MARSHLAND TITLE DILEMMA: A TIDAL PHENOMENON

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I. A TITLE STATE OF CHAOS

Throughout the coastal areas of the United States there exist countless acres of wetlands, commonly known as marsh or meadows.[1] In New Jersey there are approximately 244,000 acres of tidal marshland,[2] and this area has become the subject of unique title questions. In the decade of the sixties, the State of New Jersey has engaged in combat with thousands of recorded and previously recognized titles by the sweeping application of an old English doctrine which gave the king the right of way or incorporeal hereditament to all navigable streams and waterways and the adjacent land flowed by their tides.[3]

The lands falling within the ambit of this doctrine are those that are adjacent to a watercourse inundated by the daily ebb and flow of

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1 For a basic introduction to the components of the marsh *see* W. NIERING, THE LIFE OF THE MARSH (1966). The recent attention that the marshlands throughout the nation have attracted is reflected in the amount of literature published dealing with these areas, *see, e.g.*, J. Clark, Fish & Man (Am. Littoral Soc'y Spec. Pub. No. 5, 1967); P. JOHNSON, WETLANDS PRESERVATION (1969); PANEL REPORTS OF THE COMMISSION ON MARINE SCIENCE, ENGINEERING AND RESOURCES: MARINE RESOURCES AND LEGAL-POLITICAL ARRANGEMENTS FOR THEIR DEVELOPMENT (1969); PANEL REPORTS OF THE COMMISSION ON MARINE SCIENCE, ENGINEERING AND RESOURCES: SCIENCE AND ENVIRONMENT (1969); Cronin, *The Condition of the Chesapeake Bay*, in TRANSACTIONS OF THE THIRTY-SECOND NORTH AMERICAN WILDLIFE AND NATURAL RESOURCES CONFERENCE 137 (Mar. 13-15, 1967); Grindley, *Estuarine Environment*, in THE ENCYCLOPEDIA OF MARINE RESOURCES 206 (1969); Porro, *The Coastal and Estuarine Zone: A National Interest*, in 1 MARINE TECHNOLOGY 1970, at 561 (1970); PROCEEDINGS OF THE MARSH AND ESTUARY MANAGEMENT SYMPOSIUM (La. State Univ., July 19-20, 1967); Redfield, *Ontogeny of a Salt Marsh Estuary*, 147 SCIENCE 50 (Jan. 1, 1965).

2 Society Conservation Briefs, *New Jersey Tidal Meadowlands Must Be Preserved*, 23 N.J. NATURE NEWS 10 (Mar. 1968); *see* J. TEAL & M. TEAL, LIFE AND DEATH OF THE SALT MARSH 248 (1969) (stating that in 1895 New Jersey had 296,000 acres of salt marsh). For a scientific classification of all New Jersey wetlands, *see* United States Fish and Wildlife Service, Wetland Inventory of New Jersey (1954).

3 For a general discussion of the applicable common law, *see* J. ANGELL, A TREATISE ON THE LAW OF WATERCOURSES 3-12 (4th ed. 1850); H. COULSON & U. FORBES, THE LAW OF WATERS AND LAND DRAINAGE 93-127 (6th ed. 1952); 3 J. KENT, COMMENTARIES 427-34 (Halsted ed. 1832). *See also* J. ANGELL, A TREATISE ON THE COMMON LAW, IN RELATION TO WATERCOURSES 201-13 (2d ed. 1833); 2 W. BLACKSTONE, COMMENTARIES *37-40.

its tides. Since the level of the tides fluctuates, reaching various daily high and low-water marks, and since the doctrine gives the sovereign title to all the land flowed by the tide, a boundary had to be established to segregate the sovereign interest from the private interest. In adopting the English doctrine in the United States, two boundaries have been utilized to define the extent of the sovereign's interest in the tidelands; some states use the mean high-tide line (the average of all high waters over a specified period of time) and others use the mean low-tide line (the average of all low waters over a specified period of time)

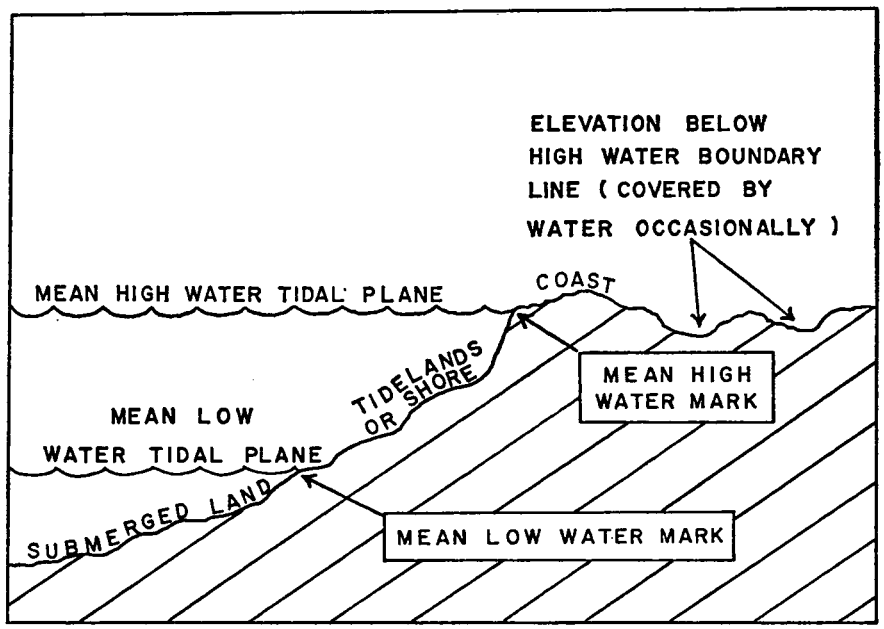

Illustration by *Gail de P. Burke*

FIG. 1. This diagram indicates both the mean high water mark and the mean low water mark. Under the present New Jersey application of the tidelands doctrine, the mean high water mark is the recognized boundary line. Previously, however, the State claimed not only the land below the mean high-tide mark, but also those areas designated on the diagram as being at an "elevation below high water boundary line."

(Fig. 1). Although in theory the delineation of sovereign and private lands is clear-cut, its application in the field creates havoc.

The area affected by the tidelands doctrine is typically the estuarine zone, which consists of an estuary (river), tidal flats, marshland and upland.[4] The bed of the waterway, namely, that property which lies

[4] *See generally* Emery & Stevenson, *Estuaries and Lagoons*, in 1 TREATISE ON MARINE ECOLOGY AND PALEOECOLOGY 673-93 (Geological Soc'y of Am. Memoir 67 (1957));van Straaten,

beneath the water, is clearly owned by the state, whereas the upland area, which is that land usually never touched by the tides, clearly belongs to the record owner.[5] It is the area known as the "bank and shore" of the waterway, lying between the high and low-water marks, that presents the difficult title problems, because it is this land which is subject to the ebb and flow of the tides.[6]

For many decades state courts have restricted the application of the tidelands doctrine to areas within the boundaries of watercourses, such as oyster beds, waterfront areas and the like.[7] However, in 1959 the State of New Jersey attempted to utilize the tidelands doctrine to capture the untold acreage of the marshes and meadowlands.[8] This has caused intense turmoil, resulting in new and complex problems. Heretofore, the doctrine predominantly affected that part of the tidelands consisting of the "bank and shore" of the watercourse. Unlike these lands, the marshes and meadowlands are heavily vegetated, low-lying strips, frequently located many acres away from the channel of the watercourse and covering a great expanse of territory.[9] Because the water flows through and around the vegetation on this land, establishing the mean high-tide line becomes extremely difficult.[10] Due to this attempted expansion of the doctrine, hundreds of properties in New Jersey have been taken and used for state purposes without compensating the record owners or lien holders;[11] prior homeowners of many years are being threatened with loss of title;[12] prior grants and state

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Origin of Recent Dutch Tidal Flat Formation, in Proceedings of Salt Marsh Conference-Sapelo Island, Georgia 9 (Mar. 25-28, 1958) [hereinafter cited as Sapelo].

5 For a discussion of the characteristic of a waterway, *see* A. WISDOM, THE LAW OF RIVERS AND WATERCOURSES (1962).

6 L. HOUCK, A TREATISE ON THE LAW ON NAVIGABLE RIVERS 119 (1868).

7 *E.g.*, Shively v. Bowlby, 152 U.S. 1 (1894); Martin v. The Lessee of Waddell, 41 U.S. (16 Pet.) 367 (1842). For the treatment of this issue by the New Jersey courts, *see* O'Neill v. State Hwy. Dep't, 50 N.J. 307, 235 A.2d 1 (1967); Bell v. Gough, 23 N.J.L. 624 (Ct. Err. & App. 1852); Schultz v. Wilson, 44 N.J. Super. 591, 131 A.2d 415 (App. Div.), *cert. denied*, 24 N.J. 546, 133 A.2d 395 (1957); Arnold v. Mundy, 6 N.J.L. 1 (Sup. Ct. 1821).

8 Sissleman v. State Hwy. Dep't, No. A769-59 (N.J. Super. Ct., App. Div., May 1, 1961). *See also* Porro, *Reclamation or Damnation—N.J. Meadowlands*, 87 N.J.L.J. 657 (1964).

9 A. GUILCHER, COASTAL AND SUBMARINE MORPHOLOGY 99 (1958); Chapman, *Relationships of Salt Marsh Vegetation*, in Sapelo, *supra* note 4, at 47-57.

10 Porro, *Invisible Boundary—Private and Sovereign Marshland Interests*, 3 NATURAL RES. LAW. 512 (1970).

11 Many of these takings have resulted in actions now pending. *See, e.g.*, Amico v. State, No. C-2021-68 (N.J. Super. Ct., Ch. Div., filed Apr. 7, 1969); New Jersey Turnpike Auth. v. Desiderio, No. L-27823-69 (N.J. Super. Ct., L. Div., filed May 11, 1970).

12 *E.g.*, Farrell v. State, No. L-28711-68 (N.J. Super. Ct., L. Div., filed May 5, 1969) (a classic case recently settled).

deeds are being ignored;[13] properties are being arbitrarily claimed and conveyed by the State to persons other than the record owners;[14] and hundreds of cases remain pending and untried before the state courts awaiting processing with the National Resource Council.[15]

On November 6, 1967, the New Jersey Supreme Court, in *O'Neill v. State Highway Department*,[16] decreed the basic rules that would be followed in New Jersey regarding the application of the tidelands doctrine. First, the court restricted the sovereign claim to the area within the mean high-tide line boundaries of a given watercourse.[17] Second, the court clearly denounced the previously attempted "elevation" test and adopted the "tidal boundary" line test.[18] Under the former test, the State did not limit its claim to the property between the watercourse and the mean high-tide line. Rather, it claimed any upland property which was at the same elevation as, or on an elevation lower than, the mean high-tide line (Fig. 1). Third, the court recognized the Coast and Geodetic Survey of the United States (now the National Ocean Survey) as the most authoritative source on the subject of tidal boundaries.[19] And lastly, the court dealt with the most important aspect of the problem, namely, the burden of proof.

Recognizing the complex problem created by artificial changes, the burden of proof was placed upon the party attacking the "existing scene" of any given premises.[20] In essence, this placed the burden of proof upon the State in most instances. Following the decision in

13 *E.g.*, Herzog v. State, No. 253-71 (D.N.J., filed Feb. 23, 1971); Siegel v. State, No. C-1653-70 (N.J. Super. Ct., Ch. Div., filed Feb. 11, 1971).

14 *E.g.*, Grande v. The Council, Div. of Res. Dev., No. C-1616-67 (N.J. Super. Ct., Ch. Div., Feb. 24, 1971).

15 This council, a division of the Department of Environmental Protection, is the administrative arm designated to process riparian grants and leases and bargain and sale deeds in instances of disputed titles. N.J. STAT. ANN. §§ 13:1B-7 *et seq.* (1968), § 13:1D-3 (Supp. 1971-72).

16 50 N.J. 307, 235 A.2d 1 (1967). For a discussion of *O'Neill* and its ramifications see the following articles by the co-author, Mr. Porro: *The Jersey Meadows: Who Owns Them? Who to Control Them?*, 11 N.J.S.B.J. 143 (1968); *Meadowland Owners' Dilemma*, 11 N.J.S.B.J. 15 & 99 (Pts. I & II, 1967-68); *The Three Faces of O'Neill*, 11 N.J.S.B.J. 55 (1968).

17 50 N.J. at 323, 235 A.2d at 9. The court defined the mean high-tide line as: "The line formed by the intersection of the tidal plane of mean high tide with the shore," and proceeded to state that "the mean (sometimes called 'ordinary') high tide is defined as the medium between the spring and the neap tides." *Id.* The court cited the well-known case of Borax, Ltd. v. Los Angeles, 296 U.S. 10, 26-27 (1935) for the proposition that the mean high tide is the mean of *all* the high tides—the average of all the tides over a period of 18.6 years. *Id.* at 323-24, 235 A.2d at 9-10.

18 50 N.J. at 324, 235 A.2d at 10.

19 *Id.* at 323, 235 A.2d at 9.

20 *Id.* at 326-27, 235 A.2d at 11.

O'Neill, the State Legislature attempted by the passage of the Hackensack Meadowland Reclamation and Development Act[21] to shift the burden back upon the record owner by directing the publication of a map depicting State-owned lands and requiring the record owner to contest this designation. However, in *State v. The Council in the Division of Resource Development*,[22] the first of a contemplated series of such maps was suppresed from being introduced into evidence by the State due to its "not having been prepared in accordance with the legislative directions,"[23] and therefore not being of evidential value regarding the question of ownership.

II. A Problem of Proof

Although the legal principles expounded in *O'Neill* are quite clear, their application presents a difficult challenge. The basic difficulty revolves around the fact that a litigant must proceed to establish the present and the former mean high-tide line of a given watercourse or tributary as it relates to the premises in question. In 1962, the United States Coast and Geodetic Survey was commissioned by the New Jersey Department of Conservation and Economic Development to establish the mean high-tide line for the Hackensack River and its tributaries.[24]

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21 N.J. Stat. Ann. §§ 13:1B-13.2 to -13.5 (Supp. 1971-72).

22 No. L-12561-68 (N.J. Super. Ct., L. Div., Sept. 8, 1971) (court order suppressing evidence), *modified*, 60 N.J. 199, 287 A.2d 713 (1972).

23 *Id.* slip opinion at 3.

24 U.S. Dep't of Commerce Coast and Geodetic Survey, Project Report: Mean-High Water Line Mapping Lower Hackensack River, New Jersey (Jan. 1964). The introduction to the report states as follows:

> This project was undertaken by the Coast and Geodetic Survey at the request of the State of New Jersey and will have extended over a period of nearly two years from the beginning of tide observations on the Hackensack River in the spring of 1962 to the delivery of the printed maps scheduled for early March 1964.
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> The primary purpose of the project was to map the Mean-High Water Line (that is, the line of intersection of mean-high water level with the ground) of the lower Hackensack River and its tributaries.
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> This project was both cooperative and reimbursable. However, the State of New Jersey reimbursed the Coast and Geodetic Survey for the greater part of the total cost under two reimbursable agreements with the Photogrammetry Division, Coast and Geodetic Survey. The work was carried out by the Marine Data, Geodesy, and Photogrammetry Divisions of the Coast Survey with the assistance of personnel from the Bureau of Navigation, State of New Jersey, that were assigned to the field party for tide observations and so on.
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> Operations on this project included:
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> 1. Tide observations and establishment of tidal bench marks on the Hackensack River (spring of 1962)
> 2. Geodetic leveling connecting the tidal bench marks (spring of 1962).

Upon completion of this project, a report was submitted which clearly defined and designated the mean high-tide line in many areas. The survey also demonstrated that other areas could not be so defined, and so designated, without extensive and extremely expensive supplemental techniques and reports.[25]

While in many instances the task of establishing the existing line is extremely difficult, it becomes impractical, if not impossible, to trace the specific line back through the centuries.[26] Yet, this is what the litigant must accomplish because the State contends that its claim is not limited by the existing level of the tides, but extends to lands which had "formerly" been tide-flowed.[27]

Great controversy has arisen with regard to this contention, and the paramount questions have become: (a) When and where did the word "formerly" first appear; (b) What point in history is it attempting to describe; and (c) What, on the other hand, should it designate. One court has recently begun to answer these questions by ordering that

> within the general claim of the State of New Jersey to own land now or formerly flowed up to the line of ordinary or mean high-tide, evidence shall be considered material, if otherwise relevant, from the year 1664 to the date of the trial.[28]

Throughout the centuries, this "invisible boundary" has undergone considerable changes and, as a result, when applying the "formerly flowed" doctrine, an almost insurmountable evidential hurdle is presented since attempting to accurately trace the former line is extremely difficult. It is not the occurrence of accretion or erosion that presents

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3. Aerial photography (November 1962)
4. Field Identification of control and preliminary field inspection along the Hackensack River proper (November 1962)
5. Preparation of aerial mosaics and a preliminary report (December 1962-January 1963)
6. Aerotriangulation and compilation of manuscript maps (various periods between February 1963 and September 1963)
7. Tidal observations and establishment of temporary bench marks along the tributaries to the lower Hackensack River (September 1963)
8. Field inspection of the mean-high water line (September-October 1963)
9. Completion of map manuscripts from the September-October field inspection (November 1963)
10. Final scribing (engraving), reproduction and printing (December 1963-February 1964)
11. Delivery of maps scheduled for early March 1964.

Id. at 1-3.

25 *Id.* at 12-13.

26 *See* Porro, *supra* note 10.

27 State v. The Council, Div. of Res. Dev., No. L-12561-68 (N.J. Super. Ct., L. Div., Sept. 8, 1971).

28 *Id.* slip opinion at 3.

the problem, for both are predicated on natural processes and, comparatively speaking, do not radically alter the boundaries of the watercourse.[29] Moreover, such natural changes can be scientifically established. Any gradual change brought about by accretion or erosion operates to change the mean high-tide line and consequently will alter the title to that strip of land. Accretion, which creates new land by depositing sediment on old land, shifts the title from the state to the private property owner,[30] whereas erosion, which is the natural wearing away of the soil of the former land, shifts title from the private property owner to the sovereign.[31]

The greater problem is presented by the artificial changes which have affected vast stretches of New Jersey's 244,000 acres of wetlands.[32] These changes fall into two categories: (1) private changes, such as landfill for residential and industrial developments; and (2) public changes, such as extensive highway systems, mosquito ditching, drainage plans, dredging of river channels, digging of subsurface wells, and many other public projects that have caused a tremendous shifting of surface and subsurface waters in the various areas. These artificial changes not only cause the direct and immediate movement of soil, but also affect the processes of erosion and accretion.[33] For example, the dredging of a channel can increase the flow of water within its existing boundaries and accelerate the rate of erosion along the shore. Therefore, over a period of time an upland owner will lose a greater portion of his land than he would have if the dredging had not occurred. Similarly, if construction of a jetty or dock creates an obstruction in the watercourse, this can accelerate accretion at one area while increasing erosion at another. It is the resulting shift in the mean

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29 1 A. SHALOWITZ, SHORE AND SEA BOUNDARIES 101-03 (1962); 1 H. FARNHAM, THE LAW OF WATERS AND WATER RIGHTS § 69 (1904).

30 *See, e.g.*, Wildwood Crest v. Masciarella, 92 N.J. Super. 53, 222 A.2d 138 (Ch. 1966), *aff'd*, 51 N.J. 352, 240 A.2d 665 (1968); *cf.* A. CAREY, TIDELANDS, A STUDY OF SHORE PROBLEMS 169 (1918).

31 *Id.*

32 For an example of the problems created by artificial changes, see Garrett v. State, No. C-3232-69 (N.J. Super. Ct., Ch. Div., Mar. 6, 1972) (opinion granting State summary judgment).

33 W. AMOS, THE LIFE OF THE SEASHORE 191-95 (1966); REPORT OF THE COMMISSION ON MARINE SCIENCE, ENGINEERING AND RESOURCES: OUR NATION AND THE SEA 54 (1969) ("In the past 20 years, dredging and filling have destroyed 7 per cent (more than a half million acres) of the Nation's important fish and wildlife estuarine habitats."); Cronin, *The Role of Man in Estuarine Processes*, in ESTUARIES 667 (1967). *See* PANEL REPORTS OF THE COMMISSION ON MARINE SCIENCE, ENGINEERING AND RESOURCES: SCIENCE AND ENVIRONMENT III-29 to III-48 (1969); Vermeule, *Drainage of the Hackensack and Newark Tide-Marshes*, 1896 ANNUAL REPORT OF THE STATE GEOLOGIST 289.

high-tide line which creates the proof dilemma. These artificial changes, unlike the uninterrupted natural processes of erosion and accretion, have no effect upon the title to the land. Although they cause the mean high-tide line to shift, there is no corresponding transfer of the title from one party to the other.[34] Therefore, where artificial changes exist, it is necessary to ascertain the mean high-tide line prior to the change in order to determine who owns the property.

In attempting to cope with the problem of historically tracing this line, numerous techniques have been utilized.[35] One of the most prevalent techniques utilized for determining the historical locus of the line is the submission of old and former maps upon which this line is depicted. A series of New Jersey geological reports and accompanying maps are often used, and in the 1880's the most valuable of all was prepared—the Atlas of New Jersey.[36] This series of maps denotes marshes within our State as being either tide marsh, fresh marsh, or marsh below high water.

In addition, another technique is the use of scientific tests to determine whether the land in question was flowed by the tide. Collectively, such techniques as botanical analysis, soil analysis, pollen analysis, topographical data, tidal data, salinity tests, acidity tests and the like,[37] can serve as a basis for establishing uniform standards to resolve the technical, legal proof problem.

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[34] The State cannot acquire interior land by such artificial works as ditching which enables the tide to ebb and flow on lands otherwise beyond it. And so too the riparian owner cannot, today, enlarge his holdings by excluding the tide. O'Neill v. State Hwy. Dep't, 50 N.J. 307, 324, 235 A.2d 1, 10 (1967); *see* Garrett v. State, No. C-3232-69 (N.J. Super. Ct., Ch. Div., Mar. 6, 1972), where artificial changes and the effect thereof, such as the causing of property previously flowed by the tide to become dry and untouched, did not divest the sovereign of its ownership in the former tideland area; Bailey v. Driscoll, 19 N.J. 363, 117 A.2d 265 (1955), for a general discussion of the statutory law requiring permits, licenses or grants from the State before any man-made changes can be made to any properties lying below the mean high-tide line.

[35] *See* material in section of text entitled "Factor Points Allocated to Scientific Criteria," *infra*.

[36] However, even these maps do not prove that a given piece of property formerly lying "below high water" (and thus within the sphere of the State's claim) has not subsequently been elevated to a status above the mean high-tide line of the given watercourse or tributary by natural processes or by legal documents, such as a prior riparian grant. On the other hand, tide marshes which are represented as being formerly at, or above, the high tide line might now be below it. Maps from the U.S. Geological Survey, the U.S. Army Corps of Engineers, New Jersey WPA [Works Progress Administration] Shoreline Maps and the like have similar difficulties. Other proofs such as historical data, topographical information, soil morphology, pollen analysis, vegetative analysis, and the electrical conductivity or resistivity of the soil also have proven to be inconclusive.

[37] *See* material in section of text entitled "Factor-Points Allocated to Scientific Criteria," *infra*.

III. A Quasi-Judicial Solution

General

Presently, a backlog of cases which relate to the tidelands problem is still awaiting a trial date, and even though recent legislation has authorized the addition of six judges to handle these matters, this is not an effective solution.[38] A case-by-case judicial determination regarding the title to approximately 244,000 acres of tideland is an overwhelming task. Extensive proofs will be required in each instance, including comprehensive map displays, extensive soil analyses, vegetation and pollen analyses, topographical data, historical and tidal data, scientific and expert testimony regarding the natural characteristics of the marsh, artificial changes, salt water intrusion—in short, a pattern of expensive and extensive litigation. It is, therefore, readily apparent why a quasi-judicial solution is desirable under such circumstances.

Although the various historical and scientific techniques are inadequate to conclusively establish the "former mean high-tide line," the sophistication that has been gained with regard to the analysis of various tests, techniques and methodologies can be utilized in a coordinated effort to establish reasonable, uniform standards for a quasi-judicial body to equitably decide a virtually impossible proof problem. Likewise, available data and technology can establish the current mean high-tide line on extended portions of wetland property sufficiently to delineate those properties where no controversy exists, from those areas where ownership is extremely controversial. The utilization of the combined historical and scientific data provides a basis for a solution to the title dilemma.

Proposed Structure

It is proposed that four commissioners be appointed to handle four separate coastal and estuarine regions of the State where marshland areas are located, and that these commissioners be assigned near these areas, thereby affording the greatest convenience for property inspection. They could either rotate among the areas or remain stationed in a particular area. It is recommended that these four areas be designated as follows:

1. Hackensack, Passaic and Hudson River basins and estuarine areas.

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38 N.J. Stat. Ann. § 2A:2-1 (Supp. 1971-72). *See generally* New Jersey Commission to Study Meadowland Development, Final Report (June 1965), Supplemental Report (Dec. 1966).

2. Newark, Elizabeth and Raritan River basins and estuarine areas.
3. Areas extending beyond the Raritan estuarine zone and along the eastern and southern coasts of New Jersey, including all tributaries and basins therein.
4. Westerly and Delaware River basins and estuarine areas.

Categorization of Properties

One of the most important aspects of the proposed resolution is a system of categorizing properties, either by the legislature or the commissioners. Through the use of technical and scientific standards, the properties in the wetlands area would be initially categorized under one of the following classifications: (1) State-owned; (2) Privately-owned; or (3) Controversial.

1. State-owned

The "State-owned" properties would include those clearly and *naturally* lying below the mean high-tide line of a given watercourse, as established by maps prepared by the National Ocean Survey, utilizing infrared photographs taken at mean high tide, and with related tidal data. The property to be placed within this category would be so designated after having met the scientific criteria for that which is known as "low marsh."[39] Also included within the category of "State-

[39] Marshland can be differentiated through an analysis of its biota into "high marsh" and "low marsh." The low marsh has an undulatory surface which is formed by the overgrowth of turfs of plants which becomes more level as growth within the marsh continues. Being located between the mean low-tide and mean high-tide, it is inundated by the daily ebb and flow of the tides. *Spartina alterniflora* is one of the first plants of any significance to invade this intertidal zone in the latitudes of New Jersey. However, abundant mates of blue-green algae grow on this marsh. See Fig. 2.

The "high marsh" is that area which is above the mean high-tide line and is only covered by tidal waters during the spring and extraordinary tides. The vegetation no longer consists of randomly scattered turfs, as in the low marsh, but forms a continuous carpet which is dissected by meandering creeks. Here, *Spartina patens* replace the *Spartina alterniflora*. In contrast to the *Spartina alterniflora*, which is a cord grass at least ten feet tall, with leaves in the summer at least one-half of an inch to two inches wide at the base, the *Spartina patens* is a fine-textured grass which grows no taller than two feet.

In the inner part, or those areas approaching the upland of the high marsh, there can be an abundant growth of fresh water peat, produced chiefly by *Phragmites communis* (fox-tails), a tall reed plant. A study of the Hackensack Meadows indicated that *Spartina alterniflora* and *Spartina patens* occur in minor abundances within the meadows, with the predominant plant being the *Phragmites*. K. Harmon & J. Tedrow, A Phytopedologic Study of the Hackensack Meadowlands (1969). In areas of the marsh where it meets the upland and the salinity is least, or towards the heads of rivers where the water is relatively fresh, reed swamp communities colonize the shore, which is represented by *Phragmites*,

owned" property would be those areas designated in either the 1880 or 1890 New Jersey Geological Survey as "marshes below high water."

The lands which are found to come within the category of "State-owned" would be deemed to be conclusively owned by the State of New Jersey unless challenged by a given property owner within 180 days of the date of publication of such category. This designation could only be rebutted by conclusive proof of salt water intrusion as a result of public improvements or by proof of the issuance of a prior grant or quitclaim deed to the area in question by the State of New Jersey. Challenges to land placed in this category would be heard by all the commissioners sitting as a body.

If the land is conclusively found to be owned by the State, either through the lapsing of the 180-day period or through litigation before the commissioners, control of the land would be transferred to the Natural Resource Council, and the commissioners would thereafter be divested of all jurisdiction pertaining to such land. The council would then be able to exercise its ordinary powers regarding the property, such as granting riparian rights, leases, and dredging and filling permits.

Scripus and *Typha* (cat-tails). This upland edge of the marsh is the limit of the peak lunar tides, or peak storm tide on record.

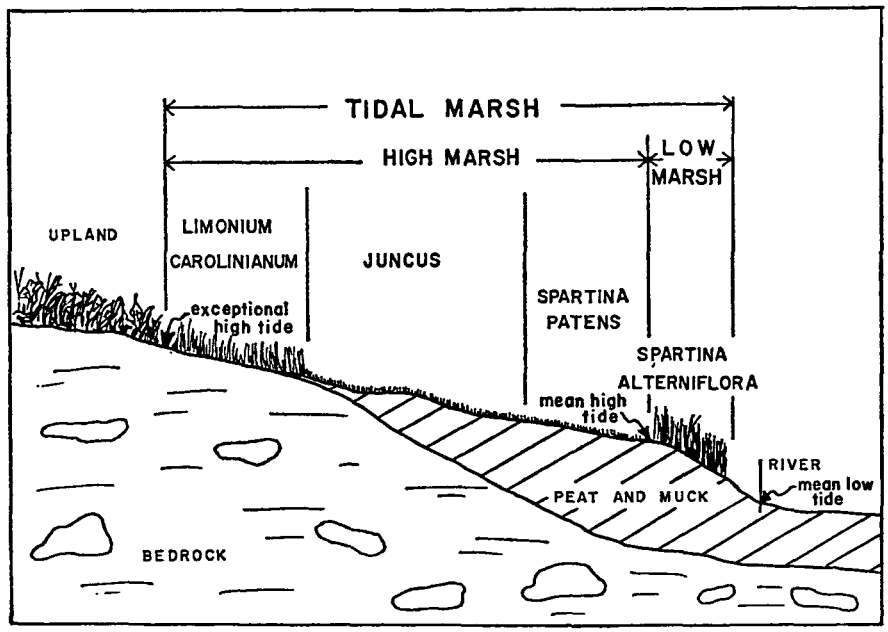

FIG. 2. Illustration by *Gail de P. Burke*

2. Privately-owned

The "privately-owned" properties would be those which are found to lie clearly and *naturally* above the National Ocean Survey mean high-tide line in an area where the line is clearly designated. Properties which have been classified as fresh water swamps or marshes on the old 1880 or 1890 New Jersey Geologic Survey Maps would also be placed in this second category, as would properties meeting the criterion scientifically known as "high marsh."[40] Additionally, properties for which prior grants or quitclaim deeds have already been obtained from the Natural Resource Council[41] would also qualify for this "privately-owned" classification.

All properties categorized under this classification would be deemed conclusively owned by the private record owner, and any alleged claim of the sovereign would be disclaimed unless challenged by the State within 180 days of publication of such category. If an objection is made, the commissioners sitting as a body would make the ultimate determination. When the State challenges the classification, in order to rebut the property's designation, it would have to prove unequivocally that the premises in question had been illegally filled by the record owner, his agent or representative, and that, but for said actions, the property in question would presently lie below the mean high-tide line.

3. Controversial Properties

All properties which are incapable of being classified as either "State-owned" or "privately-owned" will be designated as "controversial properties." However, a unique problem is presented when classifying properties in this category if within the parcel of land in question certain portions of it are either clearly and *naturally* above, or below, the mean high-tide line. In this case these portions will not be categorized with the remainder of the parcel as "controversial," but will be classified as either "State-owned" or "privately-owned."

The "controversial" properties would present significant problems of proof for both sides in an adversary proceeding. Under the proposed system, the most important part of the commisioners' function would be their jurisdiction over these properties. All properties within this category would be of an unsettled nature until application were made for clearance of title to the commisioner of the region. Each commissioner would, within his designated geographical region, hear cases

40 *See* material cited note 39 *supra.*

41 *See* note 15 *supra.*

with regard to these "controversial properties." No statutory time limit should be set after which such an application would be barred.

Under the present system when a controversy over wetland property is brought before the courts, the ultimate decision to be reached is who owns the property under the "formerly flowed" doctrine. However, as has been demonstrated above, this is an almost impossible determination to make with regard to many wetland properties. Under the proposed system, however, no such determination is required when the property is of a "controversial" nature. The commissioners in making their decision would instead apply the following valuation and factor percentage system.

IV. Valuation and Factor-Percentage System

General

In order to establish a uniform and equitable settlement formula, when conclusive proofs are either unavailable or too expensive to obtain, a factor-percentage system is recommended. Initially, an authoritative list of scientific, technical, and historical data, such as maps, reports, infrared photographs, various scientific tests and the like, must be compiled. Then each item should be given a numerical value (hereinafter called factor points) depending upon its conclusiveness and reliability. For example, a detailed scientific report for a specific area would be given more factor points than a less comprehensive report. Based upon this list of data, the claims of the State and the record owner are then able to be numerically evaluated.

The claims may be evaluated in the following manner: first, by determining which of the listed criteria (data, maps, tests, etc.) are applicable to the parcel of land in question and calculating the total number of factor points these criteria represent. Second, in order to evaluate the relative strength or weakness of either the State's or the record owner's claim, a percentage must be calculated, based upon the ratio of the factor points favorable to the contestant's claim divided by the total number of factor points applicable to the land in question. The formula to be followed can be expressed:

$$\text{Record owner's claim} = \frac{\text{factor points favorable to record owner}}{\text{total number of factor points}}$$

In order to determine the percentage representing the State's claim, the record owner's percentage must be subtracted from 100 percent.

If the factor-percentage representing the strength of the record owner's claim is above a designated percentage, hereinafter called the demarcation percentage,[42] then he will have the *right* to clear title to the land by paying to the State an amount equal to the State's factor-percentage of the unimproved market value of the property. Conversely, if the claim of the record owner is below the demarcation percentage, then the State will have the *right* to obtain clear title to the land by paying the record owner an amount equal to his factor-percentage of the unimproved market value of the property.

An example of the procedure under this method would be as follows: Assume that out of the total list of the scientific and technical criteria, 11 are applicable to the land in question with 125 as their total number of factor points—the State having 3 criteria in their favor with a total of 35 factor points, and the record owner having 8 criteria in his favor with a total of 90 factor points. Under this set of circumstances the claim of the record owner would be equal to $\frac{90}{125}$ or a factor-percentage of 72 percent, and the claim of the State would be equal to a factor-percentage of 28 percent. Assuming the demarcation percentage to be 50 percent, the record owner would have the right to obtain clear title to this land by paying to the State 28 percent of the unimproved market value of the land. On the other hand, if the record owner had a factor-percentage of 28 percent and the State 72 percent, then, with the same demarcation percentage of 50 percent, the State would have the right to obtain clear title to the land by paying to the record owner 28 percent of the unimproved market value of the property.

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42 The point of demarcation, namely, when a property owner should have the right to purchase the title, as compared to when the State should have the right to purchase the title, is one that could result in an unending debate. In order to create equities for the record owner, who believes he has secure title, pays taxes on the property, and makes improvements, it can be argued that the demarcation percentage should be weighted in this owner's favor. In this regard, the demarcation percentage could be at the 33⅓ percent mark. However, in view of the recent emphasis on protecting the public interest, particularly for conservation and preservation purposes in marshland areas, an equally effective argument can be made for weighting the demarcation percentage in favor of the State. In an attempt to avoid such debates it is suggested and recommended that the demarcation percentage be set at the 50 percent mark. Therefore, the property owner would have the right to clear title to the property by paying to the State an amount equal to the factor-percentage of the unimproved market value of the property if the State's claim ranged from 1 to 50 percent. However, if the strength of the State's claim ranges from 51 to 100 percent, no such option would exist for the property owner. In such instances the State would have the right to obtain full, unencumbered fee simple title.

If a party fails to exercise his right to clear title within 180 days, then this right will vest in the other party. As a result, the party gaining this right will pay the other party an amount equal to his factor percentage in order to clear title. For example, assume that the State has a factor-percentage of 70 percent and the landowner 30 percent. If the State fails to clear the title within 180 days then the right vests in the landowner, and he has the right to pay the State 70 percent of the unimproved market value of the land, and thereby gain clear title to the property.

Valuation

Since any improvements upon the property would normally have been placed there by the record owner at his own expense, the value of these improvements should not be considered in the settlement formula. The evaluation of the market value of the property in its unimproved state would be determined by the particular commissioner hearing the matter in a given region, and would be determined upon evidence given to said commissioners by competent real estate and appraisal testimony. The various accepted techniques of establishing market value, as utilized in condemnation hearings, would likewise be utilized in this aspect of the proceeding.

In attempting to fix the fair market value of the property in its unimproved state, set guidelines should be established. It is recommended that the appraisal should indicate first, the fair market value of the lands in their improved state, if they have in fact been improved. Improvements would include such items as buildings, structures, and fill that had been placed on the property. Then the buildings and other structures would be valued separately and added to the reasonable cost of the fill that had been placed upon the premises. The total value of the buildings, structures, and fill would then be subtracted from the total fair market value of the land in its improved state. The resulting figure would then qualify as the "fair market value of the property in its unimproved state."

Factor Points

As mentioned previously, certain scientific and technical criteria will be applied to each parcel of land in order to determine whether it has been tide flowed. Each of the criteria will be assigned a certain number of factor points relative to their conclusiveness and reliability. Since the maps which chart the mean high-tide line are considered the most reliable and conclusive of all the criteria, they have been assigned

the value of 50 factor points, the maximum value given to any one criterion. The values assigned to the remaining criteria reflect their degree of reliability and conclusiveness vis-à-vis these maps. The following list of factors is demonstrative of the criteria to be utilized in the proposed scheme. In the final analysis, further scientific and historical refinement will be required.

	Criteria	Maximum Factor Points
1.	Maps Charting Mean High-Tide Line	50
2.	New Jersey Geological Survey Maps of 1880 and 1890	40
3.	Vegetation	15
4.	WPA Maps	15
5.	United States Corps of Engineers Pierhead and Bulkhead Line Maps	10
6.	Topographical Maps Published by the United States Geological Survey	10
7.	Subsurface Data	10
8.	Acidity and Electrical Resistivity Tests:	
	Acidity	10
	Electrical Resistivity	10
9.	Historical Data	10
10.	Mosquito Ditching	5

1. Maps Charting Mean High-Tide Line

Presently, the documents that map the mean high-tide line are the National Ocean Survey Maps.[43] Since these depict the "mean high-tide line" as distinguished from other maps which indicate "shoreline" or "marshes," they should be given a maximum of 50 factor points. Additionally, surveys conducted in the future that precisely map this line[44] should also be allotted a maximum of 50 factor points.

If these maps clearly indicate that a parcel of land is either above or below the mean high-tide line, then this property would be classified as either privately-owned or State-owned unless there is other evidence showing that the line, as depicted on these maps, is the result of an artificial change. An example of such a situation would be where there

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[43] For example, the National Ocean Survey has recently mapped the mean high-tide line of the Hackensack River and its tributaries. These maps can be procured from the Navigation Bureau of the Department of Environmental Protection, New Jersey.

[44] Presently, the Newark and Elizabeth meadowlands are being mapped under the supervision of the Natural Resource Council pursuant to N.J. STAT. ANN. § 13:1B-13.2 (Supp. 1971-72).

is evidence indicating that the land had been filled, thereby causing the line to recede. Under these circumstances the land would be classified as controversial, and thereby become subject to the application of the factor-percentage system.

When the land is classified as controversial, the maximum number of points will be granted in favor of the private owner if the maps show that all of the land in the parcel is above the mean high-tide line and the maps depict the mean high-tide line for the entire parcel. However, where only a part of the land is above that line, the number of factor points allotted to the landowner will be proportionate to the amount of land above the line.

Example:

Length of mean high-tide line	Area of land in controversy	Area of land above mean high-tide line
1000 ft.	80,000 sq. ft.	40,000 sq. ft.

$$\frac{40{,}000}{80{,}000} \times 50 \text{ max. pts.} = 25 \text{ pts. to private owner}$$

If the National Ocean Survey Maps reveal the mean high-tide line for only a part of the parcel of land in question (i.e., the line is discontinuous on the map indicating the mean high-tide line on some portions of the parcel but not others), then the maximum number of 50 factor points will be reduced proportionately. For example, if the National Ocean Survey Map depicts the mean high-tide line for only 50 percent of a specific tract of land, then 25 factor points (50 points $\times$ 50 percent) will be the maximum that can be allotted. The calculations for a situation like this would be accomplished as follows:

Length of projected line[45]	Length of line actually mapped
1,000 ft.	600 ft.

$$\frac{600}{1{,}000} \times 50 \text{ max. pts.} = 30 \text{ max. pts.}$$

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45 The mean high-tide line as charted on the National Ocean Survey Maps may not be a continuous line. There are areas for which the mean high-tide could not be determined, and therefore it appears on the maps as a broken line, with the interstices indicating those places at which the mean high-tide could not be calculated. However, for the purposes of the formula in the text, it is necessary to make the assumption that if the mean high-tide were plotted in these interstitial areas, it would be a straight line from the point where the presently mapped line ends to where it begins again. This is the only way that the length of the line can be calculated in order to execute the formula, and is the reason for denominating this length as the "length of the projected line."

Total area of controversial land	Area of land above mean high-tide line[46]
80,000 sq. ft.	40,000 sq. ft.

$$\frac{40{,}000}{80{,}000} \times 30 \text{ max. pts.} = 15 \text{ pts. to private owner}$$

2. New Jersey Geological Survey Maps of 1880 and 1890

This series of maps charts the marshes within the State, classifying them as "fresh marsh," "tide marsh," or "marsh below high water."[47] "Fresh marsh" is descriptive of marshes which are not tide flowed, but are created by the drainage from land occupying a higher elevation. Since they are clearly above the mean high-tide line they would be accorded a maximum of 40 points.

"Tide marsh" is described on the maps as "being at or slightly above high tide." It is to be noted that the terminology used is "high tide," and not "mean high-tide line." Due to a lack of explanation, it is not clear what is meant by "high tide" or what techniques were utilized to map this "tide marsh." If, for instance, the surveyors adopted the procedure of viewing the high tide on a given day and mapping it, it is possible for the "tide marsh" that was charted to be above, at, or below the "mean high-tide line." For this reason, properties appearing on these maps as "tide marsh" would receive a maximum of only 30 factor points.

Areas designated on the maps as "marsh below high water" would be given 0 factor points. This designation is subject to a difficulty similar to that of the area designated as "tide marsh," namely, that the exact definition of "high water" is not indicated. Therefore, it is possible for a part of the land designated as "marsh below high water" to be above the mean high-tide line. However, this difficulty is not of the same magnitude as occurs with "tide marsh." A parcel of land designated as "tide marsh" can be partially or totally above, at, or below the mean high-tide line; whereas only the upper strip of a parcel of land designated as "marsh below high water" could possibly be above the mean high-tide line. Though the authors recognize this problem,

46 The area of the land above the mean high-tide line includes all the land above both the *actually* charted line and the *projected* line. Since in many instances it would be impossible to limit this area, with any degree of accuracy, to that region above the *mapped* portion of the line, this has been adopted as the best course, compensating for any error by reducing the maximum points obtainable for these maps when this circumstance presents itself.

47 For a report by the topographer of these maps on the drainage of the marshes, *see* Vermeule, *supra* note 33.

"marsh below high water" is still given 0 factor points, because the major portion of any parcel of land classified as "marsh below high water" will always be below the mean high-tide line.

Since nature does not respect legal boundaries, a particular tract of land may have regions classified on these maps as "fresh marsh," other regions classified as "tide marsh," and others as "marsh below high tide." Again, therefore, the factor points must be divided proportionately. For example, if 40 percent of the land is shown on the 1880 and/or 1890 maps as being "fresh marsh," 20 percent as "tide marsh," and 40 percent as "marsh below high water," the following procedure must be followed:

Fresh Marsh:	40% × 40 factors	=	16 factors
Tide Marsh:	20% × 30 factors	=	6 factors
Marsh Below High Water:	40% × 0 factors	=	0 factors
			22 total factors

The significance of these maps cannot be overemphasized because they are the link to the "formerly flowed doctrine." They represent the site as it appeared when the maps were compiled at the end of the 1880's. However, the accuracy of these maps does not approach that of the recent maps produced by the National Ocean Survey. The boundary line on recent maps has a greater degree of accuracy because surveying and cartographic techniques have improved as a result of technological developments. It is for this reason that only 40 factor points will be allocated to such maps, in contrast to the 50 points that were allotted to maps designating the mean high-tide line. As the New Jersey Supreme Court noted in *O'Neill*, when these old maps were constructed the scientists and cartographers did not intend that they would be utilized in determining ownership of riparian lands.[48]

3. Vegetation

The flora on a site can be extremely beneficial in supporting a claim of either the private owner or the state, depending upon the varieties of plants found on the land. Certain varieties of vegetation such as *Spartina patens* are typical biota of a marsh that is not inundated by the daily tides. Therefore, these plants are indicative of areas which are at or above the mean high-tide line. In contrast, the occurrence of *Spartina alterniflora* and some species of *Salicornia* are representative of vegetation located in areas that are flowed by the

[48] 50 N.J. at 326, 235 A.2d at 11.

daily tides and, therefore, located at or below mean high tide. It should be noted that in the immediate vicinity of the mean high-tide line, plants indicative of a low marsh and high marsh can grow together.[49] This zone of intermixed plant life is negligible when compared to the entire site; however its existence is still taken into consideration in the calculation of factor points.

The relative proportion of the plants on the site which are indicative of marsh above the mean high-tide line will be related to a maximum of 15 factor points. If the total tract of land is covered by these varieties of biota, then 15 factor points will be allotted in favor of the private owner. If, on the other hand, the entire tract of land is covered with vegetation indicative of land below the mean high-tide line, then 0 factor points will be allotted the private owner, but 15 factor points must still be included in computing the "total possible factor points" applicable to the land in question. Where a parcel of land has both types of vegetation covering different portions of the plot, then the factor points will be divided proportionately. For example, if 40 percent of a site contains *Spartina patens* and *Phragmites* (high marsh), and 60 percent of the site consists of *Spartina alterniflora* (low marsh), 6 factor points (40 percent $\times$ 15 points) will be allotted to the private owner; the State receives the remainder.

Although the vegetative cover in a particular marsh grows in response to differing degrees of tidal inundation, man has effectively upset the equilibrium of natural forces within this area so that it is highly unlikely that an ideal marsh will develop. As one progresses away from the New York metropolitan area, marsh development is more in accord with the ideal marsh. It is those areas where marsh growth is solely influenced by the natural phenomena that vegetation will provide a definitive boundary for the land above, and that below, the mean high-tide line. In view of these facts, vegetation has a limited application for resolving the ownership problems in regions where man has markedly upset the equilibrium and therefore only warrants a possible 15 factor points.

4. WPA Maps

These maps were compiled during the depression years by New Jersey for the purpose of charting the "shoreline" of the various water-

[49] For a general discussion of vegetation in a marsh environment, *see* J. TEAL & M. TEAL, *supra* note 2, at 84-123; Chapman, *Relationships of Salt Marsh Vegetation*, in Sapelo, *supra* note 4, at 47-57; Heusser, *History of an Estuarine Bog at Seacaucus, New Jersey*, 76 BULL. TORREY BOTANICAL CLUB 385 (1949). *See also*, Redfield, *Ontogeny of a Salt Marsh Estuary*, 147 SCIENCE 50 (Jan. 1, 1965).

courses throughout the State. The studies were conducted in the field utilizing tidal data, vegetation, and the existent physical conditions. Because the "shoreline" mapped was not arrived at through the use of the same data as are utilized in establishing the mean high-tide line, it is not congruent with the mean high-tide line. However, an inspection of these maps reveals that they closely depict the identifiable intersection of the tidal plane with the land which often coincides with the mean high-tide line as found in the National Ocean Survey Maps.

These WPA maps are not conclusive of the mean high-tide line but serve as collateral proof when used in conjunction with other materials, such as the National Ocean Survey Maps. When the line found on the WPA maps coincides with recent or older maps, it is convincing proof in tracing the history of the location of the mean high-tide line.

For the foregoing reasons, it is suggested that 15 factor points be allotted to property which is clearly above the shoreline on these maps. The actual factor points given will vary in each situation and therefore will be determined in the manner as set forth in the section entitled "Maps Charting Mean High-Tide Line."

5. United States Corps of Engineers Pierhead and Bulkhead Line Maps

The United States Corps of Engineers has a series of maps which depict in some detail the high-tide line for various watercourses. These maps, however, were devised for the predominant purpose of indicating the parameters within which a pierhead or bulkhead could be constructed, and mapping the high-tide line was only incidental to this purpose. Therefore, 10 factor points will be the total that could be obtained for these maps if they show land above the line. Again, the actual factors allocated in each instance will be determined pursuant to the procedure set out in the section entitled "Maps Charting Mean High-Tide Line."

6. Topographical Maps published by the United States Geological Survey

These documents depict the "shoreline" for the particular geographical area mapped. Because these documents are of limited usefulness they will be allocated a maximum of only 10 factor points. The procedure for allocation of actual points is presented in the above sections.

7. Subsurface Data

By analyzing subsurface materials, a scientist is able to discover

the past environmental conditions of the land and determine whether the area in question had been formerly inundated by the tides. This analysis would disclose those areas that are fresh water, and therefore not flowed by the tides, from those which are saline and inundated by the ebb and flow of the tides. It is suggested that a maximum of 10 factor points be granted for property definitely fresh water, and 0 points for property definitely saline. Brackish water, which is a mixture of fresh water and salt water, will receive factor points between these values in proportion to its salinity.

Some of the analyses which can be utilized when investigating the subsurface material are:

(a) Plant morphology and micromorphology—The identification and structure of plant remains, which constitute the peat of the marsh, can indicate the general environmental conditions under which the peats were formed. Although there is some decomposition of these plants upon burial, most of the fibers can be identified centuries later.[50] Therefore, by identifying the vegetative components of the peat, indicators are provided showing whether the peat formed under fresh water or brackish water conditions.[51]

(b) Relative abundance of sand particles and clay particles—This can be used to determine whether sand or clay is indigenous to the site or had been carried in by water from an extraneous source.[52]

(c) Clay mineral analysis by x-ray diffraction—This technique can distinguish saline from fresh water sediments. In applying the factor points to this analysis 10 points would be allotted for the presence of *vermiculite*, a mineral indicative of fresh water marsh, whereas *illite*, a mineral indicative of saline conditions,[53] would receive 0 points. When the relative abundance of these minerals is determined the factor points can be allocated accordingly. For example, if x-ray diffraction data on a sample yields 70 percent *vermiculite* and

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50 K. Harmon & J. Tedrow, A Phytopedologic Study of the Hackensack Meadowlands 12-29 (1969); D. Hill & A. Shearin, Tidal Marshes of Connecticut and Rhode Island 15 (The Conn. Agricultural Experiment Station, New Haven Bull. 709, Feb. 1970); Bloom, *Peat Accumulation and Compaction in a Connecticut Coastal Marsh*, 34 J. SEDIMENTARY PETROLOGY 599 (1964); Redfield, *supra* note 49.

51 *See generally* Heusser, *supra* note 49, at 396-99.

52 C. DUNBAR & J. RODGERS, PRINCIPLES OF STRATIGRAPHY 2-27, 46-95 (1957); D. Hill & A. Shearin, *supra* note 50, at 17. *See generally* J. GILLULY, A. WATERS & A. WOODFORD, PRINCIPLES OF GEOLOGY (2d ed. 1959).

53 K. KRAUSKOPF, INTRODUCTION TO GEOCHEMISTRY 177-203 (1967); D. Hill & A. Shearin, *supra* note 50, at 17-19. For a description of physical and chemical characteristics of minerals to aid in their classification, see W. DEER, R. HOWIE & J. ZUSSMAN, AN INTRODUCTION TO THE ROCK-FORMING MINERALS 260-63, 270-74 (1966).

30 percent *illite*, then from the maximum of 10 points, 7 points will be awarded.

Although the subsurface and soil analyses provide additional data to substantiate a claim, there are several disadvantages to their utilization. The cost factor is one such disadvantage and in most cases it would outweigh the relative beneficial knowledge that could be obtained from such data. However, in areas where the ownership problem cannot be clearly resolved by the aforementioned conventional means, these more sophisticated techniques become a valuable tool.

However, in utilizing any subsurface data, one must not lose sight of the time period for which the State is asserting its sovereign claim. Since the claimant should only be concerned with the time period from 1664 to the present,[54] the subsurface materials analyzed should not be older than 1664. The problem is determining the age of such materials. Radiometric dating, through the use of carbon-14, will not be of much assistance since the relatively short periods of time (geologically speaking) that are desired cannot be determined with a high degree of accuracy;[55] this methodology is utilized when ages in terms of thousands of years are desired. Similarly, pollen analysis, which was attempted by Harman and Tedrow in the Hackensack Meadows, has proven worthless for age determinations since the predominant pollens in these meadows were from upland trees and not marsh vegetation.[56]

8. Acidity and Electrical Resistivity Tests

Acidity: Determining the pH of marsh sediment can be used to indicate whether these sediments are permeated with fresh or salt water, and whether large quantities of sea shells have neutralized the acid. As a general rule, organic-rich material is more acidic than that which has less organic material. Seawater is alkaline and when it mixes with the organic-rich sediments the acidity decreases, or tends towards a basic solution.[57]

Through the use of acidity tests a maximum of 10 factor points could be allotted for acidity levels characteristic of a fresh marsh. The actual points given would decrease as the acidity becomes more characteristic of a salt marsh.

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54 State v. The Council, Div. of Res. Dev., No. L-12561-68 (N.J. Super. Ct., Ch. Div., Sept. 8, 1971).

55 H. FAUL, AGES OF ROCKS, PLANETS, AND STARS 11-13 (1966); W. PUTNAM, GEOLOGY 434-37 (1964); R. FLINT, GLACIAL AND QUATERNARY GEOLOGY, 406-10 (1971).

56 K. Harmon & J. Tedrow, *supra* note 50, at 34-62. *See* R. FLINT, *supra* note 55, at 385-89.

57 K. KRAUSKOPF, *supra* note 53, at 29-60; D. Hill & A. Shearin, *supra* note 50, at 9-10. *See also* B. MASON, PRINCIPLES OF GEOCHEMISTRY, 149-207 (3d ed. 1966).

Electrical Resistivity: Instruments which measure electrical resistivity of marsh sediment can also be used to indicate whether it is permeated with salt water or fresh water—the lower the resistivity, the higher the salt content.[58] On this basis, 10 points would be given for higher resistivity, which is indicative of a fresh marsh. The actual points allotted would be prorated, dependent upon the degree of salinity as determined by the resistivity tests.[59]

9. Historical Data

A maximum of 10 factor points should be given for historical data, such as old photographs, historical records and the like, which indicate that the area had been, in fact, upland property. When these data are introduced, their authenticity must be established before any factor points could be awarded. Once this prerequisite has been met, the actual factor points allotted would be dependent upon the conclusiveness, relevance and reliability of the data presented. Since historical data includes many diversified materials, the evaluation of these attributes would be the responsibility of the commissioners.

10. Mosquito Ditching

Mosquito ditches are prevalent throughout the New Jersey marshes and constitute artificial changes which significantly affect the development of a marsh.[60] Mosquitoes do not reproduce in an environment

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58 D. GRIFFITHS & R. KING, APPLIED GEOPHYSICS FOR ENGINEERS AND GEOLOGISTS 8-65 (1969); K. Harmon & J. Tedrow, *supra* note 50, at 7-11. For a discussion of the salinity of marsh sediments derived by chemical analysis, *see* Heusser, *supra* note 49, at 396-99.

59 The data from acidity and electrical resistivity tests are subject to many variables and therefore necessitate expert interpretation. The salinity of a particular sample does not necessarily represent the salinity of the environment in which it was formed. The salts could be leached to a specific level, thereby concentrating the salt in a particular zone. If the sample is taken from within this zone, the electrical resistivity will be considerably lower than the materials above the zone. If a series of tests were taken at different elevations, the data might suggest that the deeper sections were definitely brackish environments, whereas the higher elevations were fresh. In addition to the possibility of the salinity of soil reflecting whether the area had been influenced by tidal inundations, the normal metabolic processes of many marsh plants concentrate salts in their roots in excess of the medium in which they are growing. Consequently, upon death and subsequent accretion the peat will not reflect the salinity of the environment. The amount of rainfall, degree of upland drainage, and the chemicals carried in such waters also affect the acidity and electrical resistivity tests of the samples. Therefore, these tests must be used with caution; but, when utilized in conjunction with proper interpretation, they can be used to determine the general environment of the area.

60 Provost, *Managing Impounded Salt Marsh for Mosquito Control and Estuarine Resource Conservation*, in PROCEEDINGS OF THE MARSH AND ESTUARY MANAGEMENT SYMPOSIUM 163 (La. State Univ., July 19-20, 1967); *see* Heusser, *supra* note 49, at 402-03; Pepper,

that is subject to the flux of the tides but generally breed on the high marsh,[61] *i.e.*, land not flowed by the daily tides. Therefore, in order to retard their reproduction, mosquito ditches are dug to allow the land to be inundated by the tides.

Prior to the construction of these ditches, the soil of the high marsh was composed of organic and inorganic materials saturated with water. Subsequent to the construction of the ditches, the water drains out of the soil, thus causing the remaining organic and inorganic material to become compressed, thereby lowering the elevation of the land.[62] At the same time, the saline water flowing from the watercourse into the ditch is able to periodically cover the land, making it tide flowed. This is to be distinguished from the prior condition of the land where the water was interspersed within the other components of the soil. Consequently, the effect of mosquito ditches is to transform a high marsh into a low marsh.[63]

The maximum number of factor points to be given if mosquito ditches are present is 5. The difficulty in allocating factor points in relation to the amount of land covered by ditching is that there are diverse theories as to the amount of land surrounding the ditch that is affected by it. In cases where the mosquito ditches do not affect the entire parcel of the land, various formulas can be devised in order to proportionately allot the number of factor points. However, because of the options open and the disparity of opinion as to the land affected by ditching, the adoption of a formula should be left to either the legislature or the commissioners.

CONCLUSION

The tidelands dilemma cries for a resolution which would consider all aspects in order to protect all interests involved. The proposed system would provide an equitable solution with regard to the rights of both the public and the private landowner. It would be a uniform system of clearing title to all marshland and wetland properties throughout the State of New Jersey. Additionally, it would provide for an expeditious administrative clearance of title and reasonable compensation would be paid. Furthermore, it would realistically categorize the properties and provide a method of overcoming a virtually impossible problem of proof.

Mosquito Control in New Jersey: What is Being Done; What Needs to be Done, 50 PUB. HEALTH NEWS 224 (1969).

61 J. TEAL & M. TEAL, *supra* note 2, at 233-39.

62 Vermeule, *supra* note 33, at 294.

63 *See* Heusser, *supra* note 49, at 402-03.

This report is by no means intended to be a conclusive recommendation; it is, rather, a starting point for discussion, criticism and revision. The most important and complex aspect of this proposal is the factor-percentage system. This system must be established in order to equate scientific and technical factors and methodologies to a specific number of factor points, which should then be used to calculate the percentage representing the strength or weakness of a claim. The concept is sound—the detail can be established! It is time for law, science and government to sit at the same table and equitably resolve an otherwise unresolvable title or tidal dilemma.