to obtain any sort of average of highest water levels is by use of the standard of "mean high tide (water)".

While this involves a delay of a year, it appears more practical than waiting several years in order to get an average of single highest annual waters over the longer period. In either event, the local tide gauge is necessary because, as stated, water levels vary considerably from place to place in the Laguna, particularly on account of varying exposures to meteorological forces, whereas, by adopting the "mean high tide (water)" standard, the period of tide gauge operation may be reduced to one year.

Now turning to the matter of authority, although there may be in the legal profession of this State a fairly widespread impression to the contrary, we do not consider the foregoing interpretation or application of the *partidas* to encounter any insuperable obstacle in existing interpretive authority, whatever the source.

Actually much of the argument for the State rests on the Roman law as compiled, and no doubt rewritten, under the general title of *Corpus Juris Civilis* ("Body of the Civil Law") by order of the Emperor Justinian I, some fifteen hundred years before the present time and nearly a thousand years before publication of the *partidas*. Thus the law of the Romans, or at least Justinian's edition of it, is self-styled the "civil law" and is, moreover, today properly and actually referred to by that term, although the latter has also come to be often employed in a broader and somewhat loose sense, so as to include, besides the ancient Roman law, the laws of those nations of ancient Roman background, such as Italy, France, Spain and the so-called Latin-American offspring of the latter, all of which exist considerably more in code form than in court decisions. While as a matter of form, and possibly also of substance, there is, generally speaking, less similarity between the Corpus Juris Civilis and our Anglo-American decisional law (and statutes) than there is between the Corpus Juris Civilis and the codes of the other so-called "civil law" nations, the similarity in the latter instance is far from an identity, as counsel for the State properly concedes, and as State v. Grubstake Investment Association, 117 Tex. 53, 60, 297 S.W. 202, 204, expressly declares. And with particular reference to the sea shore, obviously the fact that the laws of two civilized nations separated by a thousand years both undertake to define such a universally familiar and important object as the shore does not indicate that the later law was intended by its authors to have the same meaning as the earlier, even were the terms respectively employed more similar than they actually are. Indeed, the contrary is suggested, when we consider that the Spanish law writers probably had access to the Roman law when they wrote their own in different terms. To say, as we did in State v. Balli, that certain provisions of the *partidas,* to wit, those dealing with alluvion and accretion, were "taken from" or "have their origin from" the Roman law, does not mean that even those particular provisions were intended as a mere paraphrase.

* * * * * * *

The State not unnaturally relies also upon various opinions of this Court and other courts of this state, principally, and beginning with, City of Galveston v. Menard, 23 Tex. 349, from which the State and no doubt some portion of the Bar, deduced that the rule of "mean high tide" (average of the *daily highest tides* over a long period) which is the rule of the Anglo-American law, is not the rule of the Mexican (Spanish) law prevailing at the time we are considering; but that the latter rule declares for a higher line.

It cannot, of course, be denied that language in these opinions, especially in the Menard case, supports the State's position. But candor also requires the admission that this language is confusing as to exactly what the Mexican (Spanish) law rule is as applied to a case like the present or even as applied to the State's present view of what the rule exactly is. More importantly, it must also be conceded that in none of the cases in question did the decision turn on whether the Mexican (Spanish) rule was one other than "mean high tide".

In the first place, the Menard case and most of the others repeatedly speak of the Mexican (Spanish) rule (or "civil law" rule, as they generally call it) in terms of "tide", as distinguished from the State's present emphasis on "waves" and "swells". Moreover, they state the rule in terms of highest *winter* levels as if taking it from the Institutes, which, as we have stated, and as the State at one point seems to concede, is quite inconsistent with the language of the governing law, to wit, the *partidas*. The language used is general, neither the Roman law nor the *partidas* being quoted or even referred to in specific terms, still less analyzed in critical fashion.

* * * * * * *

*Humble Oil & Refining Co.* v. *Sun Oil Co.*, 5 Cir., 190 F. 2d 191, rehearing denied 191 F. 2d 705, a case somewhat similar to the present, was decided against the owners of the abutting Spanish and Mexican grants and in its opinions contains statements corresponding to the afore-mentioned dicta of our Texas courts as to a purported difference between the respective Mexican (Spanish) and Anglo-American definitions of the shore. However, after a thorough reconsideration of that decision, which we have previously considered in other litigation, we do not find it to be compelling authority on the point here under discussion. In the first place, we regard it as having rested primarily upon the fact findings of the trial judge to the effect that the accretions, upon which the private landowners had to rest their claim, were not accretions to their property, but to the property of the State—a matter hereinafter more fully discussed. In the second place, the language of the court concerning the definition of the shore was with reference to Texas lands, and thus necessarily influenced by the dicta on that subject in our own opinions. Our own interpretation of Mexican (Spanish) law as applied to Texas land titles is as binding on the federal courts in such a case as is our interpretation of any Texas land law in any matter of Texas land titles. And a federal court would naturally be more reluctant than we ourselves to disregard our language as dicta in a matter well within our exclusive competence.

It is, moreover, worth noting that the federal court did not adopt the interpretation which the State now seems to some extent to assert, to wit, that the definition in the *partidas* refers to the line of the highest "wave", as distinguished from tide. On the contrary, it used the same language of our own earlier decisions, "highest *tide* in *winter*", the "tide" and "winter" parts of which the State now appears to regard as less sacred than the one word "highest". The court, indeed, uses language indicating that it regards the shore like we have now concluded to regard it, to wit, as that part of the land regularly covered and uncovered by the tide, the upper line of which is best determined by the 19-year average of daily highest water readings.[2]

While several of our sister states were once subject to Spanish or Mexican rule and have accordingly had occasion to deal with Spanish or Mexican grants along tide water, we are cited to no decision from any of them applying, or declaring, the Spanish law definition as the dicta in our earlier decisions declare it or as the respondent-defendant would have us here declare and apply it. Indeed, the decisions from, or relating to, those states cited for the petitioners-plaintiff rather indicate their concept of the Spanish law rule to be the same as that of the Anglo-American law. Apalachicola Land & Development Co. v. McRae, Commissioner of Agriculture, 86 Fla. 393, 98 So. 505,

2. "The tide is the rising and falling of the waters of the sea that is produced by the attraction of the sun and moon, uninfluenced by special winds, seasons, or other circumstances * * * The tide delimits the shore, and it is no respecter of the conflict of laws. Meteorological influences may be inextricably involved with the rise and fall of the true astronomical tide, but we should distinguish them as meteorological tides. Other influences may be described as atmospheric meteorological tides, but such tides are undoubtedly very minute, in comparison with the true astronomical tide over a period of 18.6 years * * * Shore is sometimes said to be synonymous with 'flats' * * * but flats are not shore unless the tide ebbs and flows over them. * * *". 190 F. 2d 191, 195.

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517; Brickell v. Trammell, Governor, 77 Fla. 544, 82 So. 221, 227–229 (both by the Supreme Court of Florida); United States v. Pacheco, 2 Wall. 587, 17 L. Ed. 865; City and County of San Francisco v. Le Roy, 138 U.S. 656, 671, 11 S. Ct. 364, 34 L. Ed. 1096 (California cases involving Mexican grants along tide waters); New Orleans Land Co. v. Board of Levee Commissioners (a Louisiana Supreme Court case involving French and Spanish grants along Lake Pontchartrain), 171 La. 718, 132 So. 121, 122.

The American courts for Puerto Rico appear likewise to have regarded the Spanish definition as calling for the line of mean high water ("the highest *regular tide*"). People of Porto Rico v. Fortuna Estates, 1 Cir., 279 F. 500, 506, certiorari denied 259 U.S. 587, 42 S. Ct. 590, 66 L. Ed. 1077.

Theoretically, the rule of mean high tide is less favorable to the State in its capacity as a landowner than a rule based on a single instance of highest annual water or a mean of several such instances. But that is not a reason for our interpreting the law differently than we would if only private interests were involved. Moreover, we are far from sure that in actual practice the rule of mean high water is less favorable than a rule calling for a higher shore line that will always be vague and difficult of ascertainment until finally fixed on the ground after extended and complicated litigation. A result of the latter kind of rule may well be to give the abutting private landowner (and his mineral lessee) an advantage over the State in the inevitable litigation, because he has longer and better access to the kind of proof that will necessarily be involved in demonstrating whether on such and such an occasion in such and such a year or years one or more "highest waves" actually reached this or that irregular line on the ground. Another result may be to discourage the mineral leasing of tidal areas from the State by smaller operators who cannot run the risk of complicated boundary litigation in addition to the other risks of mineral exploration.

We sustain the contention of the petitioners-plaintiff that the applicable rule of the Mexican (Spanish) law is that of the average of highest daily water computed over or corrected to the regular tidal cycle of 18.6 years. This means in substance mean high tide.

* * * * * * *

The judgment of the Court of Civil Appeals affirming that of the trial court is accordingly reversed and the cause remanded to the Court of Civil Appeals for further proceedings.

*On Motion for Rehearing*

Our original opinion has been criticized, and no doubt justly so, for some confusion as to whether the landward line of the shore as regards abutting Spanish or Mexican grants is that of mean high tide or mean higher high tide, since along the Texas coast there are generally two daily high tides and two daily low tides. While the difference, particularly in the Laguna Madre, is small, it conceivably could, in a given case, be substantial from the standpoint of acreage involved. It was our intention to hold, and we do hold, that the line under the Spanish (Mexican) law is that of mean higher high tide, as distinguished from the mean high tide of the Anglo-American law.

Certain *amici curiae* arguments on rehearing have urged that the shore at Surfside Beach in Brazoria County and various other Gulf beaches commonly used for public recreation, will be much narrowed (from seaward to landward) and thus undesirably limited in usage, as the result of defining the shore line in terms of tide gauge readings. It is said that if we should base the shore line on the actual, day by day, reach of the highest water upon the beach, which can be observed, and the corresponding levels noted, about as easily as reading a local tide gauge, the altitude of an average line thus established will be very much higher than that of a line based on tide gauge readings and thus formed by the intersection with the land of a plane drawn through the level of mean higher high tide as determined by the tide gauge. In other words, it is said that the level of mean higher tide, as it exists on the beach itself, is one thing but, as determined by tide gauges is quite another. Presumably this would be no less true of the level of mean *high tide,* if that were the line involved.

The factual basis for this argument is allegedly reflected in a surveyor's report annexed to the corresponding brief on rehearing. The report in turn seems to rest on a single observation made at Surfside Beach on May 14, 1958, without comparison with a local tide gauge (the Galveston gauge some forty miles away being used), and its factual correctness is challenged by the respondents Luttes et al. Nor do we know of any decision concerning either the Spanish (Mexican) law shore line or the Anglo-American line of mean high tide, which rejects the use of tide gauges as the basis for fixing the line. As regards the line of mean high tide, Borax Consolidated v. City of Los Angeles, 296 U.S. 10, 56 S. Ct. 23, 80 L. Ed. 9, strongly suggests that the Court had tide gauge readings exclusively in mind; and if *that* line be thus properly defined in terms of tide gauge readings (and accordingly applied to the large portion of the Texas coast governed by the Anglo-American rule of mean high tide) it is hard to see how it should be otherwise with a line of mean higher high tide.

On the other hand, we are not bound by the Borax Consolidated case. And while Arts. 5415a (Sec. 3) and 7467, Vernon's Tex. Civ. Stats., use words such as "tide" and "high tide", the former also includes the phrase "lands covered by the waters of * * *." See City of Galveston v. Mann, 135 Tex. 319, 143 S.W. 2d 1028. Nor can we say for certain that the factual data supplied by *amici curiae* is wrong. Conceivably the winds or other physical forces do regularly cause the levels reached each day on the beach by the highest water to be far higher than the daily levels of highest water as shown by a tide gauge. Nor, however difficult it might now appear to us (or to the Surveyors Association of Texas, according to the report of its Boundary Commission of March 21, 1957, transmitted to the Commissioner of the General Land Office under date of April 1, 1957) to determine what the level of either mean higher high tide or mean high tide is in terms of the reach of water on the beach, can we be sure that is impossible, particularly having in mind such measuring techniques as science may hereafter afford.

Whatever may be the case as to that part of our shores governed by the Anglo-American rule of mean high tide, we do think it correct to say that the Spanish (Mexican) law concept of the shore is the area in which land is regularly covered and uncovered by the sea over a long period. If it be shown in a given case that the upper level of the shore, as actually covered and uncovered by the sea, is higher (or lower) than the level of mean higher high tide as determined by tide gauges, and if it also appears that an upper median line of the shore, as actually so regularly covered and uncovered, can be determined with reasonable accuracy otherwise than by exclusive resort to tide gauges, we do not by our opinion intend to foreclose such a case.

In the instant case, it is quite plain to us that the area in suit is not regularly covered and uncovered by the Laguna waters and has not been for a long time. To say that merely because there exists, at the western edge, a "bluff line" or a "vegetation line", marking where the waters at some undisclosed period in the past evidently did reach with regularity, the latter line is the line of mean higher high tide, would, in our opinion, be much less reasonable than to fix a line of mean higher high tide by exclusive resort to tide gauges. We have no doubt that the area in suit is fast land.

* * * * * * *

Subject to the modifications in our original opinion which are specified above, the motions for rehearing of both the petitioners and the respondent are overruled.

[Judge Smith dissented from the majority opinion on the ground that the determination of the shoreline by means of tidal observations was an artificial one and contended for the use of the vegetation line as better expressing the *Partidas* definition of seashore.]

APPENDIX E

# Relation of the Tide to Property Boundaries

*(This paper was prepared by the late Rear Admiral Raymond S. Patton, Director of the Coast and Geodetic Survey from 1929 to 1937, and was published in the December 1939 issue of the Field Engineers Bulletin of the Survey. It has been modified in a few instances to reflect present conditions and experiences, such amendments being shown as bracketed material or as footnotes.)*

## GENERAL

The grants, charters and conveyances which constitute the first links in the chains of title on which are based the present ownerships of lands along our seacoasts contain frequent reference to such boundaries as the high-water line, the high-tide line, the line of ordinary high water, etc., and similar reference to the opposite, or low stage of the tide. As a rule these references are indefinite to the point of ambiguity, primarily because of the inherently complex and variable character of the tidal phenomena, and secondarily because, at the time the early descriptions were written, either the significance of the first factor was not appreciated, or it was not considered of sufficient importance to require precise definitions of the phrases used.

The result is that our courts are called upon from time to time for precise and workable interpretations of these vague and ambiguous phrases. The frequency with which such interpretations are necessary is strikingly evident to the Coast and Geodetic Survey, which, as the agency of the Federal Government officially charged with the study and prediction of the tides, and the generally recognized authority in this country on that subject, is called upon many times each year for tabulations of tidal data applicable to this or that matter in litigation.

Statistical data, however, serve the ends of justice only to the extent that they are properly interpreted, and proper interpretation of tidal data is usually possible only when the tabulation is appraised against a background of pertinent scientific principles and physical facts pertaining to the situation under consideration.

Decisions which have come to the writer's attention sometimes contain imperfections which suggest that this background is not always made available to the court. For example, a decision which on more than one occasion has been submitted to the Coast and Geodetic Survey with a request for an opinion as to its meaning reads in part as follows:

> "The limit of the monthly spring tide is, in one sense, the usual high water mark, for, as often as those tides occur, to that limit the flow extends. But it is not the limit to which we refer when we speak of 'usual' or 'ordinary' high water mark. By that designation we mean the limit reached by the neap tides. That is, those tides which happen between the full and change of the moon twice in every twenty-four hours."

It is impossible from the language quoted, to be certain as to what the court had in mind. Strictly speaking, the neap tides are those which are caused by the moon and sun in quadrature. This happens once each fortnight, and the range of tide at that time, other factors being equal, differs by a considerable percentage of the total range from the average range for the entire period between the full and change of the moon.

The custom of regarding each decision rendered as a precedent to be taken into account by the courts when dealing with similar cases would seem to have a two-fold bearing upon the situation:

(1) It probably has some tendency to extend the application of imperfect decisions to subsequent cases in which the pertinent body of fact is closely similar.

(2) We could expect a similar tendency toward an *a priori* application of decisions, which were correct with respect to the underlying body of fact on which based, to matters which superficially seem identical, yet which a searching study of both cases would reveal as having important points of difference if only those concerned knew where to look for them.

The importance of our shore lands is rapidly increasing. Values in most of our coastal states have reached levels which demand accurate knowledge of the area involved in any conveyance. The riparian rights which accrue to the owner of the adjacent upland constitute an important factor in such values. There is a rapidly growing public interest in the proprietorship in the ripa which is inherent in the sovereignty of the people. On the Atlantic and Gulf coasts at least 10 states have formally created agencies to administer some or all aspects of this sovereignty. Six of these 10 agencies have been created or charged with this function within the past 4 or 5 years. As to the Pacific coast, the extent to which California is interesting herself in the subject is nationally known.

Everywhere there seems to be uncertainty and obscurity as to the specific application of the principles embodied in the law and the court decisions to the sites to which those principles must be applied. The need for a clarification of the whole subject is plainly indicated. That clarification can come only from a meeting of the legal and engineering minds.

Therefore, to the writer, as an engineer familiar with the true tide and the related phenomena which combine to produce those periodic fluctuations in the water's surface popularly known as the tide, it seems worth while to discuss, as briefly and with as little technical detail as possible, the physical factors which must serve as a background to any adequate consideration of this subject. The discussion will make no pretense of being a complete one. Rather, the thought is, by a hasty reconnaissance, to blaze a trail which may indicate the route to be followed by those who in due time may endeavor to go into the matter thoroughly. The writer would also emphasize that he has no knowledge of the law: if that fact becomes too strikingly apparent later he can only beg his readers' indulgence on the ground that he is merely trying to contribute his mite toward the needed achievement.

## FACTORS WHICH PRODUCE THE TIDE

Four factors unite to produce the daily fluctuations in the elevation of the water surface which we call the tide. Each factor is complex, and three of the four are variable within themselves, and the great complexity and variability of the tide is due to the almost unlimited number of combinations into which these four factors can unite to produce both differences at the same time at different points and differences at the same point at different times. These four factors are:

(1) The astronomic tide-producing forces.
(2) The unchanging configuration of the major ocean basins.
(3) The variable configuration of the minor tributary basins.
(4) Related terrestrial phenomena [essentially meteorological].

*The Astronomic Tide-Producing Forces*

The astronomic or true tide results from the force which we call gravitation. Newton's law is that the attractive force which one body will exert upon another varies directly as the mass of the attracting body and inversely as the square of the distance separating the two. The only two heavenly bodies which are close enough to the earth to have any tide-producing effect are the sun and the moon. The sun is many times larger than the moon, but the latter is so much closer to the earth that its tide-producing effect is a little more than double that of the sun.

Earth, moon and sun are in constant motion and in consequence their relationships to each other are constantly changing in both direction and distance. These changes are cyclical in character and in consequence of them the tides manifest certain directly related cycles of change.

It would take too long, and it is not pertinent, to describe how the sun and moon operate to produce the tides. It will be sufficient for our purpose to list the principal characteristics of the tide, and in connection therewith to state such facts as need to be taken into account.

1. During each period of slightly more than 24 hours we have [in most places] two high and two low waters. This rule, however, is not an invariable one either as to time or place. We may have only one high and one low water during that period, and sometimes one each and at others two each. We will revert to this subject when we consider our second major factor.

2. The high and low waters of each day occur about 50 minutes later than the corresponding ones of the preceding day. This lag corresponds and is related to the daily retardation in the time of the moon's meridian passage.

3. The range of tide at any point changes from day to day, passing through fortnightly cycles. When the moon is in its first and third quarters the tide producing forces of sun and moon are opposed to each other, and, other factors being equal, the tidal range attains the minimum of its cycle. This minimum tide is called the neap tide. Thereafter there is a gradual increase in range until the time of new or full moon. At that time moon and sun are pulling together and, again other factors being equal, the tidal range attains its maximum for the cycle and is known as the spring range. The neap range is usually about 20 percent less than the mean range, and the spring range about 20 percent greater than the mean range. Spring and neap tides seldom occur at the exact times when the moon is in its equivalent phases. There is usually a lag of from one to two days which is known as the phase age of the tide.

4. The moon travels around the earth during a lunar month of 27½ days, moving in an elliptical orbit which has the earth at one focus. Therefore the distance between moon

and earth is constantly changing, and the tidal range changes in consonance. When the moon is nearest the earth, or in perigee, the tidal range, known as the perigean range, is about 20 percent greater than the average, and when the moon is in apogee, or most distant from the earth, the range is about 20 percent less than the average and is known as the apogean range. There is a lag in the occurrence of the perigean and apogean tides similar to that which we noted with respect to the spring and neap tides.

5. The moon's orbit lies in a plane which is inclined to that of the earth's equator. Twice each lunar month, therefore, the moon will be momentarily in the plane of the equator; at all other times during the month the moon will be varying distances north or south of that plane.

As the earth rotates on its axis, points everywhere on the earth's surface describe circles which are in or parallel to the plane of the equator. They are, in other words, circles of latitude.

Now consider the moon's relation to two points at the opposite ends of any diameter of any circle of latitude. At the two moments each month when the moon is in the plane of the equator its relation to these two points is identical and if all other factors were equal the tides there would be the same. At all other times during the month the moon's relation to the two points is not the same, and consequently the tides will differ from each other to an extent which will depend on the distance of the moon north or south of the equator. Because of the earth's rotation these two points may be said to change places every 12 hours. Point *A* rotates to the spot occupied 12 hours earlier by point *B*, and vice versa. Consequently, the two tides, 12 hours apart, at either point *A* or point *B* will differ from each other in the same way as, under the preceding assumption, the tide at *A* differed from that at *B*. In other words, when the moon is on the equator the two tides of each day at any point tend to be the same, and when the moon is north or south of the equator the two tides will be unequal.

This difference is called the diurnal inequality. It changes continuously with the moon's declination. When the moon is on the equator the diurnal inequality is least, and the tides are called equatorial tides, and when the moon is at its greatest north or south declination the tides are called tropic tides. The effect of the diurnal inequality can be described in a general way by stating that it is equivalent to increasing the range of one tide at the expense of the other.

6. Changes in the relative positions of earth and sun result in cyclical changes in the component of the tide resulting from the sun's attraction. These changes are similar in kind to those already described, but (1) their magnitude is less, and (2) their periods are longer, being semiannual instead of fortnightly.

7. The foregoing variables may combine in numerous different ways to produce variations in the tide. Thus a spring tide and a perigean tide occurring simultaneously will produce an actual tide of exceptionally great range, while a neap and an apogean tide would give a correspondingly reduced range. A spring and an apogean tide, or a neap and a perigean would combine to give a range not far from the average.

8. Besides the daily and semidaily tide-producing forces, we find groups having periods of half a month to a year. In addition there is a variation in the range of tide resulting from the westward motion of the moon's node of about 19° a year, or a periodicity of 18.6 years.

### *The Unchanging Configuration of the Major Ocean Basins*

As pointed out previously, the astronomic tide results from the tide-producing forces of the sun and moon and the relative positions of these two bodies with that of the earth. These forces are distributed in a regular manner over the surface of the earth, varying with the latitude. It will be observed at once, however, that although the tidal ranges vary, the variations bear no relation to latitude, being largely local or regional. What is it, therefore, which from the same causes produces such different effects?

For many years scientists held that the "progressive wave" theory furnished the answer. This theory considers the tides of the world as due principally to the action of the tidal forces on the broad and deep waters of the Southern Ocean where it was assumed these forces raised two tidal waves, 180° apart in longitude, which traversed this belt of water from east to west, forced by the moon to keep step with its own motion. These waves, sweeping around the southern latitudes, were supposed to generate secondary waves in the Atlantic and Pacific oceans, which traveled northward across the equator and into the Northern Hemisphere, impressing minor waves into all the water areas in their paths. The various tidal ranges observed then were explained by the amount the energy in the waves was concentrated due to the shape of the regions through which they traveled.

As tidal observations increased in number throughout the world, however, they did not give data to accord with this progressive wave theory, and at the beginning of this century there was evolved the "stationary wave" theory. This newer theory does away with the conception of a single world phenomenon and substitutes regional oscillating areas as the origin of the principal tides of the various oceans.

We are all familiar with a stationary wave oscillating in a small tank when one end is raised and immediately lowered. The whole mass of water moves rhythmically first to one end of the tank and then to the other, so that it is low water over one-half the tank at the same instant that it is high water over the other half, with a line across the middle about which the water oscillates, with no change in elevation.

This surge is repeated again and again with a gradually decreasing magnitude until finally the waters resume their normal state of rest. In such a tank the extent of the rise and fall of the water at the two ends will depend on the magnitude of the generating force, but the period of each oscillation across the tank is independent of the generating force. It depends solely on the length of the tank and the depth of the water in it.

If, however, the tank end be raised and lowered repeatedly at regular intervals, the period in which the water oscillates becomes equal to that of the disturbing force, but in all other respects the character of the oscillation will depend on the relation which the natural period of the tank bears to the period of the disturbing force. Thus, if the end of the tank be lifted each time at the exact instant when the water at that end has reached its greatest elevation, the oscillations will rise higher and higher until the water spills out. Conversely, if the end of the tank be raised at the instant when the water there is at its lowest point, the tendency will be to reduce and even destroy the oscillation.

This simple example very crudely suggests the basis for the stationary wave theory of the tides. The actual characteristics of the tides, as observed on all coasts of the world, can best be explained on the assumption that the waters of the oceans naturally divide themselves into basins, within each of which the waters oscillate somewhat in the manner above suggested. Each basin has its own natural period of oscillation, and is acted upon in regular periods by the forces imposed by the sun and moon. The resulting tide in the basin will depend on the relation between the natural and the imposed periods.

We have noted that, except when the moon is on the equator, we usually have two unequal tides during the day. In other words, the actual tide may be said to be composed of a semidaily and a daily component. Some of these basins will respond better to one of the periodic forces of the sun and moon than to another. We will then have regions where the semidiurnal tide is predominating, other localities the diurnal tide, or in other words, in each of the various locations the stationary waves best developed are those whose forced periods most nearly approximate the natural period of oscillation of the particular oceanic area in question. For example, we find not only areas in the Pacific Ocean and Indian Ocean of the proper dimensions to sustain stationary waves with a period of 12 hours, but also those which give rise to a well-developed daily tide and thus we find considerable diurnal inequality in this area. As it is explained that this condition arises from the combination of a daily tide with a semidaily tide, the greater the daily constituent the greater the inequality. In the Atlantic Ocean the daily tide is not well developed because the period of oscillation of this basin is near that of the semidaily tide. Therefore, there is little diurnal inequality along its shores. Finally, there are a few localities where the semidiurnal factor disappears and we have but one high and one low water a day.

From the above brief discussion of the modern concept of the tides, it will be seen that tidal ranges taken over long periods of time to average out meteorological effects will be as unchanging as the great open seas in which they are generated.

There are basins, although small compared with the oceanic areas, which may be regarded as similar to large vibrating areas, and partly by this view the large tides in the Bay of Fundy and Cook Inlet are explained. Taking the Bay of Fundy, we find that its natural period of oscillation is about 12 hours, which coincides very nicely with the period of the ocean tide. This brings about a stationary wave movement within the bay that is sustained by the tide of the ocean, and, as shown previously, in this kind of a wave the rise and fall of the tide increases with the distance from the axis about which it oscillates. The tidal range is further increased near the head of the bay by the converging shore line and gradually decreasing depth, which confines the energy of the moving mass of water into a gradually decreasing volume. The increase in range between Cape Sable and Minas Basin approximates 365 percent.

South San Francisco Bay presents a somewhat similar case, although with less increase of range at the head. The mean range of tide at Golden Gate is 3.9 [4.0] feet, with a mean value of 7.6 [7.2] feet at Alviso, or a percentage increase of 90 percent. The size and depth of the basin are such that the type of tide is partly stationary and partly progressive and this helps to explain the increase in the mean range of tide in the upper reaches of the bay.

### *The Variable Configuration of the Minor Tributary Basins*

The two factors heretofore discussed determine the characteristics of the true ocean tide. Those characteristics, save for the fluctuations of the definitely known cycles, are fixed and unchanging. The effect which the astronomical forces will exert at any future moment can be computed with mathematical accuracy. Only an inconceivable cataclysm could alter the great ocean basins sufficiently to have any perceptible effect upon their tides. Therefore we can safely say that a hundred, or a thousand, years hence the tides at any point of the ocean remote from the disturbing effect of local influence will be the same as they are at present, except for major geologic changes.

But when the basins become so localized as to be susceptible of modification by either natural or artificial agencies, important changes in their tidal regimes may be expected to accompany physical changes which occur from time to time.

Such changes are constantly in progress in many small basins indenting the coasts of the United States. Along a shore composed of sand or other readily erodable material, the inlets, by which the tidal waters of the ocean enter and leave these basins, are in a state of great instability. The waves and currents of the ocean, and particularly certain powerful components which operate in the immediate vicinity of the shore in times of storm, carry large quantities of sand to the inlets and there deposit it with a consequent tendency to reduce the cross section of the inlet, retard the flow of tidal currents into and out of the basin, and cause the inlet to close. On the other hand, the regular tidal currents through the inlet exert an unceasing effort to scour away these deposits and maintain channels adequate to accommodate their flow.

Thus at each such inlet we have a continuous conflict between two opposing sets of forces—the one group striving to close it, the other to maintain or increase its channel. The condition of the inlet at any time reflects the vicissitudes of this struggle. If the inlet currents dominate the situation the inlet will have a deep, well-defined and unobstructed channel leading from the ocean to the basin. If the alongshore forces are the stronger the inlet gorge proper may be deep and free from obstruction, but at one or both ends of the gorge, delta-like shoals will be formed containing one or more narrow, tortuous channels along the lines of maximum current flow.[1]

For a given range of ocean tide and size of basin the condition of the inlet at any time will be an important, and usually the principal, factor in determining the range of tide in the basin. The shoals already described act like dams to cut off the flow in the lower levels. The retarding effect of friction is everywhere increased. Bends, and irregularities in the widths and depths of the channels disturb the smooth, regular, streamline flow of the waters, deflect one portion of the current against another, and tend toward a condition of turbulence. The accumulative effect of all these factors is that each basin at any moment has its own characteristic tidal range, and that this range is usually less, and occasionally very much less than the range in the adjacent ocean. Similar retarding influences exist elsewhere within the basin, with the result that the tidal range frequently decreases gradually with increasing distance from the inlet.

The variations in tidal range resulting from the foregoing factors are well illustrated by tidal observations made some years ago in Barnegat Bay, N.J. At this spot the range of ocean tide is 4.0 feet. At a point near the inner end of the inlet and distant ¾ mile from the ocean the range was 2.0 feet. At a point on the west shore of the bay, directly opposite the inlet and 4½ miles distant therefrom, the range was 0.8 foot. At Bay Head, the northern extremity of the bay, 21 miles from the inlet, the range was 0.7 foot.

Such examples could be multiplied indefinitely. If, in addition to the conditions we are now considering, we will keep in mind the opposite conditions as exemplified in

1. When the alongshore forces are the predominant ones, inlet migration is also a common phenomenon. *See*, for example, fig. 91 in this volume showing the progressive southerly movement of Barnegat Inlet, N.J., between 1839 and 1936.

San Francisco Bay, where the tidal range increases with increasing distance from the entrance, a brief examination of the column of mean tidal ranges, in the official *Tide Tables* published by the Coast and Geodetic Survey, will afford convincing evidence of the high degree of individuality and variability of the ranges in the basins along our coasts.

The foregoing illustrates varying mean ranges at different points in a basin at the same period of time. We likewise have variations in the range at a single point at different periods.

Basin ranges are reduced by the growth of shoals at the inlets, by the closing of one or more of the inlets through which the tidal waters enter and leave the basin, by the building up of mud flats and the growth of marsh within the basin, etc. Basin ranges are increased by storms which erode the shoals at the seaward end of the inlet, by freshets which augment the scouring effect of the tidal flow and produce a better channel through the inlet shoals, by the opening of a new inlet through the barrier beach which separate ocean and basin, etc.

Such changes have been accomplished artificially. Men have filled up inlets and converted tidal basins into tideless lagoons. Conversely, engineers working in aid to navigation have improved inlet channels and thereby materially increased basin ranges. A case in point occurs at the Coquille River, Oreg. Here the range of ocean tide is 5.2 feet. In 1880, the bar at the entrance had a low-tide depth of 3 feet and the range of tide inside was 3.3 feet. By 1928, artificial improvement had increased the bar depth to 13.5 feet and the range inside to 5.1 feet.

*Related Terrestrial [Meteorological] Phenomena*

By reason of certain influences of non-tidal origin, additional to the minor effects of the long-period forces already mentioned, the imaginary plane of sea level, above and below which the tides oscillate daily by approximately equal amounts, is itself subject to variations in elevation. Some of these affect the range of tide and others do not, but all affect the position of the contours along the margin of the land marked out by the high or low waters at different times.

Typical of these terrestrial [meteorological] factors are wind and barometric pressure. A storm wind of some days duration blowing from off the land toward the ocean has been known to reduce the water level adjacent to the shore as much as 3 feet below normal. Conversely, a wind blowing in the opposite direction will temporarily elevate the water surface an equal amount above normal.[2]

Variations in barometric pressure likewise bring about fluctuations in sea level. Indeed, as a first approximation, any arm of the sea may be regarded as a huge inverted water barometer. When the barometric pressure over this arm rises the level of the water will be lowered, while a decrease in the barometric pressure raises the level of the water. Thus, at any point on the coast sea level varies from day to day, from month to month, and from year to year. From one day to the next sea level may vary by a foot or more, and within the same year two values of daily sea level may differ by 5 feet or more. Monthly sea level is subject to variations of both periodic and nonperiodic character, so that within a year sea level for two different months may differ by as much as a

2. It is not uncommon to have the normal level of the water elevated by more than 3 feet. The depression of the water is usually less than the elevation.

foot. Yearly values of sea level may show differences of a quarter of a foot or even more.

## MEAN VALUES OF TIDAL PLANES

By reason of all the foregoing complex variations the most convenient method of dealing with the relationships between the various phases of the tide is in terms of average or mean values. Thus, we have mean lower low water, mean low water, mean sea level, mean tide level, mean high water, mean higher high water, etc. Each of these expressions designates a more or less accurately determined average value, of the phase designated, usually expressed in terms of its vertical relationship to one or more of the others, or to permanently marked points on shore.

Obviously, the accuracy of determination of these mean values will depend on the length of the series of observations from which they are derived. If we start with no known relationships, a series several years in length is the minimum which gives an accuracy sufficient for present engineering purposes, and a series of 19 years will be even better, as it takes full account of the longest-period forces.

Series of such length, however, are necessary at only a few widely separated points so selected as to be indicative both of the various basin tides and of regional meteorological conditions. These furnish primary stations from which the relationships at secondary stations in their vicinity can be derived by comparisons based on much shorter periods of observations. A considerable number of these primary stations is already available in this country, so that it is today a relatively simple matter to obtain accurate knowledge of the tidal planes at most of the points where it may be needed.[3]

## TIDAL CONTOURS AS PROPERTY BOUNDARIES

All the foregoing indicates the background of fact which must be taken into account in any adequate solution of this problem. We are now ready to deal with the problem itself.

It is no part of the writer's purpose to advocate any particular tidal contour, as, in theory, the proper one to separate the proprietorship of the state from that of the individual. While that question is very much in evidence at present, it is in principle one for determination by the jurist rather than the engineer. Therefore, solely for the purpose of definiteness and simplicity of discussion, mean high water will be assumed to have been adopted. The factors to be considered would be equally applicable to any other contour selected.

The problem then becomes one of so formulating the law or the court decision that it shall be so definite and specific that the engineer using standard engineering methods in applying it on the ground, can arrive at only one result. Our boundary is the line or contour along which the substantially horizontal plane of mean high water intersects the sloping surface of the land. We must recall that we are dealing here with two different relationships—vertical and horizontal.

Each mean plane is ascertained and perpetuated in terms of its vertical distance above or below permanently marked points called bench marks. The Federal Government has

3. Present-day terminology refers to these as "control tide stations." The number of such stations at which continuous tide observations are now available has been increased since 1937. There are now 70 such stations in conterminous United States as compared with 45 in 1937.

established this relationship at thousands of points along our coasts. Each determination makes possible the location, on adjacent parts of the shore, of the position of the contour of intersection. If for any reason the elevation of the plane be changed, the contour of intersection will be shifted along the sloping surface of the land.

Even though the elevation of the tidal plane remains unchanged, usually, from time to time, there will be appreciable horizontal changes in the position of the line along which the plane intersects the surface of the land. These changes result from the action of waves and currents in producing erosions from and accretions to the land. They are in progress all the time, and physiographically speaking, at a very rapid rate. In fact, this zone where land and water meet is, generally speaking, the scene of the most rapid and radical natural changes which occur anywhere on the earth's surface.

It is the writer's understanding that this variability in position of this line of intersection is generally recognized in the law; that erosions and accretions are regarded as acts of God, and that as the proprietor has no recourse from the loss suffered from the first, so he is entitled to the gain from the second—at least in those cases where the changes are so imperceptible that they cannot be noted from day to day. The following discussion assumes the correctness of that understanding.

### *On the Outer Coast*

On the outer coast, the following considerations make the problem a simple one from the engineer's viewpoint.

For all practical purposes the elevations of the various mean tidal planes are fixed and unchanging, and their relation to adjacent bench marks is a constant one.[4] A possible exception to this rule occurs in the very infrequent case where an elevation or subsidence of the coast may be in progress. This exception, however, is not a serious one. In the first place, these geologic changes are usually so slow that generations are required for them to attain to appreciable amounts. In the second place, the coastal bench marks either are now or soon will be connected to the federal precise level net of the United States, so that any change in the relation between tidal plane and bench mark can be detected by leveling carried beyond the zone of earth movement.

The range of tide, and hence the elevation of the mean high-water line, varies from point to point along the coasts. The rate of change, however, is a very gradual one. Therefore, assuming a reasonable spacing of bench marks, it usually will be sufficiently accurate for the engineer who must indicate on the ground the momentary position of the mean high-water line, to start at the nearest bench mark, carry spirit levels to the pre-determined elevation of the line and then by the same method stake out along the beach the contour having that elevation throughout.

In the rare cases when the high-water plane has a more pronounced slope it would be a simple matter for the engineer to interpolate elevations between two adjacent bench marks (whose elevations with respect to each other can be derived from the federal precise level net) and to run his contour to conform thereto. We should recall, however, that a line

4. Studies made in recent years based on long-series observations indicate slow, secular changes in the relation of land and sea. For example, investigations indicate that in the last 40 years the relative rise of sea level along the Atlantic and Gulf coasts has been 0.011 foot per year; while along the Pacific coast, it has been 0.005 foot per year. For a discussion of this phenomenon, *see* Part 1 of this volume at 231 A.

so marked would have no permanent value, as erosions and accretions eventually would make it inapplicable.

Along the outer coast, therefore, it should not be difficult for the legislature or the court to formulate a precise and unambiguous definition of any tidal contour adopted as a boundary, by stating it in terms of its elevation with respect to a series of bench marks along the coast, and possibly, as a further precaution, by stating the elevations of the bench marks in terms of the federal precise level net.

Application of the method is facilitated by the fact that for many sections of the coast all necessary data already exist in the archives of the Federal Government.

### *In the Basins*

In the basins, the situation is much more complicated. Possibly it will be found that the method suggested for the outer coast can be applied here also, but certainly its application will be a proper one only if it takes careful account of the actual tidal regime of the basin.

I doubt whether there exists on any part of our coasts a natural basin—that is, one unimproved by man—where a contour derived from the elevation of mean high tide in the adjacent ocean and carried at that elevation around the basin by spirit levels would not depart more or less from the position of the true mean high-tide line of the basin. In short, in the basins the plane of mean high water is usually a tilted or warped surface, or a combination of both.

As an extreme case, consider Barnegat Bay, for which tidal data have already been given. That bay is bordered, particularly along parts of its western shore, by extensive areas of low, flat marsh or meadow, and the area which would be included between the true and the instrumental mean high-tide line could appropriately be measured in square miles rather than acres. At the opposite extreme we have San Francisco Bay as an example, where the mean high-tide line derived from the ocean would lie far out in the waters in some of the southern parts of the bay.

The writer would not imply that such discrepancies would survive in any litigation. He merely cites them as extreme examples, which differ only in degree and not in principle from cases which have come to his attention. The situation, while complicated, is not inherently difficult. Exact knowledge of the tidal regime of the basin will afford the solution.

Such knowledge in most cases is not available at the present time. While the tides in all or nearly all the basins on our coasts have been measured the work was done for other purposes and would require supplementing for this one. The additional work could be quickly and cheaply performed. A relatively short period of simultaneous observations at a number of points about the basin would afford data which, by comparison with those at a primary station, could be reduced to accurate mean values. Between the points thus determined interpolations would furnish intermediate values of adequate accuracy, and the method suggested for the outer coast could be applied. The value of the result would depend on the adequacy in number and location of the points at which the observations were made, and this matter should receive careful consideration by an experienced agency.

The foregoing relates to a sound engineering method of defining the present mean high-water line for future use. Sometimes it is necessary to ascertain the most probable position of that line as of some date in the remote past. The difficulties attending such an effort afford the most conclusive argument for obviating similar future uncertainties regarding present conditions.

Usually after all obtainable data have been assembled it will be found that any determination which may be made is subject to considerable uncertainties. Surveys and maps must be used whose accuracy is problematical. Interpolations must be made between showings of conditions as of two more or less widely separated dates, which depend not only on the correctness of the showings as of the two dates, but also on an assumption of continuity in rate and character of change during the intervening period which may or may not have existed. Local testimony envelops the situation in a fog of uncertainty and contradiction.

In the last analysis, the difficulties are those of relative values. A century or more ago when the foundations for some of our present difficulties were laid, the methods and processes used, and the precautions taken, were such as were considered appropriate to the then existing values. No thought, or too little thought, was given to the future. Since that period values have increased tremendously; in many cases land is worth more per square foot today than it was per acre then. And so, in some regions, our court calendars are crowded with cases seeking authoritative determinations of questions for which the methods originally used would have afforded no adequate basis for determination even if they had not been further obscured by the lapse of time.

It does not seem to the writer that we are profiting as we should from these experiences. Nothing is more certain than that values will continue to increase, and that if we continue to act only in terms of present-day values our actions will be as inadequate for our successors a century in the future as those of our predecessors a century ago are now proving to us.

Especially in matters pertaining to this tidal boundary, on one side of which proprietorship is vested in the state, it would seem that we should hope for constructive, forward-looking vision adequate to meet the situation.

## ARTIFICIAL CHANGES IN BASIN REGIMES

This is a subject of some importance at present, and which will become increasingly so in the future. Important cases within this category, involving property of considerable value, have been decided on bases which, insofar as the writer is informed, took no account of the human instrumentality involved; if so, presumably because that aspect of the matter was not brought to the attention of the court.

It has already been stated that artificial works of improvement at a basin can materially change its tidal regime, and here the question of responsibility, including the possibility of demonstrating that the same exists, becomes an interesting one. The first is a legal question, the latter essentially an engineering one.

To give concreteness to the picture let us again revert to Barnegat Bay. For many years the range of tide toward the northern end of the bay has been only a few inches and the physiography of the region has adjusted itself to that range. Now suppose that during some severe storm an inlet broke through the beach which separates bay from ocean. The range of tide in the bay would immediately be increased, probably to an extent which overflowed the low, flat meadowlands in the vicinity. This would be an act of God, for which no court would entertain a plea for relief from any damaged landowner.

But suppose that, without giving due thought to the consequences, men dug the same inlet, as has been attempted in more than one locality. Then it would seem to the layman that the damaged property owner would have in theory a just cause for seeking damages, and to the engineer that the relation between cause and effect was so direct and obvious that the ground for an award of damages could readily be shown.

In other actual cases, however, this relationship between cause and effect is not so clear. In engineering work it is sometimes economical to resort to indirect means to accomplish a desired purpose, as when engineers, instead of resorting to a large amount of expensive dredging to remove a shoal or improve a channel, build a relatively inexpensive training wall which so deflects the current as to cause it to do the work for them. In such cases the change may be brought about so gradually, extending over such a period of years, that the relation between cause and effect becomes obscured and difficult of proof.

As this is written there is pending in a certain state a case involving the ownership of an island in the heart of one of our important seaports, in which the city is seeking to wrest title from a corporation now in possession. This case is one of a number of similar ones; the total values involved probably run well into the millions of dollars.

The case hinges on the question whether the island was covered by the tide at ordinary high water as of a certain date almost a century ago. The city can produce presumably reliable evidence to show that it was so covered some two decades ago. On the other hand, there is other evidence of a much earlier date, presumably of equal reliability and including official federal surveys, which indicate that the tract in question was then bare at high tide.

In the writer's opinion no actual contradiction is involved in these two seemingly conflicting groups of evidence. Between the two periods, to which the respective groups apply, extensive artificial improvements of the basin and its entrance were made which could scarcely have failed to result in a material increase in the tidal range, and as a result of this increase the island, which was of the typical marsh formation and therefore low and flat, could well have been bare at high tide at the earlier period and covered at the later one.

This case is typical of those in which the relation between cause and effect is difficult of proof. Tidal data taken in the basin prior to the beginning of the improvement would give a direct and conclusive answer to the problem. But if tidal observations were ever made they can no longer be found, and presumably the case will be decided on a basis of probabilities as indicated by other indirect and less conclusive evidence.

If this case were unique it would not merit the space which has been given it here. But it is not unique; it is a sign-post to point out the way to avoid countless similar controversies in the future. The development of our coastal basins is in its infancy. The next century will see progress of which we scarcely dream today. That progress will be brought about in large part by the states or their political subdivisions or agencies which also have a function of guarding the rights of their citizens. Factors in that guardianship pertinent to our subject are on the one hand to protect the individual from uncompensated damage and on the other hand to protect the citizens as a whole against excessive damage claims by individuals. To that protection an exact knowledge of physical conditions prior to improvement is an essential prerequisite, of which exact knowledge of the tidal boundary constitutes an important part.

APPENDIX F

# Nautical Chart Symbols and Abbreviations

(Promulgated by the U.S. Coast and Geodetic Survey, the U.S. Naval Oceanographic Office, and the U.S. Lake Survey)

## GENERAL REMARKS

*Chart No. 1* contains the standard symbols and abbreviations which have been approved for use on nautical charts published by the United States of America.

*Symbols and abbreviations* shown on Chart No. 1 apply to the regular nautical charts and may differ from those shown on certain reproductions and special charts.

*Terms, symbols and abbreviations* are numbered in accordance with a standard form approved by a Resolution of the Sixth International Hydrographic Conference, 1952.

*Vertical figures* indicate those items where the symbol and abbreviation are in accordance with the Resolutions of the International Hydrographic Conferences.

*Slanting figures* indicate those items where the symbol and/or abbreviation differ from the Resolutions of the Conferences, or for which Resolutions do not yet exist.

*(Those items which differ from the Resolutions are underlined.)*

*Slanting letters in parentheses* indicate that the items are in addition to those shown on the approved standard form.

*Colors* are optional for characterizing various features and areas on the charts.

*Lettering* styles and capitalization as used on Chart No. 1 are not always rigidly adhered to on the charts.

*Longitudes* are referred to the Meridian of Greenwich.

*Scales* are computed on the middle latitude of each chart, or on the middle latitude of a series of charts.

*Buildings* - A conspicuous feature on a building may be shown by a landmark symbol with descriptive note (See L-63 & I-n). Prominent buildings that are of assistance to the mariner are crosshatched (See I-3a,5,47 & 66).

*Shoreline* is the line of Mean High Water, except in marsh or mangrove areas, where the outer edge of vegetation (berm line) is used. A heavy line (A-9) is used to represent a firm shoreline. A light line (A-7) represents a berm line.

*Heights* of land and conspicuous objects are given in feet above Mean High Water, unless otherwise stated in the title of the chart.

*Depth Contours and Soundings* may be shown in meters on charts of foreign waters.

*Visibility* of a light is in nautical miles for an observer's eye 15 feet above water level.

*Buoys and Beacons* - On entering a channel from seaward, buoys on starboard side are red with even numbers, on port side black with odd numbers. Lights on buoys on starboard side of channel are red or white, on port side white or green. Mid-channel buoys have black-and-white vertical stripes. Junction or obstruction buoys, which may be passed on either side, have red-and-black horizontal bands. This system does not always apply to foreign waters. The dot of the buoy symbol, the small circle of the light vessel and mooring buoy symbols, and the center of the beacon symbol indicate their positions.

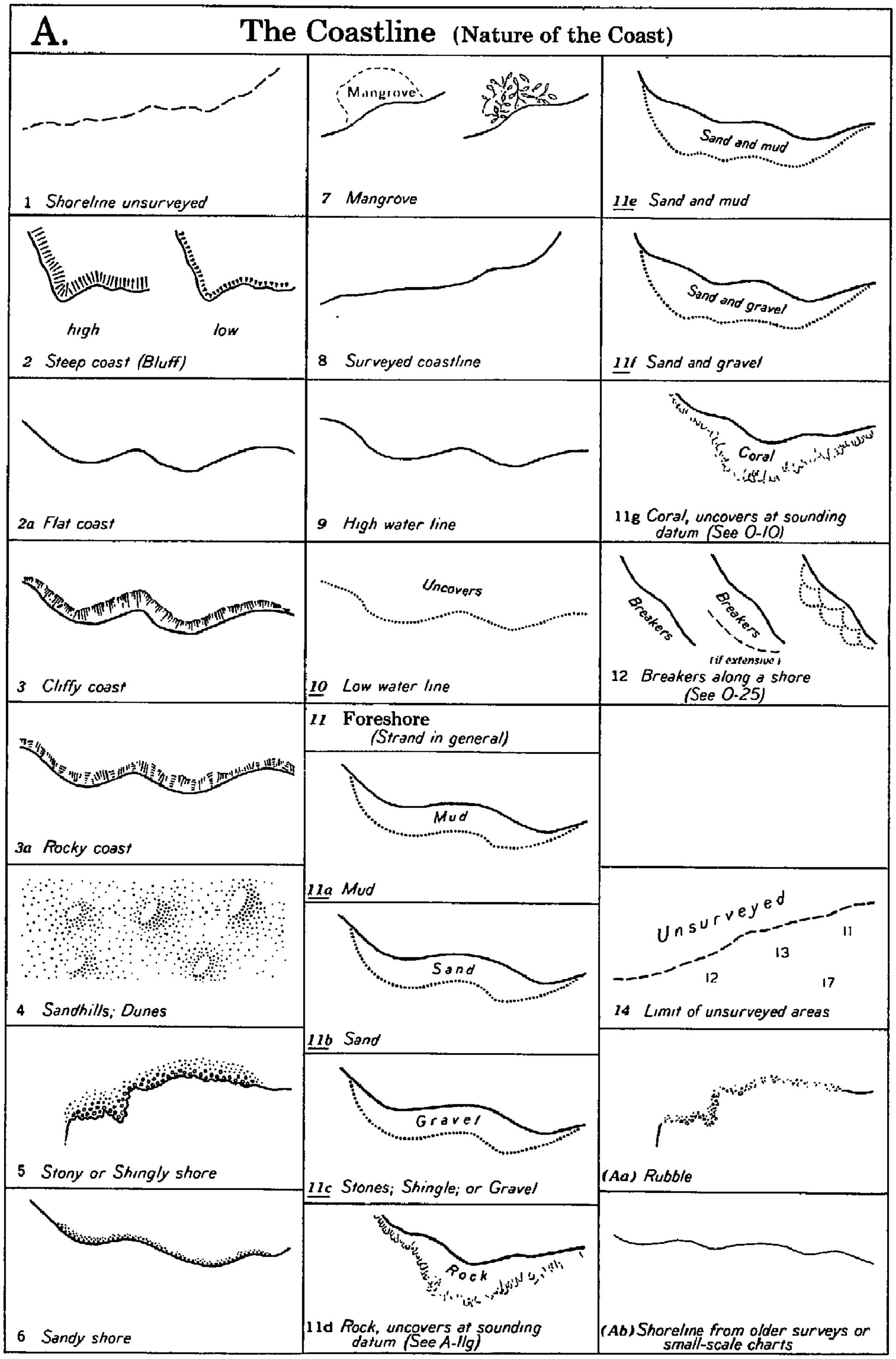
*Improved channels* are shown by limiting dashed lines, the depth, month, and the year of latest examination being placed adjacent to the channel, except when tabulated.

*U. S. Coast Pilots, Sailing Directions, Light Lists, Radio Aids,* and related publications furnish information required by the navigator that cannot be shown conveniently on the nautical chart.

*U. S. Nautical Chart Catalogs and Indexes* list nautical charts, auxiliary maps, and related publications, and include general information (marginal notes, etc.) relative to the charts.

*A glossary* of foreign terms and abbreviations is generally given on the charts on which they are used, as well as in the Sailing Directions.

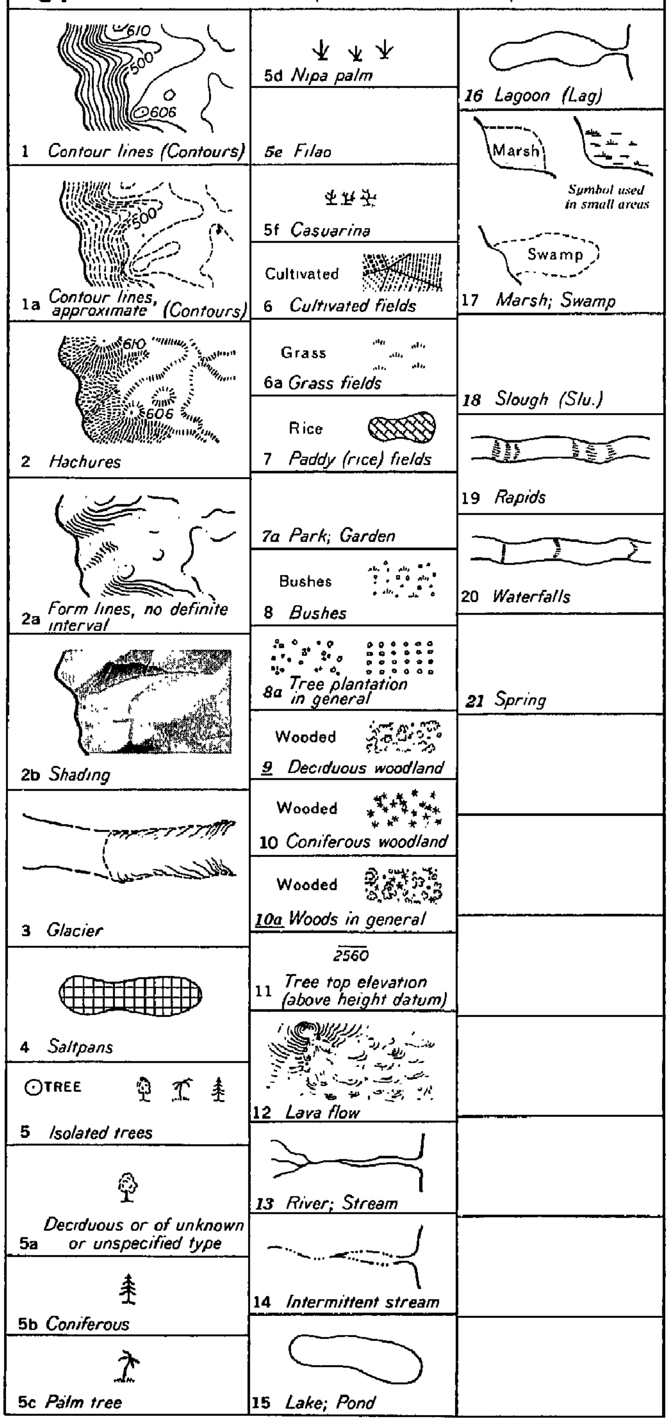
*Charts already on issue* will be brought into conformity as soon as opportunity affords.


A. The Coastline (Nature of the Coast)
1 Shoreline unsurveyed
7 Mangrove
Mangrove
11e Sand and mud
Sand and mud
high
low
2 Steep coast (Bluff)
8 Surveyed coastline
11f Sand and gravel
Sand and gravel
2a Flat coast
9 High water line
11g Coral, uncovers at sounding datum (See O-10)
Coral
3 Cliffy coast
Uncovers
10 Low water line
Breakers
Breakers
(if extensive)
12 Breakers along a shore (See O-25)
3a Rocky coast
11 Foreshore (Strand in general)
Mud
11a Mud
Unsurveyed
11
13
12
17
14 Limit of unsurveyed areas
4 Sandhills; Dunes
Sand
11b Sand
5 Stony or Shingly shore
Gravel
11c Stones; Shingle; or Gravel
(Aa) Rubble
6 Sandy shore
Rock
11d Rock, uncovers at sounding datum (See A-11g)
(Ab) Shoreline from older surveys or small-scale charts

## B. Coast Features

| | | |
|---|---|---|
| 1 | *G* | *Gulf* |
| 2 | *B* | *Bay* |
| (Ba) | *B* | *Bayou* |
| 3 | *Fd* | *Fjord* |
| 4 | *L* | *Loch; Lough; Lake* |
| 5 | *Cr* | *Creek* |
| 5a | *C* | *Cove* |
| 6 | *In* | *Inlet* |
| 7 | *Str* | *Strait* |
| 8 | *Sd* | *Sound* |
| 9 | *Pass* *Thoro* | *Passage; Pass* *Thorofare* |
| 10 | *Chan* | *Channel* |
| 10a | | *Narrows* |
| 11 | *Entr* | *Entrance* |
| 12 | *Est* | *Estuary* |
| 12a | | *Delta* |
| 13 | *Mth* | *Mouth* |
| 14 | *Rd* | *Road; Roadstead* |
| 15 | *Anch* | *Anchorage* |
| 16 | *Hbr* | *Harbor* |
| 16a | *Hn* | *Haven* |
| 17 | *P* | *Port* |
| (Bb) | *P* | *Pond* |
| 18 | I | *Island* |
| 19 | It | *Islet* |
| 20 | Arch | *Archipelago* |
| 21 | Pen | *Peninsula* |
| 22 | C | *Cape* |
| 23 | Prom | *Promontory* |
| 24 | Hd | *Head; Headland* |
| 25 | Pt | *Point* |
| 26 | Mt | *Mountain; Mount* |
| 27 | Rge | *Range* |
| 27a | | *Valley* |
| 28 | | *Summit* |
| 29 | Pk | *Peak* |
| 30 | Vol | *Volcano* |
| 31 | | *Hill* |
| 32 | Bld | *Boulder* |
| 33 | Ldg | *Landing* |
| 34 | | *Table-land (Plateau)* |
| 35 | *Rk* | *Rock* |
| 36 | | *Isolated rock* |
| (Bc) | *Str* | *Stream* |
| (Bd) | *R* | *River* |
| (Be) | *Slu* | *Slough* |
| (Bf) | *Lag* | *Lagoon* |
| (Bg) | *Apprs* | *Approaches* |
| (Bh) | *Rky* | *Rocky* |

## C. The Land (Natural Features)



## D. Control Points

| | | | |
|---|---|---|---|
| 1 | △ | | *Triangulation point (station)* |
| 2 | ⊙ | | *Fixed point (landmark) (See L-63)* |
| 3 | · 256 | | *Summit of height (Peak) (when not a landmark)* |
| (Da) | 256 | | *Peak, accentuated by contours* |
| (Db) | 256 | | *Peak, accentuated by hachures* |
| (Dc) | | | *Peak, elevation not determined* |
| (Dd) | ⊙ 256 | | *Peak, when a landmark* |
| 4 | ⊕ | Obs Spot | *Observation spot* |
| 5 | | BM | *Bench mark* |
| 6 | ∘ | See View | *View point* |
| 7 | | | *Datum point for grid of a plan* |
| 8 | | | *Graphical triangulation point* |
| 9 | | Astro | *Astronomical* |
| 10 | | Tri | *Triangulation* |
| (De) | | C of E | *Corps of Engineers* |
| 12 | | | *Great trigonometrical survey station* |
| 13 | | | *Traverse station* |
| 14 | | Bdy. Mon | *Boundary monument* |
| (Df) | ◇ | | *International boundary monument* |

## E. Units

| | | | | | |
|---|---|---|---|---|---|
| 1 | hr | *Hour* | 12b | cd | *Candela (new candle)* |
| 2 | m. min | *Minute (of time)* | 13 | lat | *Latitude* |
| 3 | sec | *Second (of time)* | 14 | long | *Longitude* |
| 4 | m | *Meter* | 15 | pub | *Publication* |
| 4a | dm | *Decimeter* | 16 | Ed | *Edition* |
| 4b | cm | *Centimeter* | 17 | corr | *Correction* |
| 4c | mm | *Millimeter* | 18 | alt | *Altitude* |
| 4d | $m^2$ | *Square meter* | 19 | ht; elev | *Height; Elevation* |
| 4e | $m^3$ | *Cubic meter* | 20 | ° | *Degree* |
| 5 | km | *Kilometer* | 21 | ′ | *Minute (of arc)* |
| 6 | in | *Inch* | 22 | ″ | *Second (of arc)* |
| 7 | ft | *Foot* | 23 | No | *Number* |
| 8 | yd | *Yard* | | | |
| 9 | fm | *Fathom* | | | |
| 10 | cbl | *Cable length* | | | |
| 11 | M | *Nautical mile* | (Ea) | St. M | *Statute mile* |
| 12 | kn | *Knot* | (Eb) | Msec | *Microsecond* |
| 12a | t | *Ton* | | | |

## F. Adjectives, Adverbs and other abbreviations

| | | |
|---|---|---|
| 1 | gt | *Great* |
| 2 | lit | *Little* |
| 3 | lrg | *Large* |
| 4 | sml | *Small* |
| 5 | | *Outer* |
| 6 | | *Inner* |
| 7 | mid | *Middle* |
| 8 | | *Old* |
| 9 | anc | *Ancient* |
| 10 | | *New* |
| 11 | St | *Saint* |
| 12 | conspic | *Conspicuous* |
| 13 | | *Remarkable* |
| 14 | D., Destr | *Destroyed* |
| 15 | | *Projected* |
| 16 | dist | *Distant* |
| 17 | abt | *About* |
| 18 | | *See chart* |
| 18a | | *See plan* |
| 19 | | *Lighted; Luminous* |
| 20 | sub | *Submarine* |
| 21 | | *Eventual* |
| 22 | AERO | *Aeronautical* |
| 23 | | *Higher* |
| 24 | exper | *Experimental* |
| 25 | discontd | *Discontinued* |
| 26 | prohib | *Prohibited* |
| 27 | explos | *Explosive* |
| 28 | estab | *Established* |
| 29 | elec | *Electric* |
| 30 | priv | *Private, Privately* |
| 31 | prom | *Prominent* |
| 32 | std | *Standard* |
| 33 | subm | *Submerged* |
| 34 | approx | *Approximate* |
| (Fa) | unverd | *Unverified* |
| (Fb) | AUTH | *Authorized* |
| (Fc) | CL | *Clearance* |
| (Fd) | maintd | *Maintained* |
| (Fe) | aband | *Abandoned* |
| (Ff) | cor | *Corner* |
| (Fg) | concr | *Concrete* |
| (Fh) | fl | *Flood* |
| (Fi) | extr | *Extreme* |
| (Fj) | mod | *Moderate* |
| (Fk) | bet | *Between* |
| (Fl) | 1st | *First* |
| (Fm) | 2nd | *Second* |
| (Fn) | 3rd | *Third* |
| (Fo) | 4th | *Fourth* |

# G. Ports and Harbors

| | | | |
|---|---|---|---|
| 1 | | Anch | *Anchorage (large vessels)* |
| 2 | | Anch | *Anchorage (small vessels)* |
| 3 | | Hbr | *Harbor* |
| 4 | | Hn | *Haven* |
| 5 | | P | *Port* |
| 6 | | Bkw | *Breakwater* |
| 6a | | | *Dike* |
| 7 | | | *Mole* |
| 8 | | | *Jetty (partly below MHW)* |
| 8a | | | *Submerged jetty* |
| (Ga) | | | *Jetty (small scale)* |
| 9 | | Pier | *Pier* |
| 10 | | | *Spit* |
| 11 | | | *Groin (partly below MHW)* |
| 12 | ANCHORAGE PROHIBITED | ANCH PROHIB | *Anchorage prohibited (See P-25)* |
| 13 | *Spoil Area* | | *Spoil ground* |
| (Gb) | *Dumping Ground* | | *Dumping ground* |
| (Gc) | 80 85 83 *Disposal Area Depths from survey of June 1963* 95 90 98 | | *Disposal area* |
| 14 | | Fsh stks | *Fisheries; Fishing stakes* |
| 14a | | | *Fish trap; Fish weirs (actual shape charted)* |
| 14b | | | *Duck blind* |
| 15 | | | *Tunny nets (See G-14a)* |
| 15a | *Oys* | Oys | *Oyster bed* |
| 16 | | Ldg | *Landing place* |
| 17 | | | *Watering place* |
| 18 | | Whf | *Wharf* |
| 19 | | | *Quay* |
| 20 | | | *Berth* |
| 20a | 14 | | *Anchoring berth* |
| 20b | 3 | | *Berth number* |
| 21 | | Dol. | *Dolphin* |
| 22 | | | *Bollard* |
| 23 | | | *Mooring ring* |
| 24 | | | *Crane* |
| 25 | | | *Landing stage* |
| 25a | | | *Landing stairs* |
| 26 | | Quar | *Quarantine* |
| 27 | | | *Lazaret* |
| 28 | | Harbor Master | *Harbor master's office* |
| 29 | | Cus. Ho. | *Customhouse* |
| 30 | | | *Fishing harbor* |
| 31 | | | *Winter harbor* |
| 32 | | | *Refuge harbor* |
| 33 | | B. Hbr. | *Boat harbor* |
| 34 | | | *Stranding harbor (uncovers at LW)* |
| 35 | | | *Dock* |
| 36 | | | *Dry dock (actual shape on large-scale charts)* |
| 37 | | | *Floating dock (actual shape on large-scale charts)* |
| 38 | | | *Gridiron; Careening grid* |
| 39 | | | *Patent slip; Slipway; Marine railway* |
| 39a | | Ramp | *Ramp* |
| 40 | Lock | | *Lock (point upstream) (See H-13)* |
| 41 | | | *Wet dock* |
| 42 | | | *Shipyard* |
| 43 | | | *Lumber yard* |
| 44 | | Health Office | *Health officer's office* |
| 45 | | *Hk* | *Hulk (actual shape on lrg. scale charts) (See O-11)* |
| 46 | PROHIBITED AREA | PROHIB AREA | *Prohibited area* |
| 47 | | | *Anchorage for seaplanes* |
| 48 | | | *Seaplane landing area* |
| 49 | *Under construction* | | *Work in progress* |
| 50 | | | *Under construction* |
| (Gd) | *Subm ruins* | | *Submerged ruins* |

# H. Topography (Artificial Features)

| | |
|---|---|
| 1 | *Road* (Rd) *or Highway* (Hy) — *Small scale chart* |
| 2 | *Track, Footpath, or Trail* |
| 3 | *Railway* (Ry) *(single or double track); Railroad* (RR) — M & L S RR; *Same grade*; *Ry above*; *Ry below* |
| 3a | *Tramway* |
| 3b | *Railway station* |
| 3c | *Tunnel (railroad or road)* |
| 3d | *Embankment, Levee* |
| 3e | *Cutting* |
| 4 | *Overhead power cable* (OVHD PWR CAB) — OVERHEAD POWER CABLE AUTHORIZED CL 140 FT; TOWER; TOWER |
| 5 | *Power transmission line* |
| 5a | *Power transmission mast* |
| 6 | *Prominent telegraph or telephone line* — Tel |
| 7 | *Aqueduct; Water pipe* |
| 8 | *Viaduct* — Viaduct |
| 8a | *Oil pipeline* — Pipeline |
| 9 | *Pile; Piling; Post (above MHW) (See L-59, O-30)* — Pile; Piling; Post |
| 9a | *Mast* — MAST; Mast |
| 10 | *Highway (See H-1)* |
| 11 | *Sewer* — Sewer |
| 12 | *Culvert* |
| 13 | *Canal; Ditch, Lock, Sluice (point upstream)* — Canal; Lock; Ditch; Sluice (Tidegate. Floodgate) |
| 14 | *Bridge* (BR) *in general* |
| 14a | *Stone, concrete bridge (Same as H-14)* |
| 14b | *Wooden bridge (Same as H-14)* |
| 14c | *Iron bridge (Same as H-14)* |
| 14d | *Suspension bridge (Same as H-14)* |
| 15 | *Drawbridge (in general)* |
| 16 | *Swing bridge (Same as H-15)* |
| 16a | *Lift bridge* |
| 16b | *Weighbridge or Bascule bridge* |
| 17 | *Pontoon bridge* |
| 17a | *Footbridge* |
| 18 | *Transporter bridge (Same as H-14)* |
| 18a | *Bridge clearance, vertical* — VERT. CL 6 FT |
| 18b | *Bridge clearance, horizontal* — HOR CL 28 FT |
| 19 | *Ferry* (Fy) — Ferry; Ferry; *On small-scale chart* |
| 20 | *Ford* |
| 21 | *Dam* |
| 22 | *Fence* |
| 23 | *Training wall* |
| (Ha) | *Log boom* — Log boom |

## I. Buildings and Structures (see General Remarks)

| | | | |
|---|---|---|---|
| 1 | | | *City or Town (large scale)* |
| (1a) | # o | | *City or Town (small scale)* |
| 2 | | | *Suburb* |
| 3 | | Vil | *Village* |
| 3a | | | *Buildings in general* |
| 4 | | Cas | *Castle* |
| 5 | | | *House* |
| 6 | | | *Villa* |
| 7 | | | *Farm* |
| 8 | | Ch | *Church* |
| 8a | | Cath | *Cathedral* |
| 8b | ⊙SPIRE | Spire | *Spire; Steeple* |
| 8c | | | *Christian Shrine* |
| 9 | | | *Roman Catholic Church* |
| 10 | | | *Temple* |
| 11 | | | *Chapel* |
| 12 | | | *Mosque; Minaret* |
| (1b) | | | *Moslem Shrine* |
| 13 | | | *Marabout* |
| 14 | | Pag | *Pagoda* |
| 15 | | | *Buddhist Temple; Joss-House* |
| 15a | | | *Shinto Shrine* |
| 16 | | | *Monastery; Convent* |
| 17 | | | *Calvary; Cross* |
| 17a | Cem | | *Cemetery, Non-Christian* |
| 18 | Cem | | *Cemetery, Christian* |
| 18a | | | *Tomb* |
| 19 | | | *Fort (actual shape charted)* |
| 20 | | | *Battery (Same as 1-19)* |
| 21 | | | *Barracks* |
| 22 | | | *Powder magazine* |
| 23 | Airport | | *Airplane landing field* |
| 24 | Airport | | *Airport, large scale (See P-13)* |
| (1c) | O | | *Airport, military (small scale)* |
| (1d) | | | *Airport, civil (small scale)* |
| 25 | | | *Mooring mast* |
| 26 | King St | St | *Street* |

| | | | |
|---|---|---|---|
| 26a | Locust Ave | Ave | *Avenue* |
| (1e) | Grand Blvd | Blvd | *Boulevard* |
| 27 | | Tel | *Telegraph* |
| 28 | | Tel.Off | *Telegraph office* |
| 29 | | P O | *Post office* |
| 30 | | Govt. Ho | *Government house* |
| 31 | | | *Town hall* |
| 32 | | Hosp | *Hospital* |
| 33 | | | *Slaughterhouse* |
| 34 | | Magz | *Magazine* |
| 34a | | | *Warehouse; Storehouse* |
| 35 | ⊙MON | °Mon | *Monument* |
| 36 | ⊙CUP | °Cup | *Cupola* |
| 37 | ⊙ELEV | °Elev | *Elevator; Lift* |
| (1f) | | Elev | *Elevation; Elevated* |
| 38 | | | *Shed* |
| 39 | | | *Zinc roof* |
| 40 | Ruins | °Ru | *Ruins* |
| 41 | ⊙TR | °Tr | *Tower* |
| 42 | ⊙WINDMILL | | *Windmill* |
| 43 | | | *Watermill* |
| 43a | ⊙WINDMOTOR | | *Windmotor* |
| 44 | ⊙CHY | °Chy | *Chimney; Stack* |
| 45 | ⊙S'PIPE | °S'pipe | *Water tower; Standpipe* |
| 46 | ● | | *Oil tank* |
| 47 | | Facty | *Factory* |
| 48 | | | *Saw mill* |
| 49 | | | *Brick kiln* |
| 50 | ⚒ | | *Mine; Quarry* |
| 51 | °Well | | *Well* |
| 52 | | | *Cistern* |
| 53 | ⊙TANK | °Tk | *Tank* |
| 54 | | | *Noria* |
| 55 | | | *Fountain* |

## I. Buildings and Structures (continued)

| | | | |
|---|---|---|---|
| 61 | | Inst | *Institute* |
| 62 | | | *Establishment* |
| 63 | | | *Bathing establishment* |
| 64 | | Ct Ho | *Courthouse* |
| 65 | | Sch | *School* |
| (Ig) | | H. S | *High school* |
| (Ih) | | Univ | *University* |
| 66 | ■ ▨ □ | Bldg | *Building* |
| 67 | | Pav | *Pavilion* |
| 68 | | | *Hut* |
| 69 | | | *Stadium* |
| 70 | | T | *Telephone* |
| 71 | ⊕ ● | | *Gas tank; Gasometer* |
| 72 | ⊙ GAB | ○ Gab | *Gable* |
| 73 | | | *Wall* |
| (Ii) | | Ltd | *Limited* |
| (Ij) | | Apt | *Apartment* |
| (Ik) | | Cap | *Capitol* |
| (Il) | | Co | *Company* |
| (Im) | | Corp | *Corporation* |
| (In) | ⊙ | | *Landmark (conspicuous object)* |
| (Io) | ○ | | *Landmark (position approx.)* |

## J. Miscellaneous Stations

| | | | |
|---|---|---|---|
| 1 | | Sta | *Any kind of station* |
| 2 | | Sta | *Station* |
| 3 | C.G | | *Coast Guard station (Similar to LS. S.)* |
| (Ja) | ⊙ C.G WALLIS SANDS | | *Coast Guard station (when landmark)* |
| 4 | ⊙ LOOK.TR | | *Lookout station; Watch tower* |
| 5 | | | *Lifeboat station* |
| 6 | LS. S | | *Lifesaving station (See J-3)* |
| 7 | | Rkt. Sta | *Rocket station* |
| 8 | | ⊙ PIL. STA | *Pilot station* |
| 9 | | Sig Sta | *Signal station* |
| 10 | | Sem | *Semaphore* |
| 11 | | S Sig Sta | *Storm signal station* |
| 12 | | | *Weather signal station* |
| (Jb) | ⊙ W.B. SIG. STA | | *Weather Bureau signal station* |
| 13 | | | *Tide signal station* |
| 14 | | | *Stream signal station* |
| 15 | | | *Ice signal station* |
| 16 | | | *Time signal station* |
| 17 | | | *Time ball* |
| 18 | | | *Signal mast* |
| 19 | ⊙ FS ○ FS | ⊙ FP ○ FP | *Flagstaff; Flagpole* |
| (Jc) | ⊙ F. TR | ○ F.Tr | *Flag tower* |
| 20 | | | *Signal* |
| 21 | | Obsy | *Observatory* |
| 22 | | Off | *Office* |
| (Jd) | ○ BELL | | *Bell (on land)* |
| (Je) | ○ HECP | | *Harbor entrance control post* |

# K. Lights

| | | |
|---|---|---|
| 1 | | *Position of light* |
| 2 | Lt | *Light* |
| (Ka) | | *Riprap surrounding light* |
| 3 | Lt Ho | *Lighthouse* |
| 4 | AERO | *Aeronautical light (See F-22)* |
| 4a | | *Marine and air navigation light* |
| 5 | Bn | *Light beacon* |
| 6 | | *Light vessel; Lightship* |
| 8 | | *Lantern* |
| 9 | | *Street lamp* |
| 10 | REF | *Reflector* |
| 11 | Ldg Lt | *Leading light* |
| 12 | RED | *Sector light* |
| 13 | RED GREEN | *Directional light* |
| 14 | | *Harbor light* |
| 15 | | *Fishing light* |
| 16 | | *Tidal light* |
| 17 | Priv maintd | *Private light (maintained by private interests; to be used with caution)* |
| 21 | F | *Fixed light* |
| 22 | Occ | *Occulting light* |
| 23 | Fl | *Flashing light* |
| 24 | Qk Fl | *Quick flashing (scintillating) light* |
| 24a | I Qk Fl<br>Int Qk Fl | *Interrupted quick flashing light* |
| (Kb) | E Int | *Equal interval (isophase) light* |
| 25a | S Fl | *Short flashing light* |
| 26 | Alt | *Alternating light* |
| 27 | Gp Occ | *Group occulting light* |
| 28 | Gp Fl | *Group flashing light* |
| 28a | S-L Fl | *Short-long flashing light* |
| 28b | | *Group short flashing light* |

| | | |
|---|---|---|
| 29 | F Fl | *Fixed and flashing light* |
| 30 | F Gp Fl | *Fixed and group flashing light* |
| 31 | Rot | *Revolving or Rotating light* |
| (Kbb) | Mo | *Morse code* |
| 41 | | *Period* |
| 42 | | *Every* |
| 43 | | *With* |
| 44 | | *Visible (range)* |
| (Kc) | M | *Nautical mile (See E-11)* |
| (Kd) | m, min | *Minutes (See E-2)* |
| (Ke) | sec | *Seconds (See E-3)* |
| 45 | Fl | *Flash* |
| 46 | Occ | *Occultation* |
| 46a | | *Eclipse* |
| 47 | Gp | *Group* |
| 48 | Occ | *Intermittent light* |
| 49 | SEC | *Sector* |
| 50 | | *Color of sector* |
| 51 | Aux | *Auxiliary light* |
| 52 | | *Varied* |
| 61 | Vi | *Violet* |
| 62 | | *Purple* |
| 63 | Bu | *Blue* |
| 64 | G | *Green* |
| 65 | Or | *Orange* |
| 66 | R | *Red* |
| 67 | W | *White* |
| 67a | Am | *Amber* |
| 68 | OBSC | *Obscured light* |
| (Kf) | Fog Det Lt | *Fog detector light (See Nb)* |

## K. Lights (continued)

| | | |
|---|---|---|
| 69 | | *Unwatched light* |
| 70 | Occas | *Occasional light* |
| 71 | Irreg | *Irregular light* |
| 72 | Prov | *Provisional light* |
| 73 | Temp | *Temporary light* |
| (Kg) | D Destr | *Destroyed* |
| 74 | Exting | *Extinguished light* |
| 75 | | *Faint light* |
| 76 | | *Upper light* |
| 77 | | *Lower light* |
| 78 | | *Rear light* |
| 79 | | *Front light* |
| 80 | Vert | *Vertical lights* |
| 81 | Hor | *Horizontal lights* |
| (Kh) | VB | *Vertical beam* |
| (Ki) | RGE | *Range* |
| (Kj) | Exper | *Experimental light* |
| (Kk) | TRLB | *Temporarily replaced by lighted buoy showing the same characteristics* |
| (Kl) | TRUB | *Temporarily replaced by unlighted buoy* |
| (Km) | TLB | *Temporary lighted buoy* |
| (Kn) | TUB | *Temporary unlighted buoy* |

## L. Buoys and Beacons (see General Remarks)

| | | |
|---|---|---|
| 1 | • | *Position of buoy* |
| 2 | | *Light buoy* |
| 3 | BELL | *Bell buoy* |
| 3a | GONG | *Gong buoy* |
| 4 | WHIS | *Whistle buoy* |
| 5 | C | *Can or Cylindrical buoy* |
| 6 | N | *Nun or Conical buoy* |
| 7 | SP | *Spherical buoy* |
| 8 | S | *Spar buoy* |
| 8a | P | *Pillar buoy* |
| 9 | | *Buoy with topmark (ball) (See L-70)* |
| 10 | | *Barrel or Ton buoy* |
| (La) | | *Color unknown* |
| (Lb) | FLOAT | *Float* |
| 12 | FLOAT | *Lightfloat* |
| 13 | | *Outer or Landfall buoy* |
| 14 | BW | *Fairway buoy (BWVS)* |
| 14a | BW | *Mid-channel buoy (BWVS)* |
| 15 | R "2" | *Starboard-hand buoy (entering from seaward)* |
| 16 | "1" | *Port-hand buoy (entering from seaward)* |
| 17 | RB RB | *Bifurcation buoy (RBHB)* |
| 18 | RB RB | *Junction buoy (RBHB)* |
| 19 | RB RB | *Isolated danger buoy (RBHB)* |
| 20 | RB G | *Wreck buoy (RBHB or G)* |
| 20a | RB G | *Obstruction buoy (RBHB or G)* |
| 21 | Tel | *Telegraph-cable buoy* |
| 22 | | *Mooring buoy (colors of mooring buoys never carried)* |
| 22a | | *Mooring* |
| 22b | Tel | *Mooring buoy with telegraphic communications* |
| 22c | T | *Mooring buoy with telephonic communications* |
| 23 | | *Warping buoy* |
| 24 | Y | *Quarantine buoy* |
| 25 | Explos Anch | *Explosive anchorage buoy* |
| 25a | AERO | *Aeronautical anchorage buoy* |
| 26 | Deviation | *Compass adjustment buoy* |
| 27 | BW | *Fish trap buoy (BWHB)* |
| 27a | | *Spoil ground buoy* |
| 28 | | *Anchorage buoy (marks limits)* |
| 29 | Priv maintd | *Private buoy (maintained by private interests, use with caution)* |

# L. Buoys and Beacons (continued)

| | | | |
|---|---|---|---|
| 30 | | | *Temporary buoy (See Kk, l, m, n)* |
| 30a | | | *Winter buoy* |
| 31 | | *HB* | *Horizontal stripes or bands* |
| 32 | | *VS* | *Vertical stripes* |
| 33 | | *Chec* | *Checkered* |
| (Lc) | | *Diag* | *Diagonal buoy* |
| 41 | □ | *W* | *White* |
| 42 | ■ | *B* | *Black* |
| 43 | | *R* | *Red* |
| 44 | | *Y* | *Yellow* |
| 45 | | *G* | *Green* |
| 46 | | *Br* | *Brown* |
| 47 | | *Gy* | *Gray* |
| 48 | | *Bu* | *Blue* |
| (Ld) | | *Am* | *Amber* |
| (Le) | | *Or* | *Orange* |
| 51 | | | *Floating beacon* |
| 52 | △RW Bn △W Bn ▲R Bn | | *Fixed beacon (unlighted or daybeacon)* |
| | ▲Bn | | *Black beacon* |
| | △ Bn | | *Color unknown* |
| (Lf) | ⊙MARKER | | *Private aid to navigation* |
| 53 | | Bn | *Beacon, in general (See L-52)* |
| 54 | | | *Tower beacon* |

| | | | |
|---|---|---|---|
| 55 | | | *Cardinal marking system* |
| 56 | △ Deviation Bn | | *Compass adjustment beacon* |
| 57 | | | *Topmarks (See L-9, 70)* |
| 58 | | | *Telegraph-cable (landing) beacon* |
| 59 | Piles | | *Piles (See O-30, H-9)* |
| | ⊥⊥ | | *Stakes* |
| | *Stumps* | | *Stumps (See O-30)* |
| | ⊥⊥ | | *Perches* |
| 61 | ⊙CAIRN | °Cairn | *Cairn* |
| 62 | | | *Painted patches* |
| 63 | ⊙ | | *Landmark (conspicuous object) (See D-2)* |
| (Lg) | o | | *Landmark (position approximate)* |
| 64 | | *REF* | *Reflector* |
| 65 | ⊙MARKER | | *Range targets, markers* |
| (Lh) | *W Or* *W Or* | | *Special-purpose buoys* |
| 70 | *Note:* | | *TOPMARKS on buoys and beacons may be shown on charts of foreign waters. The abbreviation for black is not shown adjacent to buoys or beacons.* |
| (Li) | | *Ra Ref* | *Radar reflector (See M-13)* |

## M. Radio and Radar Stations

| | | |
|---|---|---|
| 1 | °R. Sta | *Radio telegraph station* |
| 2 | °R. T | *Radio telephone station* |
| 3 | R. Bn | *Radiobeacon* |
| 4 | R. Bn | *Circular radiobeacon* |
| 5 | R.D | *Directional radiobeacon; Radio range* |
| 6 | | *Rotating loop radiobeacon* |
| 7 | R.D.F | *Radio direction finding station* |
| (Ma) | TELEM ANT | *Telemetry antenna* |
| 9 | R. MAST | *Radio mast* |
| | R. TR | *Radio tower* |
| (Mb) | TV TR | *Television tower* |
| 10 | R. TR. (WBAL) 1090 Kc | *Radio broadcasting station (commercial)* |
| 10a | °R. Sta | *Q.T.G Radio station* |
| 11 | Ra | *Radar station* |

| | | |
|---|---|---|
| 12 | Racon | *Radar responder beacon* |
| 13 | Ra Ref | *Radar reflector (See Lj)* |
| 14 | Ra (conspic) | *Radar conspicuous object* |
| 14a | | *Ramark* |
| 15 | D.F.S | *Distance finding station (synchronized signals)* |
| (Mc) | AERO R. Bn 302 | *Aeronautical radiobeacon* |
| (Md) | AERO R. Rge 342 | *Aeronautical radio range* |
| (Me) | Ra Ref Calibration Bn | *Radar calibration beacon* |
| (Mf) | CONSOL Bn 190 Kc MMF | *Consol (Consolan) station* |
| (Mg) | Loran Sta Venice | *Loran station (name)* |
| (Mh) | LORAN TR SPRING ISLAND | *Loran tower (name)* |
| (Mi) | 10 | *Radio calling-in point for traffic control* |

## N. Fog Signals

| | | |
|---|---|---|
| 1 | Fog Sig | *Fog-signal station* |
| 2 | | *Radio fog-signal station* |
| 3 | *GUN* | *Explosive fog signal* |
| 4 | | *Submarine fog signal* |
| 5 | *SUB-BELL* | *Submarine fog bell (action of waves)* |
| 6 | *SUB-BELL* | *Submarine fog bell (mechanical)* |
| 7 | *SUB-OSC* | *Submarine oscillator* |
| 8 | *NAUTO* | *Nautophone* |
| 9 | *DIA* | *Diaphone* |
| 10 | *GUN* | *Fog gun* |
| 11 | *SIREN* | *Fog siren* |

| | | |
|---|---|---|
| 12 | *HORN* | *Fog trumpet* |
| 13 | *HORN* | *Fog horn* |
| 14 | *BELL* | *Fog bell* |
| 15 | *WHIS* | *Fog whistle* |
| 16 | *HORN* | *Reed horn* |
| 17 | *GONG* | *Fog gong* |
| 18 | | *Submarine sound signal not connected to the shore (See N-5, 6, 7)* |
| 18a | | *Submarine sound signal connected to the shore (See N-5, 6, 7)* |
| (Na) | *HORN* | *Typhon* |
| (Nb) | *Fog Det Lt* | *Fog detector light (See Kf)* |

# O. Dangers

(25)

1 Rock which does not cover (elevation above MHW)

Uncov 2 ft  Uncov 2 ft

(2)  (2)

2 Rock which covers and uncovers, with height in feet above chart (sounding) datum

3 Rock awash at the level of chart (sounding) datum

When rock of O-2 or O-3 is considered a danger to navigation

4 Sunken rock with less than 6 feet of water over it (Same as O-26)

5 Sunken rock with between 6 and 33 ft. of water over it (Same as O-26)

5 Rk

5a Shoal sounding on isolated rock (replaces symbol)

6 Sunken rock with more than 66 feet of water over it (Same as O-26)

21 Rk  21 Wk  21 Obstr

6a Sunken danger with depth cleared by wire drag (in feet or fathoms)

Reef

7 Reef of unknown extent

Sub Vol

8 Submarine volcano

Discol Water

9 Discolored water

Coral  Co  Co  Co

10 Coral reef, detached (uncovers at sounding datum)

Co 3 Reef Line

Coral or Rocky reef, covered at sounding datum (See A-IId, IIg)

11 Wreck showing any portion of hull or superstructure above sounding datum

Masts

12 Wreck with only masts visible above sounding datum

13. Old symbols for wrecks

13a Wreck always partially submerged

14 Sunken wreck which may be dangerous to surface navigation (See O-6a)

5 Wk

15 Wreck over which depth is known

16 Sunken wreck, not dangerous to surface navigation

Foul

17 Foul ground

Tide Rips

18 Overfalls or Tide rips — Symbol used only in small areas

Eddies

19 Eddies — Symbol used only in small areas

Kelp

20 Kelp, Seaweed — Symbol used only in small areas

21 Bk Bank
22 Shl Shoal
23 Rf Reef (See A-IId, IIg; O-10)
23a Ridge
24 Le Ledge

25 Breakers (See A-12)

26 Sunken rock (depth unknown)

When rock is considered a danger to navigation

5 Obstr

27 Obstruction

28 Wreck (See O-11 to 16)

Wreckage  Wks

29 Wreckage

29a Wreck remains (dangerous only for anchoring)

Subm piles

30 Submerged piling (See H-9, L-59)

Snags  Stumps

30a Snags, Submerged stumps (See L-59)

31 Lesser depth, possible

32 Uncov Dries (See A-10; O-2, 10)
33 Cov Covers (See O-2, 10)
34 Uncov Uncovers (See A-10; O-2, 10)

3 Rep (1958)

Reported (with date)

Eagle Rk (rep 1958)

35 Reported (with name and date)

36 Discol Discolored (See O-9)
37 Isolated danger

38 Limiting danger line

rky

39 Limit of rocky area

41 PA Position approximate
42 PD Position doubtful
43 ED Existence doubtful
44 P Pos Position
45 D Doubtful

Subm Crib  Crib (above water)

(Oa) Crib

Platform (lighted) HORN

(Ob) Offshore platform (unnamed)

Hazel (lighted) HORN

(Oc) Offshore platform (named)

## P. Various Limits, etc.

| | | |
|---|---|---|
| 1 | | *Leading line; Range line* |
| 2 | | *Transit* |
| 3 | | *In line with* |
| 4 | | *Limit of sector* |
| 5 | | *Channel, Course, Track recommended (marked by buoys or beacons)(See P-21)* |
| (Pa) | | *Alternate course* |
| 6 | | *Leader cable* |
| 7 | | *Submarine cable (power, telegraph, telephone, etc.)* |
| 7a | Cable Area | *Submarine cable area* |
| 8 | Pipeline | *Submarine pipeline* |
| 8a | Pipeline Area | *Submarine pipeline area* |
| 9 | | *Maritime limit in general* |
| 9a | RESTRICTED AREA | *Limit of restricted area* |
| 10 | | *Limit of fishing zone (fish trap areas)* |
| 11 | | *Limit of dumping ground, spoil ground (See P-9, G-13)* |
| 12 | | *Anchorage limit* |
| 13 | | *Limit of airport (See I-23, 24)* |
| 14 | | *Limit of sovereignty (Territorial waters)* |
| 15 | | *Customs boundary* |
| 16 | | *International boundary (also State boundary)* |
| 17 | | *Stream limit* |
| 18 | | *Ice limit* |
| 19 | | *Limit of tide* |
| 20 | | *Limit of navigation* |
| 21 | | *Course recommended (not marked by buoys or beacons)(See P-5)* |
| 22 | | *District or province limit* |
| 23 | | *Reservation line* |
| 24 | COURSE 053°00' TRUE MARKERS MARKERS | *Measured distance* |
| 25 | PROHIBITED AREA | *Prohibited area (See G-12)* |

## Q. Soundings

| | | |
|---|---|---|
| 1 | SD | *Doubtful sounding* |
| 2 | 65 | *No bottom found* |
| 3 | | *Out of position* |
| 4 | | *Least depth in narrow channel* |
| 5 | 30 FEET APR 1958 | *Dredged channel (with controlling depth indicated)* |
| 6 | 24 FEET MAY 1958 | *Dredged area* |
| 7 | | *Swept channel (See Q-9)* |
| 8 | 6 | *Drying or uncovering height in feet above chart (sounding) datum* |
| 9 | 17 119 | *Swept area, not adequately sounded (shown by green tint)* |
| 9a | 29 23 3 22 8 30 18 21 7 | *Swept area adequately sounded (swept by wire drag to depth indicated)* |
| 10 | | *Hair-line depths* |
| 10a | $8_2$ 19 | *Figures for ordinary soundings* |
| 11 | $8_2$ 19 | *Soundings taken from foreign charts* |
| 12 | $8_2$ 19 | *Soundings taken from older surveys or smaller scale charts* |
| 13 | $8_2$ 19 | *Soundings taken by echo* |
| 14 | $8_2$ 19 | *Sloping figures (See Q-12)* |
| 15 | $8_2$ 19 | *Upright figures (See Q-10a)* |
| 16 | (25) (2) | *Bracketed figures (See O-1, 2)* |
| 17 | 6 | *Underlined sounding figures (See Q-8)* |
| 18 | $3_2$ $6_1$ | *Soundings expressed in fathoms and feet* |
| (Qa) | 6 5 2ft | *Stream* |

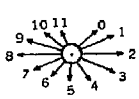
## R. Depth Contours and Tints (see General Remarks)

| Feet | Fathoms | | Feet | Fathoms | |
|---|---|---|---|---|---|
| 0 | 0 | | 300 | 50 | |
| 6 | 1 | | 600 | 100 | |
| 12 | 2 | | 1,200 | 200 | |
| 18 | 3 | | 1,800 | 300 | |
| 24 | 4 | | 2,400 | 400 | |
| 30 | 5 | | 3,000 | 500 | |
| 36 | 6 | | 6,000 | 1,000 | |
| 60 | 10 | | 12,000 | 2,000 | |
| 120 | 20 | | 18,000 | 3,000 | |
| 180 | 30 | | Or continuous lines, with values | | 5 (blue or black) 100 |
| 240 | 40 | | | | |

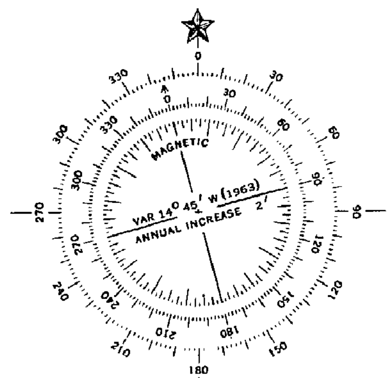
## S. Quality of the Bottom

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 1 | | Ground | 25 | Ms | Mussels | 50 | spk | Speckled |
| 2 | S | Sand | 26 | Spg | Sponge | 51 | gty | Gritty |
| 3 | M | Mud; Muddy | 27 | | Kelp | 52 | | Decayed |
| 4 | Oz | Ooze | 28 | Wd | Seaweed | 53 | fly | Flinty |
| 5 | Ml | Marl | | Grs | Grass | 54 | glac | Glacial |
| 6 | Cl | Clay | 29 | | Seatangle | 55 | | Tenacious |
| 7 | G | Gravel | | | | 56 | wh | White |
| 8 | Sn | Shingle | 31 | | Spicules | 57 | bk | Black |
| 9 | P | Pebbles | 32 | Fr | Foraminifera | 58 | vi | Violet |
| 10 | St | Stones | 33 | Gl | Globigerina | 59 | bu | Blue |
| 11 | Rk; rky | Rock; Rocky | 34 | Di | Diatoms | 60 | gn | Green |
| 11a | Blds | Boulders | 35 | Rd | Radiolaria | 61 | yl | Yellow |
| 12 | Ck | Chalk | 36 | Pt | Pteropods | 62 | or | Orange |
| 12a | Ca | Calcareous | 37 | Po | Polyzoa | 63 | rd | Red |
| 13 | Qz | Quartz | 38 | | Cirripeda | 64 | br | Brown |
| 13a | | Schist | 38a | | Fucus | 65 | ch | Chocolate |
| 14 | Co | Coral | 38b | | Mattes | 66 | gy | Gray |
| (Sa) | Co Hd | Coral head | 39 | fne | Fine | 67 | lt | Light |
| 15 | Mds | Madrepores | 40 | crs | Coarse | 68 | dk | Dark |
| 16 | Vol | Volcanic | 41 | sft | Soft | | | |
| (Sb) | Vol Ash | Volcanic ash | 42 | hrd | Hard | 70 | | Varied |
| 17 | La | Lava | 43 | stf | Stiff | Z | | Uneven |
| 18 | Pm | Pumice | 44 | sml | Small | | | |
| 19 | T | Tufa | 45 | lrg | Large | | | |
| 20 | Sc | Scoriae | 46 | stk | Sticky | | | |
| 21 | Cn | Cinders | 47 | brk | Broken | | | |
| 22 | Mn | Manganese | 47a | grd | Ground | 76 | | Fresh water springs in sea-bed |
| 23 | Sh | Shells | 48 | | Rotten | | | |
| 24 | Oys | Oysters | 49 | | Streaky | | | |

## T. Tides and Currents

| | | |
|---|---|---|
| 1 | *HW* | *High water* |
| 1a | *HHW* | *Higher high water* |
| 2 | *LW* | *Low water* |
| (Ta) | *LWD* | *Low water datum* |
| 2a | *LLW* | *Lower low water* |
| 3 | *MTL* | *Mean tide level* |
| 4 | *MSL* | *Mean sea level* |
| 4a | | *Elevation of mean sea level above chart (sounding) datum* |
| 5 | | *Chart datum (datum for sounding reduction)* |
| 6 | *Sp* | *Spring tide* |
| 7 | *Np* | *Neap tide* |
| 8 | *MHWS* | *Mean high water springs* |
| 8a | *MHWN* | *Mean high water neaps* |
| 8b | *MHHW* | *Mean higher high water* |
| (Tb) | *MHW* | *Mean high water* |
| 9 | *MLWS* | *Mean low water springs* |
| 9a | *MLWN* | *Mean low water neaps* |
| 9b | *MLLW* | *Mean lower low water* |
| (Tc) | *MLW* | *Mean low water* |
| 10 | *ISLW* | *Indian spring low water* |
| 11 | | *High water full and change (vulgar establishment of the port)* |
| 12 | | *Low water full and change* |
| 13 | | *Mean establishment of the port* |
| 13a | | *Establishment of the port* |
| 14 | | *Unit of height* |
| 15 | | *Equinoctial* |
| 16 | | *Quarter; Quadrature* |
| 17 | *Str.* | *Stream* |
| 18 | 2 kn | *Current, general, with rate* |
| 19 | 2 kn | *Flood stream (current) with rate* |
| 20 | 2 kn | *Ebb stream (current) with rate* |
| 21 | Tide gauge | *Tide gauge; Tidepole, Automatic tide gauge* |
| 23 | *vel* | *Velocity; Rate* |
| 24 | *kn.* | *Knots* |
| 25 | *ht.* | *Height* |
| 26 | | *Tide* |
| 27 | | *New moon* |
| 28 | | *Full moon* |
| 29 | | *Ordinary* |
| 30 | | *Syzygy* |
| 31 | *fl* | *Flood* |
| 32 | | *Ebb* |
| 33 | | *Tidal stream diagram* |
| 34 | A B | *Place for which tabulated tidal stream data are given* |
| 35 | | *Range (of tide)* |
| 36 | | *Phase lag* |
| (Td) |  | *Current diagram, with explanatory note* |

## U. Compass




*Compass Rose*

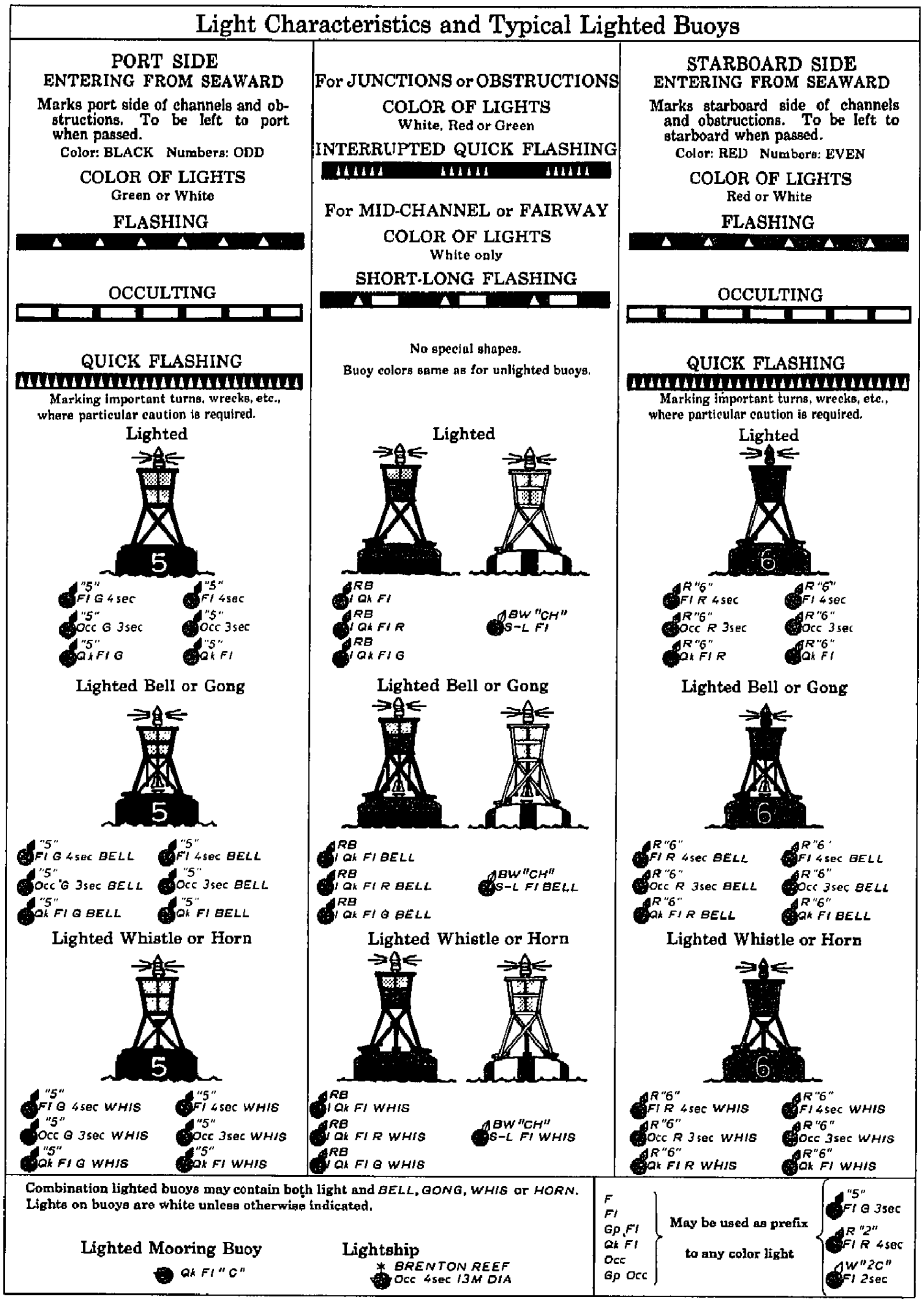
*The outer circle is in degrees with zero at true north. The inner circles are in points and degrees with the arrow indicating magnetic north.*

| | | |
|---|---|---|
| 1 | N | *North* |
| 2 | E | *East* |
| 3 | S | *South* |
| 4 | W | *West* |
| 5 | NE | *Northeast* |
| 6 | SE | *Southeast* |
| 7 | SW | *Southwest* |
| 8 | NW | *Northwest* |
| 9 | N | *Northern* |
| 10 | E | *Eastern* |
| 11 | S | *Southern* |
| 12 | W | *Western* |
| 21 | brg | *Bearing* |
| 22 | | *True* |
| 23 | mag | *Magnetic* |
| 24 | var | *Variation* |
| 25 | | *Annual change* |
| 25a | | *Annual change nil* |
| 26 | | *Abnormal variation; Magnetic attraction* |
| 27 | deg | *Degrees (See E-20)* |
| 28 | de | *Deviation* |

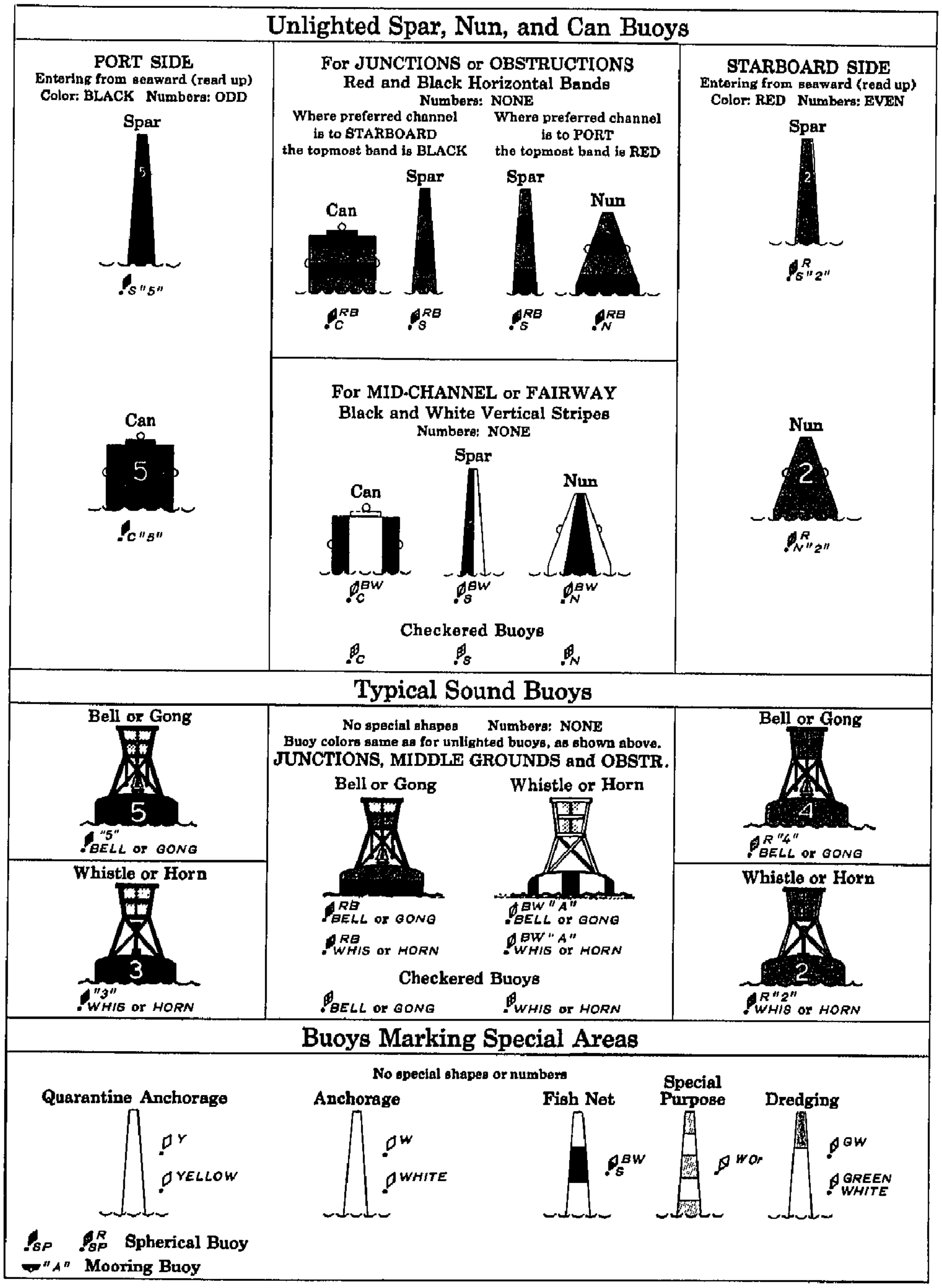
# NAVIGATIONAL AIDS

# IN

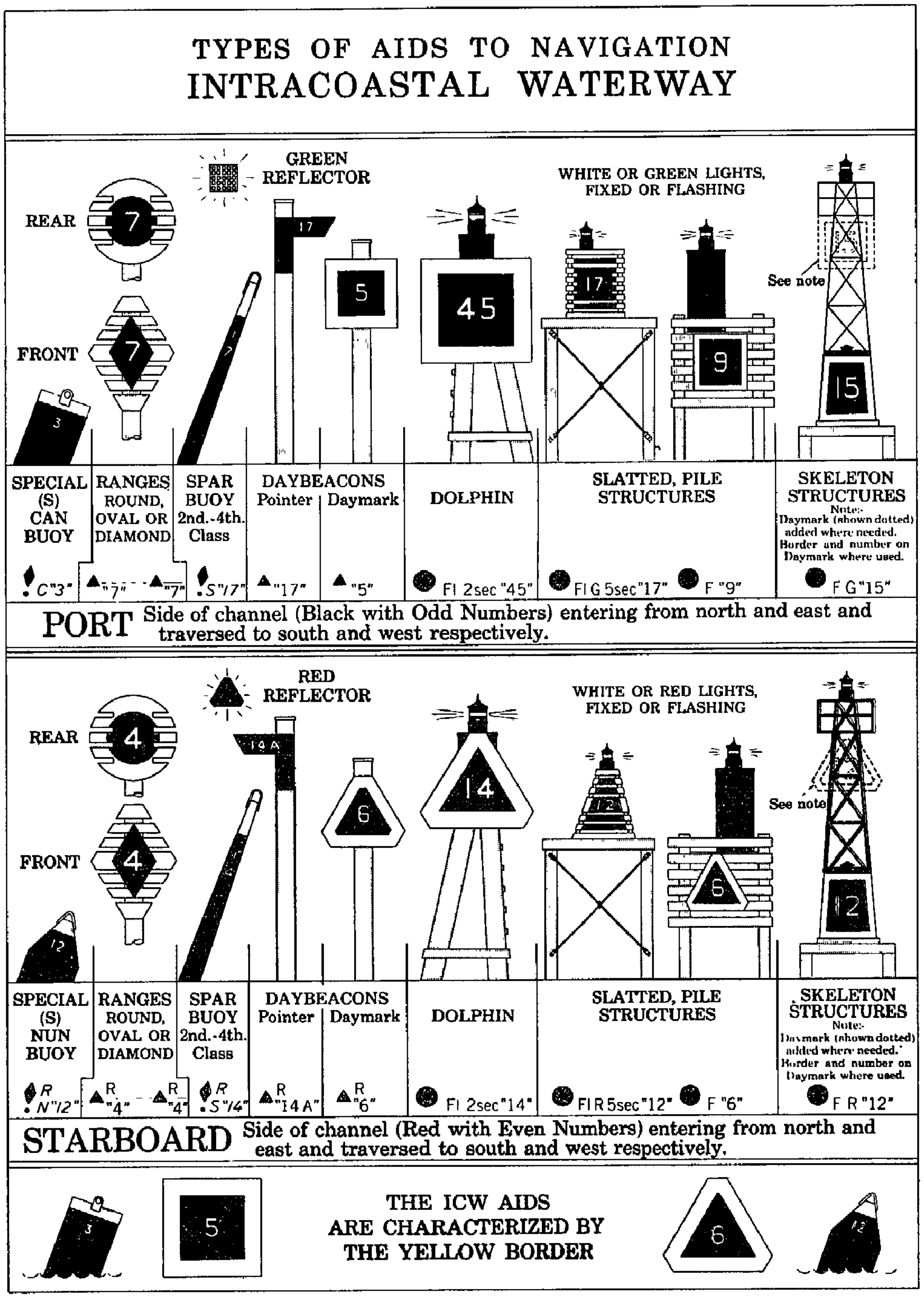
# UNITED STATES WATERS



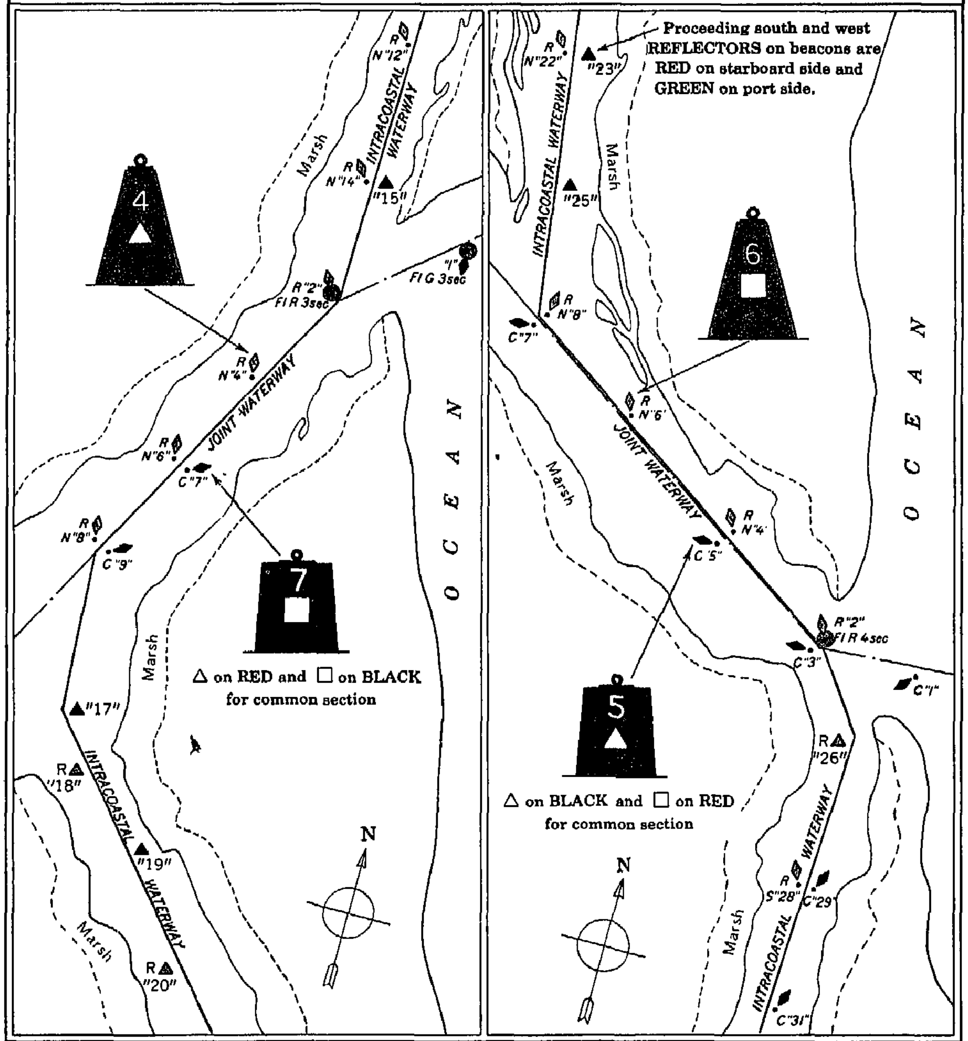

Lighted buoyage of the United States with explanation of their standard chart symbols and abbreviations. Light characteristics do not apply to Mississippi River System.




**Unlighted buoyage of the United States with explanation of their standard chart symbols and abbreviations.**


TYPES OF AIDS TO NAVIGATION
INTRACOASTAL WATERWAY
GREEN REFLECTOR
WHITE OR GREEN LIGHTS, FIXED OR FLASHING
REAR
FRONT
See note
SPECIAL (S) CAN BUOY
RANGES ROUND, OVAL OR DIAMOND
SPAR BUOY 2nd.-4th. Class
DAYBEACONS Pointer Daymark
DOLPHIN
SLATTED, PILE STRUCTURES
SKELETON STRUCTURES
Note:- Daymark (shown dotted) added where needed. Border and number on Daymark where used.
C"3"
"7"
"7"
S"17"
"17"
"5"
Fl 2sec"45"
Fl G 5sec"17"
F "9"
F G"15"
PORT Side of channel (Black with Odd Numbers) entering from north and east and traversed to south and west respectively.
RED REFLECTOR
WHITE OR RED LIGHTS, FIXED OR FLASHING
REAR
FRONT
See note
SPECIAL (S) NUN BUOY
RANGES ROUND, OVAL OR DIAMOND
SPAR BUOY 2nd.-4th. Class
DAYBEACONS Pointer Daymark
DOLPHIN
SLATTED, PILE STRUCTURES
SKELETON STRUCTURES
Note:- Daymark (shown dotted) added where needed. Border and number on Daymark where used.
R N"12"
R "4"
R "4"
R S"14"
R "14 A"
R "6"
Fl 2sec"14"
Fl R 5sec"12"
F "6"
F R "12"
STARBOARD Side of channel (Red with Even Numbers) entering from north and east and traversed to south and west respectively.
THE ICW AIDS ARE CHARACTERIZED BY THE YELLOW BORDER

## ILLUSTRATING THE SYSTEM OF DUAL-PURPOSE MARKING WHERE THE ICW AND OTHER WATERWAYS COINCIDE




**SKETCH A:**
ICW joins another waterway, which is numbered from seaward, at buoy No. 2 and is common with it to buoy No. 9. ICW numbers and yellow borders are omitted in this section but the △ or □ is used on the regular aids to designate the ICW.

**SKETCH B:**
ICW joins another waterway at buoy No. 8 and is common with it to buoy No. 3. This section is numbered in the opposite direction to that of the ICW. The ICW numbers and yellow borders are omitted from the regular aids but a △ or □ is shown to designate the ICW.

APPENDIX G

# Table of Cases Cited

*(References are to pages)*

# INDEX

706–026 O–64–47

# Index

*(Only the main text has been indexed and only those cases that have had an impact on the development of the law of riparian boundaries and related fields. References are to pages.)*

## A

## C

## D

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## H



706–026 O–64–48

## O

## R

## U

U.S. GOVERNMENT PRINTING OFFICE: 1964 O—706-026