University of Wisconsin-Extension

GEOLOGICAL AND NATURAL HISTORY SURVEY
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ANNOTATED BIBLIOGRAPHY OF GEOLOGICAL, HYDROLOGIC, SOILS, AND CLIMATOLOGIC INFORMATION FOR WISCONSIN'S GREAT LAKES COASTAL ZONE COUNTIES

by

J. Stark

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1975

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Financial assistance for this study has been provided through the Wisconsin Coastal Zone Management Act of 1972 administered by the federal office of Coastal Zone Management, National Oceanic and Atmospheric Administration.

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INTRODUCTION

The majority of Wisconsin's Great Lakes Shoreline is subject to periodic and severe erosion which causes extensive and costly property loss and shoreline damage and presents a real hazard to human life. The cause of this erosion is rooted in geologic, hydrologic, soils, and climatologic factors. To determine the best method(s) to minimize the threat to life, property, and shoreline it is essential to know what information is available and its accessibility. This information has not been compiled. The purpose of this project is to present an annotated bibliography of geologic, hydrologic, soils and climatologic information for Wisconsin's Great Lakes Coastal Zone Counties.

This annotated bibliography is intended primarily for use by persons and groups involved with coastal zone management problems. Examples of users are county and regional planning commissions, engineers responsible for design of protective structures, state and federal agencies responsible for coastal zone management, and all researchers involved with applied problems of the causes of erosion and determinations of what can and must be done to minimize or eliminate erosion.

The bibliography was supported by the Wisconsin Department of Administration and the Wisconsin Geological and Natural History Survey. Financial assistance was provided through the Wisconsin Coastal Zone Management Act of 1972 administered by the federal office of Coastal Zone Management, National Oceanic and Atmospheric Administration.

The author wishes to thank the many persons who assisted with the preparation of this bibliography. Special acknowledgement is given to Dr. M.E. Ostrom, State Geologist and Director, Dr. David Hadley and Dr. Val Mitchell of the Wisconsin Geological and Natural History Survey; Dr. David Mickelson, Dept. of Geology and Geophysics, University of Wisconsin; Mr. Chuck Hess, Wisconsin Department of Natural Resources; and Ms. Chris Hanson, State Cartographer's office for their advice and pertinent suggestions concerning the scope of this publication.

The bibliography contains references to published as well as some unpublished information on geologic, hydrologic, soils and climatologic data pertaining to Wisconsin's Coastal counties. In addition, some supplemental information is contained that does not specifically fit into any of the four areas of interest. The supplemental data pertains primarily to information concerning lake currents, lake levels, shoreline protection and shoreline management. Most of the references are annotated and noted as to where they may be obtained.

The complete bibliography contains 459 citations although many entries are composed of a series of monthly or yearly publications under the same title. The bibliography is indexed alphabetically by author for each subject area. The breakdown of the subject areas is as follows:

Subject Area	Number of Entries
Geology	228
Hydrology	121
Soils	52
Climatology	25
Supplemental Data	33

The abbreviation in the upper right corner of each entry indicates where the reference is located. The following is a list of symbols used to denote location.

DNR	Department of Natural Resources, Pyare Square Bldg., 4610 University Avenue, Madison
SGL	Wisconsin Geological and Natural History Survey, 1815 University Avenue, Madison
SHL	Wisconsin Historical Society Library, 816 State Street, Madison
St. Climat.	State Climatologist's office, Meteorology and Space Science Bldg., 1225 West Dayton, Madison
U-Minn.	University of Minnesota-Minneapolis
USGS	U.S. Geological Survey-Library, 1815 University Avenue, Madison
UW-AL	Univ. of Wis.-Agricultural Library, Steenbock Memorial Library, Madison
UW-EL	Univ. of Wis.-Engineering Library, Room 356, Mech. Eng. Bldg., Madison
UW-Geog.	Univ. of Wis.-Geography Library, Room 250, Science Hall, Madison
UW-GL	Univ. of Wis.-Geology Library, Room 430, Weeks Hall, Madison
UW-Mil	Univ. of Wis.-Milwaukee
UW-ML	Univ. of Wis.-Memorial Library, 728 State Street, Madison
UW-SG	Univ. of Wis.-Sea Grant Reading Room, Meteorology and Space Science Building, Madison
UW-Sup	Univ. of Wis.-Superior
WRC	Univ. of Wis.-Water Resources Center, Reference Room, 1975 Elm Drive, Bldg. C

Other Abbreviations Used

G.S.A.	Geological Society of America
U.S.D.A.	United States Department of Agriculture
U.S.G.S.	United States Geological Survey
U.W.	University of Wisconsin
W.S.P.	Water Supply Paper

Due to time constraints, the bibliography probably is not complete. It is hoped, however, that it covers most of the pertinent published information concerning the four areas of interest.

GEOLOGICAL REFERENCES

Agassiz, L. 1848.
The terraces and ancient river bars, drift, boulders, and polished surfaces of Lake Superior: Am. Assoc. Adv. Sci., Proc., v. 1, 1848, p. 68-70.

Alden, W.C. 1904. UW-GL
The Delavan lobe of the Lake Michigan glacier of the Wisconsin stage of glaciation and associated phenomena: U.S.G.S., Prof. Paper 34, 106 p., illus., maps.

This paper describes the Delavan lobe of the Lake Michigan glacier which thrust itself out between the converging west front of the Lake Michigan glacier and the south front of the Green Bay glacier a distance of 25 miles beyond the main west front of the Lake Michigan glacier. The area includes Racine, Kenosha, and Walworth counties, and adjacent parts of Milwaukee, Waukesha, Jefferson, Rock, and Dane Counties.

Alden, W.C. 1905. UW-GL
The drumlins of southeastern Wisconsin: U.S.G.S. Bull. 273, 46 p., illus., map; U.S. 59th Cong., 1st session, House Doc. 206.

The author discusses the distribution, orientation, form, structure, and lithologic composition of the drumlin fields of southeastern Wisconsin. A section of the paper is devoted to the theory of the origin of drumlins.

Alden, W.C. 1906. UW-GL
Description of the Milwaukee quadrangle: U.S.G.S. Geologic Atlas of the United States, Milwaukee Special Folio, no. 140, p. 11-12, map.

This atlas contains a detailed geologic map and descriptive geologic history of the Milwaukee quadrangle.

Alden, W.C. 1918. UW-GL
The Quaternary geology of southeastern Wisconsin, with a chapter on the older rock formations: U.S.G.S., Prof. Paper 106, 356 p., illus., maps; (abs.) Wash. Acad. Sci. Jour., v. 15, p. 537.

This paper contains sections dealing with the bedrock geology, geography, topography, and drainage of southeastern Wisconsin. In addition, detailed chapters on the Pleistocene history of the area are presented.

Allen, R.C.; Barrett, L.P. 1915. UW-GL
Contributions to the pre-Cambrian geology of northern Michigan and Wisconsin: Mich. Geol. and Biol. Survey, pub. 18 (geol. ser. 15) p. 13-164, maps.

This book contains a detailed description of the pre-Cambrian geologic history of northern Michigan and the eastern portion of northern Wisconsin.

Allen, R.C.; Leith, C.K. 1915. UW-GL
Discussion of correlation of pre-Cambrian formations of Lake Superior Region: Jour. Geol., v. 23, p. 703-729.

The authors discuss some of the problems involved in correlating pre-Cambrian rock units within the Lake Superior region.

Anderson, R.C. 1957. UW-GL
Pebble and sand lithology of the major Wisconsin glacial lobes of the central lowlands: G.S.A., Bull., v. 68, no. 11, p. 1415-1450, illus., tables.

Pebble and sand-grain counts were taken from the axial portions of moraines of six Wisconsin glacial lobes of the Central Lowland (Erie, Saginaw, Lake Michigan, Green Bay, Des Moines, and Iowan), and the observed distribution of lithologic types was interpreted in terms of provenance, lithologic properties, and glacial processes. It appears unlikely that the glacial lobes of the central lowland can be differentiated on the basis of a single "indicator" lithology. Investigation of the relative proportion of lithologic types appears to be the most fruitful method for the differentiation of glacial lobes.

Andrews, E. 1870. UW-ML
The North Americal lakes considered as chronometers of post-glacial time: Chicago Acad. Sci., Trans., v. 2, p. 1-24, map.

This article calculates the length of post-glacial time from data gathered along the shores of Lake Huron and Lake Michigan. The elements from which the calculations are made include the average rate of erosion, the width of the subaqueous plateau formed by the erosion since the lake stood at its present level, the amount and direction of sand movement, and the amount of sand in different beaches. The total length of time since the end of the Pleistocene is calculated between 5,300 and 7,500 years.

Antevs, E. 1929. UW-GL
Maps of the Pleistocene glaciation: G.S.A., Bull., v. 40, p. 631-720.

Contained in this article are generalized maps and a small section pertaining to the Pleistocene glaciations in Wisconsin. The article, in its entirety, deals with the Pleistocene history of the earth.

Anzoleaga, R; Ocala, L.C.; Meyer, R.P. 1969.
Shallow seismic refraction profiles in western Lake Superior and their relation to geologic structures (abs.) in Inst. Lake Superior Geology, 15th Ann., Tech. Session, Abs., Oshkosh, Wis., Wisconsin State Univ., Dept. Geology, p. 7.

Ayers, J. 1967.
The surficial bottom sediments of Lake Michigan in Ayers, J. and Chandler, D., eds., Studies on the environment and eutrophication of Lake Michigan: Univ. Mich., Great Lakes Res. Div., Sp. Rpt. no. 30, p. 247-253.

Bagg, R.M. 1930.
The geologic history of Door County, Wisconsin: Peninsula Historical Review (Door County Historical Society) v. 4, no. 2, p. 17-26.

Bahnick, D.A. (and others). 1972. UW-GL
Effects of south shore drainage basins and clay erosion on the physical and chemical limnology of western Lake Superior: Internat. Assoc. Great LakesRes., 15th Conf., Proc., p. 237-248, illus., tables.

A study of certain chemical and geological parameters for the extreme southwestern edge of Lake Superior waters and its sediments is presented. Parameters determined were temperature, dissolved oxygen COD conductivity, ammonia, ortho and polyphosphate, nitrate, copper, iron, magnesium, calcium, sodium, hardness, alkalinity, and dissolved and suspended solids.

Results indicate that the input of red clay into Lake Superior from rivers and shoreline erosion leads to higher values of specific conductance, alkalinity, hardness, calcium, magnesium, sodium, iron, orthophosphate, color, value, and COD.

Ball, J.R. 1921. UW-ML
The intercision of Pike River, near Kenosha, Wisconsin: Ill. State Acad. Sci., Trans., v. 13, p. 323-326.

The lower portion of the course of the Pike River is incised in the plain of Glacial Lake Chicago. It crosses this plain in such manner that for nearly $3\frac{1}{2}$ miles it flows practically parallel to the shoreline of Lake Michigan.

The remnant of the lacustrine plain in this region is suffering rapid removal by wave erosion of Lake Michigan. This fact, plus the parallel position of the stream in relation to the shoreline furnishes the setting for intercision. Intercision occurs where a lake shortens the course of a stream by intercepting the stream somewhere between its source and mouth.

Ball, J.R.; Powers, W.E. 1930. UW-ML
Shore recession in southeastern Wisconsin: Ill. State Acad. Sci., Trans., v. 22, p. 435-441, tables.

Two conclusions may be drawn from this study of shore recession: first, the recession is rapid and wasteful where it is not checked by breakwaters or "groins", or by a temporary beach of the lake's own making; and second, the rate of recession is not uniform but variable, being rapid at times of high lake level, and very slow at times when the lake waters are low.

Ball, J.R. 1938. UW-ML
Wave erosion along the west shore of Lake Michigan: Chicago Naturalist, v. 1, no. 1, p. 11-20, illus., map.

This article describes the geologic history of Lake Michigan. In addition the causes and problems associated with erosion along the western shore are discussed.

Bayley, W.S. 1893. UW-GL
The basic massive rocks of the Lake Superior region: Jour. Geol., v. 1, nos. 5,6,7, p. 433-456, 587-596, 688-716.

This early article discusses the pertalogy and mineralogy of the basic rock types in the Lake Superior Region.

Bean, E.F.; Thompson, J.W., Jr. 1944. UW-ML
Topography and geology of the Brule River Basin (Wis.), Pt. 2 of Brule River survey: Wis. Acad. Sci., Arts and Letters, Trans., v. 36, 1944, p. 7-17, illus., maps.

The authors describe the topography and geology of the (Bois) Brule River in northwestern Wisconsin. The bedrock geology of the basin consists of Keweenawan sandstone and lava flows. The Pleistocene deposits consits of a terminal moraine, outwash, glacial drift modified by lake action, and lake clay.

Bean, E.F. 1949. SGL
Geologic map of Wisconsin: Wis. Geol. and Nat. Hist. Survey, one-sheet, scale 1:1,000,000.

A generalized geologic map of Wisconsin.

Berkson, J.M. 1972. UW-ML
Microrelief of western Lake Superior: Ph.D. Thesis, U.W., Madison, 63 p., illus., map.

The Lake Superior floor northwest of the Keweenaw Peninsula can grossly be classified as having three zones of microroughness based on echogram character. The zones are roughly depth-dependent. The Zone A bottom, found between the shore and about 180 feet, is generally smooth on the echogram and consists mainly of sand and rocky deposits. Zone B found between 180 feet and 550 feet has microroughness of 5 feet to 15 feet relief and separation of 300 feet to 1000 feet. The bottom consists of glacial till and lacustrine clay. Zone C is found in depths over approximately 550 feet and consists of lacustrine clay. Narrow troughs with depths to 40 feet and separation of 200 feet to 2000 feet occur in this zone.

Black, R.F. 1960. UW-GL
Pleistocene history of Wisconsin (abs.) in Inst. Lake Superior Geology, 6th Ann., 1960: Madison, Wis., U.W., Dept. Geology: Wis. Geol. and Nat. Hist. Survey, p. 13.

Reconnaissance in all counties in Wisconsin, local detailed studies, and radiocarbon dates on deposits of the Wisconsin stage provide data that necessitates a review of the Pleistocene history of Wisconsin. It now seems relatively certain that no Pleistocene deposits at the surface or buried are older than the Wisconsin stage, with the possible exception of the Windrow formation. According to workers outside Wisconsin, the Wisconsin stage began between 50,000 to 70,000 years ago. The earliest dated advance in Wisconsin, about 30,000 years ago, was synchronous in the Lake Michigan and Superior lobes. This advance is here

designated Rockian after the Rock River which traverses much of the area of deposition in southern Wisconsin and in Illinois. Subsequent deglaciation during the Farmdalian substage, 22,000 to 28,000 years ago according to data from Illinois was incomplete--ice blocks remained in deep valleys until after the readvance of the ice during Cary time in southern Wisconsin and during Valderan time in northern Wisconsin. These ice blocks subsequently produced many of our large lakes such as Mendota, Green, and Geneva in the south and Ceder, Twin, and Pelican in the north. Unfortunately, the chronology in Wisconsin of the Farmdalian deglaciation and subsequent readvances and retreats of the ice up to the Two Creekan substage 11,000 to 12,500 years ago has no support of radiocarbon dates and is imperfectly known. Permafrost was present for a time according to casts of ice-wedge polygons and to well-developed solifluction and other frost phenomena.

Black, R.F. 1962. UW-GL
Pleistocene chronology of Wisconsin (abs.): G.S.A., Sp. Paper 68, p. 137.

With the possible exception of clastics traditionally assigned to the Windrow formation of Cretaceous Age no Pleistocene deposits older than the Wisconsin Stage are recognized in Wisconsin. The earliest recognized ice invasion called Rockian after the Rock River in southern Wisconsin and northern Illinois, advanced simultaneously westward from the Lake Michigan Lobe and eastward from the Des Moines Lobe about 30,000 years ago. The Rockian deglaciation, characterized by extensive stagnation features, is correlated tentatively with the Farmdalian interstadial of Illinois, dated about 22,000 to 28,000 years ago. None of the subsequent readvances entered southwest Wisconsin and each was generally successively less extensive than the preceding. The Tazewell is poorly represented; the Cary is multiple and widespread. The Valders, fowwowing Two Creeks time, is limited to the northern and southern parts of the state.

Black, R.F. 1964. SGL
The physical geography of Wisconsin: Wis. Geol. and Nat. Hist. Survey, reprint, 7 p., illus., map.

On the basis of the kinds of rocks and the topography they produce, Wisconsin may be divided into two general geomorphic regions--northern and southern. The Northern Highland region is part of the Laurentian Upland or pre-Cambrian shield. This is the southernmost extension of a vast area of northern and eastern Canada. In it a complex of igneous and metamorphic rocks is more than 600 million years old and represents the roots of ancient mountains. Among the rocks represented are various kinds of granite, granitic gneiss, rhyolite, basalt, and metasediments. The southern region is part of the Central Plains Region which extends southward along the Mississippi River drainage. It contains flat-lying sedimentary sandstones, shales, and dolomites lithified from sediments laid down in ancient oceans 300 to 600 million years ago. Those rocks constitute the Paleozoic section of Wisconsin.

Black, R.F. 1966. UW-Geog

Valders glaciation in Wisconsin and Upper Michigan - a progress report: Great Lakes Res. Div., Pub. no. 15, p. 169-175.

Reconnaissance in northern Wisconsin and contiguous upper Michigan suggests (1) the Valders ice did not reach northcentral Wisconsin, apparently being confined to the eastern half of Lake Superior and to the northern part of Lake Michigan; (2) the Valders ice did appreciable work between those lakes, striating bedrock and building drumlins, end moraines, outwash plains, and stagnant ice features; (3) the ice during at least one pulse deployed radially outward from a center between those lakes; and (4) there the Valders drift is characteristically not red clayey till as it is to the south, but it is sandy and stony.

Black, R.F. 1968. UW-GL

Glacial features of the Kettle Interlobate Moraine, eastern Wisconsin. (abs.): G.S.A., Sp. Paper 121, p. 650-651.

The common border of the Green Bay and Lake Michigan lobes of the late Woodfordian age is a drainageway established on, and partly let down from, the surface junction of the two lobes. In the Northern Kettle Moraine State Forest, that drainageway, now .5 to 3 miles wide, is a marked depression that is floored largely with stratified clastics. Rising abruptly from the center of the depression are numerous striking moulin kames and from the flanks numerous crevasse fills, eskers, kames, and other stagnant-ice features that constitute "end" moraines of the two lobes. The end moraines are .5 to 3 miles wide and merge abruptly up-ice into ground moraine with drumlins and scattered stagnant-ice features. Abrupt bends in the interlobate moraine seem related to bedrock topography and local direction of ice movement of the opposing lobes.

Black, R.F. 1969.

Glacial geology of Northern Kettle Moraine State Forest, Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 57, p. 99-119, illus.; (abs.) Abs. North Am. Geol., p. 1191 Abs. (A) v. 3, p. 283, 1970.

The common border of the Green Bay and Lake Michigan lobes of late-Woodfordian Age is a drainageway established on and partly let down from the surface junction of the two lobes. In the Northern Kettle Moraine State Forest that drainageway, now 0.5 to 3.0 miles wide is a marked depression that is floored largely by stratified clastics. Rising abruptly from the center of the depression are numerous striking moulin kames and from the flanks numerous crevasse fills, eskers, kames, and other stagnant-ice features that constitute "end" moraines of the two lobes. The "end" moraines are 0.5 to 3.0 miles wide and merge abruptly up ice into ground moraine with drumlins and scattered stagnant-ice features. Abrupt bends in the interlobate moraine seem related to bedrock topography and local direction of ice movement of the opposing lobes.

Black, R.F. 1970. SGL

Glacial Geology of Two Creeks Forest bed, Valderan type locality and northern Kettle Moraine State Forest: Wis. Geol. and Nat. Hist. Survey, Inf. Circ. 13, 40 p., illus,: (abs.) Abs. North Am. Geol., p. 900, June, 1971.

This guide is divided into four parts--a detailed road log (part 1) with only brief stop descriptions, and three documentary reports, one for each of the three areas, to provide more detail on hard-to-find material. The three stops or areas are described as discrete entities for convenience both in writing and in reading. They are: Part 2 - The two Creeks Buried Forest; Part 3 - Valderan type locality; and Part 4 - Northern Kettle Moraine State Forest.

Black, R.F. (and others). 1970. SGL

Pleistocene geology of southern Wisconsin, G.S.A., Ann. Mtg., Milwaukee, Wisconsin, 1970, a field trip guide (with special papers): Wis. Geol. and Nat. Hist. Survey, Inf. Circ. 15, 175 p., illus., tables.

This field trip guide is designed to show: (1) representative sections of the Pleistocene stratigraphy, and (2) representative glacial features particularly drumlins and landforms marginal to the Driftless Area. The guidebook contains 9 special papers pertaining to the Pleistocene geology of southern Wisconsin.

Black, R.F. 1974. SGL

The Two Creeks buried forest in Late Quaternary environments of Wisconsin: Am. Quat. Assoc., Third Biennial Meeting, field guide, p. 44-57.

In the bank of Lake Michigan, which rises today about 30 feet above water level, is a detailed sequence of deposits which depict vast changes in climate and in geologic events from a time perhaps 14,000 radiocarbon years ago to the present. Stratigraphically, the bank shows at water level a compact, red to grey clayey till and massive lake deposits of similar appearance. According to well logs, the till rests directly on the Niagara dolomite of Silurian age which is 40 to 80 feet below lake level. The till grades imperceptibly upward and laterally into the massive lake sequence which, in turn, grades into rhythmically bedded clay with some silt and sand. The rhythmically bedded deposits represent the Late Woodfordian glacial sequence which was deposited probably 14,000 and 12,000 radiocarbon years ago.

Above the rhythmically bedded deposits locally are layers of yellow-brown sand and gravel from a few inches to 4 feet thick. They are considered shallow water, near shore, and beach deposits resulting from wave and current action on the underlying deposits. The buried forest rests on and is formed in the beach and lake deposits. Trees in it are radiocarbon dated at 11,840 years B.P. On top of the forest bed are light yellow to dark yellow lake sands, fine to coarse in texture. They are considered to be the result of the rising lake level in front of the advancing Valders ice.

On top of the sands rest 2 to 12 feet of red clayey till of Valderan age, estimated at 10,000 to 11,500 radiocarbon years B.P.

Bretz, J.H. 1951. UW-GL

The stages of Lake Chicago - their causes and correlations: Am. Jour. Sci., v. 249, no. 6, p. 401-429, illus.

The three named stages of Glacial Lake Chicago record (1) the earliest static lake level (Glenwood), (2) a time of rapid lowering because of outlet deepening, (3) a pause in this deepening and lowering to produce the second static stage (Calumet), (4) renewed lowering because of renewed outlet deepening, and (5) a final level (Toleston) determined by a rock sill in the outlet channel floor. The dam for the lake was not the Valparaiso moraine but the younger Tinley moraine and its valley train. No stoping by retreat of rapids was involved in outlet deepening. The thesis of this paper is that the outlet down-cuttings are to be correlated with times when glacial lakes in the Erie and Huron basins discharges into Lake Chicago and thus added to the erosive ability of its outlet river; the two earlier static water levels with times when these eastern lakes discharged elsewhere. Deposition of the Valders red drift of the northern Lake Michigan basin is thought to have been contemporaneous with the intermediate stage of Lake Chicago. The Port Huron moraine is believed to be of late Cary age and, in earlier studies, to have been incorrectly correlated across Lake Michigan.

Brunning, C.J. 1970. UW-Mil

Determination of the Valderan-Woodfordian Boundary in Southeastern Wisconsin: M.S. Thesis, U.W., Milwaukee, 46 p.

To test the color based Woodfordian-Valderan till boundary in Southeastern Wisconsin, forty samples for analytical study were taken from fresh cut banks or excavations along traverses crossing the boundary. Sample analysis indicates that there is no difference between the tills in (a) grain size analysis of the non-carbonate fraction, (b) carbonate content, (c) magnetic susceptability and (d) extractable iron content. Therefore, analytical determination of the boundary using these criteria is impossible.

Based on physical properties, the yellowish brown (Woodfordian) till is not weathered reddish brown (Valderan) till. However, the presence of reddish brown (Valderan) till seven miles west of the boundary suggests that either (a) Alden's glacial geology map of the area is in error, or (b) Woodfordian till locally is reddish brown in color and thus the tills of Southeastern Wisconsin cannot be mapped on the basis of color.

Buckley, E.R. 1901. UW-GL

The clays and clay industry of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 7 (econ. ser. 4), 304 p., illus., map.

This early report, prepared for the brick and tile industry of Wisconsin, contains sections on the occurrence, classification, and physical properties of Wisconsin's clay deposits.

Cahow, A.C. 1971. UW-GL

Abandoned shorelines and related geomorphic features of Bayfield County, Wisconsin: Unpub. M.A. Thesis, Mich. St. Univ., 55 p.

Shorelines formed by the glacial and postglacial ancestors of Lake Superior were mapped in detail. Altitudinal and lateral variations in their degree of development were interpreted in terms of the lake history of the Superior basin and the variables controlling shoreline modification.

Callender, E.; Rossman, R. 1970. UW-GL

Sedimentary geochemistry of Green Bay, Lake Michigan (abs.): G.S.A., Abs. with Programs, v. 2, no. 7, p. 513-514.

Green Bay is divided into a highly polluted southern basin and a less polluted northern basin. The main contributor to the pollution of Green Bay is the Fox River which has spread fine-grained organic-rich sediments throughout the southern basin. This reduced silty clay is in strong contrast to the oxidized medium sand that occurs in the northern basin.

Rivers supply most of the metallic elements to Greey Bay water. Those entering northern Green Bay contribute more dissolved iron and manganese than those entering the southern basin while manganese and iron concentrations in southern Green Bay are significantly higher than those in the northern basin. The transitional metal content of suspended particulate material decreases from south to north along the axis of the bay away from the influence of the Fox River.

The transition metal content of surficial sediments in Green Bay reflect several geochemical processes. Of major importance is the formation and subsequent dissolution of ferromanganese nodules. Nodules that once formed in the southern basin are slowly dissolving due to oxygen depletion in the bottom water as a consequence of pollution. These oxidized sediments contain high concentrations of minor elements some of which are toxic in the aquatic environment.

The minor element content of Green Bay bottom sediments is evaluated in light of possible sources, basic geochemical processes, and diagenetic effects in order to determine man's influence on the recent sedimentary history of the Bay.

Chamberlin, T.C. 1877. UW-GL

Geology of eastern Wisconsin in Geology of Wis.: Wis. Geol. Survey, v. 2, pt. 2, p. 91-405, maps (in atlas); (abs.) Am. Jour. Sci., v. 15 (3), p. 62-64, 1878.

This article describes the general geology of Rock, Jefferson, Dodge, Green Lake, Winnebago, Outagamie, Waupaca, Shawano, Oconto, Door, Kewaunee, Brown, Calumet, Manitowoc, Sheboygan, Fond du Lac, Washington, Ozaukee, Milwaukee, Waukesha, Walworth, Racine and Kenosha Counties. Chapters are included pertaining to the subject areas of topography, hydrology, native vegetation, soils, Quaternary geology, Archean geology, Lower Silurian geology, Upper Silurian geology, and Devonian geology.

Chamberlin, T.C. 1878. UW-ML
On the extent and significance of the Wisconsin kettle moraine: Wis. Acad. Sci., Arts, and Letters, Trans., v. 4, p. 201-234, maps.

This early paper includes discussion on the surface features, drift composition, drift source, ice movement, and methods of formation relating to Wisconsin's interlobate kettle moraine.

Chamberlin, T.C. 1878. UW-GL
The terminal moraine of the second glacial epoch: U.S.G.S., 3rd ann. rpt., p. 315-326, 381-388, illus.

Three terminal moraines of the Wisconsin Glacial Stage are defined for the state of Wisconsin. These moraines are referred to as the Green Bay, Lake Michigan, and Lake Superior terminal moraines. Morainal topography, extent, and drift composition for each of the moraines is reviewed.

Cleland, H.F. 1911. UW-GL
The fossils and stratigraphy of the Middle Devonic of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. no. 21, sci. ser. 6, p. 1-21, illus., map.

This paper gives the results of a study of all the known outcrops of the Wisconsin Devonian and their contained fauna. In it were discussed (1) the relation of the strata to those above and below, (2) the unconformities, (3) the lithologic characters, and (4) the character, relationships, and geographical distributions of the faunas.

Collie, G.L. 1901. UW-GL
The Wisconsin shoreline of Lake Superior: G.S.A. Bull., v. 12, p. 197-216.

The region described in this paper is that portion of the Wisconsin shore of Lake Superior which lies between Point Detour and the Montreal River. The shore, in part, is made up of a series of cliffs, either composed of glacial debris or of Potsdam sandstone. In part, the shoreline is composed of a series of shore deposits, chiefly in the form of bars. The topography of the mainland is such as existed during pre-Glacial time, but is masked and modified by glacial deposits. The mainland has a rugged topography, at a distance from the lake, and the lake is bordered by a coastal plain a few miles wide, whose simple topography consists of a smooth surface without prominent elevations, in which deep valleys are incised.

In a general way, the lake level has gradually fallen since the Pleistocene, but this has not been a continuous process, as fluctuations have occurred. At the time of writing an apparent rise of the lake level was substantiated by two pieces of evidence: (a) the lower courses of the streams which empty into the lake have estuary features--they are drowned streams--and (b) certain shore features, such as bars and spits, were in the process of rapid destruction. Apparently these formations were made when the lake was lower, but with its rise they are being destroyed. Wave erosion, especially on the exposed islands, has given rise also to a series of erosion forms, such as caverns, coves, cliffs, and stacks.

Consoer, Townsend and Associates. 1973. SGL
Shoreline erosion study for village of Fox Point, Wisconsin: Chicago, Illinois, 74 p., illus., maps.

This erosion study contains discussion on a general description of the area, geology, factors affecting erosion, study methods, shoreline changes, problem areas, erosion control methods, cost estimates, and recommendations. In addition, a map of the present shoreline is included.

Davis, R.A., Jr.; McGeary, D.F.R. 1965. U-Minn
Stability in nearshore bottom topography and sediment distribution southeastern Lake Michigan: 8th Conf. Great Lakes Res. Proc., p. 222-231, illus.

Detailed underwater study of nearshore areas in southeastern Lake Michigan indicates that the bottom topography and sediment distribution are relatively stable. Seven sets of traverses were run with a period of two months between them, and two sets were run before and after storms. No apparent distinction exists between data collected after two months and that collected after storms. Offshore bars are constant in their relationship to the shore but show some variation in profile shape. Indicies of similarity for depth of water, mean grain size and sorting show good correlation between traverses, with mean grain size having lowest values.

Dell, C.I. 1972. UW-GL
The origin and characteristics of Lake Superior Sediments: Internat. Assoc. Great Lakes Res., 15th Conf. Proc., p. 361-370, illus.

Seven sediment types have been deposited in Lake Superior since deglaciation. During the early stage of deglaciation when only the southern half of the lake was open, three of the sediment types were deposited: brown sand associated with red till, red massive clays and overlying these, red varved clays. As the ice retreated to the north, gray varved clay began to be deposited over an extensive area of the lake. This material was derived from the calcareous gray till of the region from Nipigon to White River. The varves formed as the result of a solution effect on the carbonates. After the ice had retreated from the north shore, the sediment supply was greatly diminished; varve formation ceased and noncalcareous massive gray clay was deposited. This unit is at the sediment-water interface over much of the northern half of the lake. In the southern half of the lake a brown silty sediment overlies red till, red clays or massive gray clay. The brown sediment was derived from erosion and weathering of red tills and previously deposited red lake sediments. Near the shore the uppermost unit is a sand.

Desor, E. 1851.
On clay and drift deposits near Lake Superior, and their connection with similar deposits farther West: Boston Soc. Nat. Hist., Proc., v. 3, p. 235-236, 242.

Desor, E. 1851. UW-ML
On the superficial deposits of the Lake Superior district in Foster and Whitney, Report on the geology of Lake Superior district, pt. 2: p. 232-240; Am. Jour. Sci., v. 13 (2) p. 93-109.

This report describes four glacial deposits in the Lake Superior region. In ascending order they show the following characteristics: (1) a layer of coarse materials, composed of pebbles intermingled with loam, (2) a layer of clay, (3) a deposit of sand, gravel, and pebbles, irregularly stratified, and (4) isolated boulders.

Dickas. A.B.; Tychsen, P.C. 1969. WRC
Sediments and geology of Bois Brule River western Lake Superior: Internat. Assoc. Great Lakes Res., 12th Conf. Proc., p. 161-169, illus., maps, Ann Arbor, Mich.

A sedimentary analysis was made of the bed load of the Bois Brule River, Douglas County, Wisconsin, to better understand the statistical characteristics of the clastic material being transported by this stream and its contribution to the Halocene sedimentation history of the Wisconsin shoreline of Lake Superior. In addition, bedrock and glacial deposits were mapped throughout the drainage basin.

Results indicate that the glacial cover is the prime source of the clastic materials of the river load, concurring with the mapping program of the drainage area. A secondary source is outcropping Keweenawan sandstones. Earlier studies indicate the river load is deposited in Lake Superior out to a distance of ½ to 1 mile from the shoreline with the finer material found at the greater distance from the littoral zone.

Dickas, A.B. 1970. UW-GL
Depositional environment of Lake Superior sands through grain size analysis: Internat. Assoc. Great Lakes Res., 13th Conf., Proc., pt. 1, p. 227-232, illus.

As part of the problem of recognizing and reconstructing paleoenvironments of arenaceous units in western Lake Superior, grain size parameters of modern fluvial, littoral, and inner neritic lake sediments have been analyzed.

Of all available graphs, that of phi deviation versus the diameter was found to be the most successful as it correctly classified 86.1% of all samples into a fluvial and a nonfluvial field. Further differentiation of nonfluvial fields is displayed.

While the method presented here is quite functional, correlation with other studies indicates that differing lines of separation between genetic fields must be determined on the local geographic level as predetermined by depositional energy factors.

Dubois, R.N. 1972. UW-GL

Inverse relation between foreshore slope and mean grain size as a function of heavy mineral content: G.S.A., Bull., v. 83, no. 3, p. 871-875, illus.

Along the sandy beach of Terry Andrae State Park on Lake Michigan, an inverse relationship exists between foreshore slope angle and mean grain size. Mean grain size decreases as the heavy mineral content increases. Grain size, wave steepness, and wave length have been reported as variables affecting the foreshore slope angle. It is here suggested that the heavy mineral content in the mid-foreshore be accepted as an active variable that influences the foreshore slope angle.

Dubois, R.N. 1972. UW-ML

Seasonal variation in beach and nearshore morphology and sedimentology along a profile of Lake Michigan, Wisconsin: Ph.D. Thesis, U.W., Madison, 165 p., illus., maps.

The initial task of this study was (1) to confirm the existence of seasonal beach-nearshore patterns along Lake Michigan and (2) to identify the variables influencing the seasonal changes of the beach-nearshore zone. The study site was located at Terry Andrae State Park, Wisconsin. From April through November, 1971, morphometric and sedimentological data were collected weekly from two beach-nearshore profiles; the data were correlated with process variables, i.e., lake level, wind statistics, and wave properties. The statistical tests employed were stepwise correlation and regression analysis.

A definite seasonal beach cycle was found to exist on Lake Michigan and presumably also on other shores of the Great Lakes.

Dutton, C.E. 1968. UW-GL

Summary report on the geology and mineral resources of the Huron, Seney, Michigan Islands, Green Bay, and Gravel Islands National Wildlife Refuges of Michigan and Wisconsin: U.S.G.S., Bull. 1260-I, p. I1-I14, illus.; (abs.) Abs. North Am. Geol., p. 639, May, 1968.

Surface materials of most of these areas are largely sand or gravel of Pleistocene or Recent age. Bedrock of the areas is believed to be largely sedimentary rock of Paleozoic age. In all areas, bedrock types are those common in nearby areas; the bedrock is unlikely to be exploitable in or near the refuge areas.

Dutton, C.E.; Bradley, R.E. 1970. SGL

Lithologic, geophysical, and mineral commodity maps of Precambrian rocks in Wisconsin: U.S.G.S., Misc. Geol. Invest. Map, I-631, 15 p., illus., maps.

The purpose of this report is to present and explain a series of maps of the Precambrian rocks of Wisconsin that have been assembled to make more readily available a great amount of unpublished data on file at the Wisconsin Geological and Natural History Survey. The maps and report also contain pertinent summary information from published reports. The three principal maps of northern Wisconsin (sheets 1,2,3) show respectively: (1) lithological data, (2) magnetic anomalies and Bouguer gravity anomalies, and (3) inferred areal geology of principal lithologic units. Map units shown on sheet 3 are explained on sheet 4. Sheet 5 shows combined lithologic, geologic, and geophysical information for the southern part of the state. The principal map features and their interpretation are discussed in the text.

Dutton, C.E.; Bradley, R.E. 1971. SGL
Bibliography of Precambrian geology of Wisc.: Wis. Geol. and Nat. Hist. Survey, open file report, 28 p.

This report presents a bibliography of all published work pertaining to the Precambrian geology of Wisconsin through 1968.

Edil, T.B.; Pezetta, J.M.; Wolf, P.B. 1975. UW-EL
Sedimentation and erosion control in the "red clay" area of the western Lake Superior basin--a demonstration project: unpublished report to the Ashland County Soil and Water Conservation District, part I, 48 p., illus., maps.

The primary purpose of the first phase of this study has been the identification and analysis of several demonstration sites within Ashland County and the establishment of cost estimates for the development of suitable means of effective shore protection measures in highly sensitive locations.

Edil, T.B.; Pezetta, J.M.; Wolf, P.B. 1975. UW-EL
Sedimentation and erosion control in the "red clay" area of the western Lake Superior basin--a demonstration project: unpublished report to the Ashland County Soil and Water Conservation District, part II, 21 p., illus.

The primary purpose of the second phase of this study has been to present specific recommendations about the type and nature of shoreline protection works and the materials and costs involved for the treatment of two of these sites.

Ellsworth, E.W. 1932. UW-ML
Varved clays of Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 27, p. 47-58, illus., map.

The author describes the location and chemical analysis of the varved clay deposits in Wisconsin. The clays studied represent the basin deposits of at least four glacial lakes: Glacial Lake Chicago, Glacial Lake Oshkosh, Glacial Lake Wisconsin, and the glacial lake of northwestern Wisconsin.

Engstrom, W.N. 1972. UW-ML

Spatial patterns in beach morphology and sedimentology in the Apostle Islands of northern Wisconsin: Ph.D. Thesis, U.W., Madison, 257 p., illus., maps.

This study is concerned with spatial patterns in beach morphology and sedimentology in the Apostle Islands of northern Wisconsin. The islands were selected for study primarily because within the group there is a wide variety of wave energy situations. Thirty-nine beaches were examined.

Beach heights and widths in the Apostle Islands tend to be greatest in high energy situations where vigorous swash penetrates for shoreward and builds up the beach by washover deposition.

Evanson, E.B.; Farrand, W.R. 1971. UW-GL

Further revision of the Valders drift border of the Lake Michigan lobe: G.S.A., Abstracts with Programs, v. 3, no. 7, p. 560.

Recent studies in the Ontario, Huron, and Erie basins and in the glacial Grand River demonstrate that the Glenwood and Calumet stages of Lake Chicago are pre-Twocreekan.

Glenwood and Calumet shorelines and features (deltas, river terraces, etc.) graded to these levels can be traced from Manistee, Michigan, around the south end of Lake Michigan and north to Two Rivers, Wisconsin. The presence of Glenwood and Calumet shore features on the "red drift" between Muskegon and Manistee, Michigan, and between Milwaukee and Two Rivers, Wisconsin, demonstrates a pre-Valderan age for these deposits and negates Bretz's (1951) hypothesis that the deposits are Valderan in age. The southern limit of the Valders advance in the Lake Michigan Lobe is now placed immediately north of Manistee, Michigan and Two Rivers, Wisconsin, as originally interpreted by Goldthwait, Alden, and Leverett.

The Glenwood deposits in Wisconsin are not horizontal as originally reported by Leverett and Goldthwait, but rise to approximately 660' A.T. and include the sediments of Lake Shoto, previously thought to be post-Valders.

Evanson, E.B. 1972.

Late Pleistocene shoreline stratigraphic relationships in the Lake Michigan basin: unpub. Ph.D. dissertation, Univ. of Michigan, 88 p.

Evanson, E.B. 1973. UW-GL

Late Pleistocene shorelines and stratigraphic relations in the Lake Michigan Basin: G.S.A., Bull., v. 84, p. 2281-2298, illus.

Recent investigations in the Ontario, Huron, and Erie basins and in the Glacial Grand River demonstrate that the entire Glenwood Stage and at least an early portion of the Calumet Stage of Glacial Lake Chicago are pre-Twocreekan.

Glenwood and Calumet shoreline features can be traced from Manistee, Michigan, southward around the south end of Lake Michigan and northward to Two Rivers, Wisconsin. The presence of Glenwood shore

features on the red drift between Muskegon and Manistee, Michigan, and between Milwaukee and Two Rivers, Wisconsin, demonstrates a pre-Twocreekan age for these drift deposits.

Stratigraphic relations in Manitowoc County, Wisconsin strongly suggest that the Glenwood deposits are younger than the type Valders at Valders. Furthermore, the red clay till north of Manistee, Michigan, and Two Rivers, Wisconsin, where it overlies the Two Creeks forest bed is post-Glenwood in age and thus is not correlatable with the type Valders till, as previously assumed. The use of the term "Valders" for the post-Glenwood till is rejected and the new name "Two Rivers till" is proposed for the Manitowoc County area.

Evanson, E.B.; Eschman, D.F.; Farrand, W.R., eds. 1973. UW-GL
The "Valders" problem, Lake Michigan basin: Midwest Friends of the Pleistocene, 22d. Ann. Field Conf., 59 p., illus.

This pamphlet was used as a guidebook for a 1973 field trip by the Midwest Friends of the Pleistocene to the Lake Michigan Basin Area. It discusses the widespread extent and continuity of red tills and bottom deposits related to the Glenwood stage of Lake Chicago on both sides of Lake Michigan.

Evanson, E.B.; Mickelson, D.M. 1974. SGL
A reevaluation of the lobation and red till stratigraphy and nomenclature in part of eastern Wisconsin in Late Quaternary environments of Wisconsin: Amer. Quat. Assoc., Third Biennial Meeting, field guide, p. 102-118.

Recent studies by Evanson on the Glenwood stage of Glacial Lake Chicago demonstrate that the red clay tills south of Two Rivers, Wisconsin and Manistee, Michigan, are pre-Twocreekan. The presence of undisturbed Glenwood sediments on the surface of the Twin Rivers lowland precludes the possibility of post-Twocreekan ice of the Lake Michigan lobe reaching Valders as previously assumed. Although the detailed work necessary to delineate the post-Twocreekan margin has not been completed, the authors feel that the post-Twocreekan ice advanced from the Lake Michigan basin as far west as the Two Rivers Moraine, as far SSE as the Denmark moraine, and as far east as Forest Junction, Sherwood and Quinney, Wisconsin. The red till within this re-entrant and bounded on the south by Thwaites' and Alden's red till limit is assumed to be of Port Huron Age.

Farrand, W.R. 1960.
Former shorelines in western and northern Lake Superior Basin: Unpublished Ph.D. Thesis, Dept. of Geology, Univ. of Michigan, Ann Arbor.

Farrand, W.R.; Zumberg, J.H.; Parker, J. 1966. UW-GL
New bathymetric map of Lake Superior and some geological implications (abs.) in Inst. Lake Superior Geol., 12th Ann. Conf. 1966: Sault St. Marie, Michigan, Michigan Tech. Univ., p. 6.

Parker has compiled a new bathymetric map with a 100-foot contour interval for the eastern half of Lake Superior on the basis of recent U.S. Lake Survey soundings. This map has been completed, in connection with the University of Michigan Lake Superior Project, by the addition of the best data available for the western half of the basin. The strong valley-and-ridge topography of the eastern part of the basin contrasts strongly with the rest of the lake where broad, smooth-floored basins are the characteristic form. However, sub-bottom depth recorder surveys show that bedrock valleys similar in size to those of the eastern basin also exist in the west, where they have been completely filled with glacial and postglacial sediments so that they no longer find expression in the topography of the lake bottom. In one of these buried valleys near the Minnesota coast, late Pleistocene sediments are more than 700 feet thick. In the eastern basin, on the other hand, Pleistocene sediments form, in general, only a thin veneer over a rugged bedrock topography which resembles that of the Finger Lake area of New York.

Farrand, W.R. 1969. UW-GL

The Quaternary history of Lake Superior: Internat. Assoc. Great Lakes Res., 12th Conf. Proc., p. 181-197, illus., tables.

The Quaternary history of the Lake Superior basin is very largely restricted to Late Pleistocene time with the possible exception of the submerged valley system found so well developed in the eastern basin of the Lake. These valleys resemble a fluvial network modified by glaciation, and they may reflect the preglacial drainage of this area. The Quaternary sedimentary cover on the bottom of the lake presents merely the waning phases of the Wisconsin Glaciation; the section begins with red till, passes upward through red and then gray varves, and ends with gray and brown postglacial clays. These sediments are too thin in the east to mask the bedrock topography, but in the western basin the thickness exceed 1000 feet in some places. The late-glacial lacustrine episode preserved in the sediments is also recorded by former shorelines as high as 500 feet above present lake level in the Duluth area, and up to 750 feet above the lake on Isle Royale where they have been subjected to glacial rebound. The earliest stages of the lake drained westward into the Mississippi system, but as the ice sheet withdrew the drainage shifted to the east by means of various routes. An extremely low stage occurred about 10,000 years ago, and lake level has been rising gradually in response to glacial rebound since that time.

Farrand, W.R. 1970. UW-GL

Revision of the Valders drift border of the Lake Michigan lobe (abs.): G.S.A., Abs. with Programs, v. 2, no. 6, p. 387.

Field work and the study of air photos and new topographic maps show clearly on the east side of Lake Michigan that (1) the Glenwood and Calumet beaches can be traced as far north as Ludington and (2) the red clay till lithology is not unique to the Valders drift in Michigan. The occurrences of red till of both Port Huron and Valders ages in Cheboygan Co., Michigan and of red till of Valparaiso age near Grand Rapids eliminate the possibility of correlating by till color alone. It is here suggested that the Valders drift limit lies across Lake Michigan in the latitude of Manistee and that the red drift bordering the lake as far south as Muskegon and Milwaukee is of Port Huron age, as it was originally interpreted by Goldthwait, Alden, and Leverett.

Foster, J.W.; Whitney, J.D. 1851. SHL
Report on the geology of the Lake Superior land district pt. 2: U.S., 32d Cong., sp. sess., Senate Ex. Doc. 4, 406 p., illus., maps.

A general report of the geology of the Lake Superior land district is contained. Chapters deal specifically with: (1) classification and nomenclature of the rocks, (2) the Azoic System, (3) granite rocks of the Azoic Period, (4) iron ores, (5) economic geology of the Azoic Series, (6) composition of the Trappean rocks, (7) mineralogy, (8) Lower Silurian system, (9) Upper Silurian and Devonian series, (10) miscellaneous observations on the Paleozoic series, (11) chemistry and economic geology of the Paleozoic series, (12) Paleozoic fossils, (13) superficial deposits, (14) elevations of mountain chains, (15) parallelism of the Paleozoic deposits of Europe and America, (16) observed fluctuations of the lakes, (17) magnetic variations, and (18) botany.

Frye, J.C.; William, H.B. 1960. UW-GL
Classification of the Wisconsinan Stage in the Lake Michigan glacial lobe: Ill. Geol. Survey Div. Circ. 285, 16 p., illus.

The revised time-stratigraphic classification of the Wisconsinan Stage of the Lake Michigan lobe as used by the Illinois Geological Survey consists of the following substages in descending order: Valderan, Twocreekan, Woodfordian, Farmdalian, and Altonian. Extrapolation from presently available radiocarbon dates suggests that Wisconsinan time started 50,000 to 70,000 radiocarbon years ago. More than half of this time falls within the Altonian, the oldest of the substages. New rock-stratigraphic names introduced are Roxana silt, Morton loess, and Richland loess. A new category of units based on surface form of the deposits is introduced as morphostratigraphic classification.

Frye, J.C.; Willman, H.B.; Black, R.F. 1965. UW-GL
Outline of glacial geology of Illinois and Wisconsin in Wright, H.E., Jr. and Frey, D.C. eds. The Quaternary of the United States, Princeton Univ. Press, Princeton, N.J., p. 43-62, illus., maps.

The authors present an outline of the glacial history of Illinois and Wisconsin. Discussion is presented on the Nebraskan, Kansan, Illinoian, and Wisconsin Stages of glaciation in the area.

Frye, J.C. 1973. SGL
Sedimentology of a beach ridge complex and its significance in land-use planning: Ill. State Geol. Survey, Environmental Geol. Notes, no. 63, 24 p., illus.

This paper emphasizes that a beach ridge complex is transitory, that erosion in some areas and aggradation in others is a natural phenomenon, and that the processes that have been controlling the distribution of these coastal features in the past will continue to be effective agents in the future.

Fuller, M.L.; Sandford, S. 1906. UW-GL
Record of deep-well drilling for 1905. U.S.G.S. Bull. 298, p. 176-181, 295-296.

Well locations and water table measurements are listed for deep wells drilled during 1906 in Wisconsin.

Goldthwait, J.W. 1906. UW-GL
Correlation of the raised beaches on the west side of Lake Michigan: Jour. Geology, v. 14, no. 5, p. 411-424, illus.

This article deals with the glacial lake beaches of the Lake Michigan Basin in Wisconsin. The shorelines discussed include the Algonquin, Nipissing and Lake Chicago beaches.

Goldthwait, J.W. 1907. SGL
The abandoned shorelines of eastern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 17 (sci. ser. 5) 134 p., illus., maps.

This report contains chapters on the following subject matter: (1) an outline of the history of the extinct lakes in the Great Lakes Basin, (2) a historical review of previous work on abandoned Great Lakes shorelines, (3) Descriptions of the old shorelines in eastern Wisconsin and (4) a reconstruction of warped water planes along the west shore of Lake Michigan.

Goldthwait, J.W. 1908. UW-GL
A reconstruction of the water planes of the extinct glacial lakes in the Lake Michigan Basin: Jour. Geol., v. 16, no. 5, p. 459-479, illus., (abs.) Science, v. 24, (ns) p. 724-725.

Correlation of extinct glacial lake beaches in the Lake Michigan Basin is discussed. Some of the problems involved in reconstructing water planes from ancient beaches is presented.

Goldthwait, J.W. 1908. UW-ML
The altitude of the Algonquin beach and its significance (abs.): Science, v. 28 (ns) p. 382-383.

Precise measurements of the altitude of the Algonquin beach and other "raised beaches" bordering Lake Michigan indicate that in the basin the Algonquin beach slants southward at a repeatedly diminishing rate, becoming horizontal near Manistee, Michigan, and Kewaunee, Wis. This horizontality over the southern half of the Lake Michigan basin appears to indicate that the beach there is now at an altitude at which it stood when first formed, and that it has been undisturbed by differential uplift.

Goldthwait, J.W. 1910. UW-GL
Isobases of Algonquin and Iroquois beaches and their significance: G.S.A. Bull., v. 21, p. 231, map; discussion, v. 21, p. 761-762.

Detailed surveys of the Algonquin and Iroquois beaches around Lake Michigan furnished the ground for the construction of a set of isobases for each beach. The rough parallelism of the isobases with the glacial boundary and with the border of the pre-Cambrian oldland of Canada seems to strengthen the position that in North America the central areas of recent warping were not merely centers of glaciation, but centers of continental uplifts of much earlier dates.

Grant, U.S. 1900. UW-GL
Preliminary report on the copper-bearing rocks of Douglas Co., Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 6 (econ. ser. 3) 55 p., maps; 2d ed., 83 p., maps, 1901.

This early paper discusses the bedrock geology and geologic history of Douglas County. Particular emphasis is placed on the copper bearing rocks of the area.

Grass, D.L. (and others). 1972.

Composition of Pleistocene sediments in southern Lake Michigan, U.S.A.: Internat. Geol. Congress, 24th Ann., sec. 8, p. 215-222, illus.

Hadley, D.W. 1974. SGL
A geological reconnaissance of Bender County Park, Milwaukee County, Wisconsin: Wis. Geol. and Nat. Hist. Survey, open file report, 12 p., illus.

This survey was designed to investigate the geology of Bender County Park, to relate the geology to the rapid shoreline erosion occurring at the park, and to evaluate the potential of the park as a site for the construction of a marina.

Hadley, D.W. 1974. SGL
Shoreline erosion in southeastern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Special report, unpublished.

Much of the shore of Lake Michigan in Ozaukee, Milwaukee, Racine, and Kenosha Counties, Wisconsin, is an area of high, steep bluffs developed in loose unconsolidated silt, sand, gravel, and clay of glacial origin.

Near record high lake water levels, the result of unusually high precipitation in recent years, have greatly accelerated the rate of shoreline erosion. Storm waves are breaking against or in close proximity to the bluffs and erosion at the foot of the bluffs has rendered them highly unstable. This has resulted in a large number of landslides. The highly unstable nature of the bluffs, coupled with the presence of occupied dwellings close to their edges, has

produced dangerous conditions in many areas. The situation is further aggravated by groundwater seepage from the bluff over large portions of the area.

Specific sections of this report include discussion on glacial history and geologic setting, processes at work along the lake shore, erosion of the bluffs, courses of action, and zoning.

Hall, H.C. 1966. UW-GL

Keweenawan geology of the Lake Superior region in Steinhart and Smith, eds., The earth beneath the continents: Am. Geophys. Union, Geophys. Mon. 10 (Natl. Acad. Sci. - Natl. Research Council Pub. 1467) p. 3-27, illus.

Keweenawan sediments and volcanics occurring at numerous localities around Lake Superior form a large structural basin known as the Lake Superior syncline. The syncline appears to connect at its western end with a narrow trough of Keweenawan rocks which extends northward from the central United States and only emerges from beneath a cover of younger sediments in the Lake Superior region. The Lake Superior syncline thus forms part of a major tectonic feature of North America. Keweenawan time in the Lake Superior region was characterized by production of an enormous quantity of basic volcanics. Igneous activity was confined essentially to a single episode of volcanism and subsequent intrusion, which occurred during an early stage in the evolution of the syncline. Volcanism was punctuated by short pauses that permitted formation of thin interflow sediments. During the latter part of Keweenawan time the syncline continued to subside after the cessation of volcanic activity. A basin of deposition was established in which there accumulated a thick sequence of sandstones and conglomerates.

Hall, J. 1851. UW-ML

Lower Silurian system in Foster and Whitney, Report on the geology of the Lake Superior land district, pt. 2: U.S. 32d Cong., sp. sess., Senate Ex. Doc., no. 4, p. 145-147; Am. Jour. Sci., v. 17 (2) p. 181-194.

This report describes the lower Silurian system of the Lake Superior district. The extent and characteristics of Chazy, Birds-Eye, Black River, and Trenton Limestones is presented.

Hamblin, W.K. 1961. UW-GL

Paleogeographic evolution of the Lake Superior region from late Keweenawan to late Cambrian time: G.S.A., Bull. v. 72, no. 1, p. 1-18, illus.; (abs.) G.S.A. Bull., v. 70, no. 12, pt. 2, p. 1614.

A combined study of the regional stratigraphy, petrology, and paleo-currents was made of the Freda sandstone, Jacobsville sandstone, Bayfield group, Dresbach formation, and Franconia formation. Data pertaining to the location and nature of the source of sediments were obtained primarily from petrology and directional sedimentary structures. Environmental reconstructions were based on patterns of lithologic variations, kinds of sedimentary structures, and heavy minerals.

Hands, E.B. 1970. UW-GL
A geomorphic map of Lake Michigan shorelines: Internat. Assoc. Great Lakes Res., 13th Conf. Proc., pt. 1, p. 250-265, illus.

The classification presented here is based on interpretation of aerial photographs and topographic sheets. Shore types are: unconsolidated bluffs, formed where moraines intersect the shoreline; dunes, restricted primarily to the eastern shore; deltas, found in Green Bay; rock exposures; marshes; swamps; and low dry plains. The nearshore classification is primarily descriptive of longshore bar patterns and turbid water areas, but an enigmatic cellular pattern characterizes two localities. Updrift beach accumulations and diverted stream mouths provide evidence of a southerly littoral drift along both the east and west coasts of Lake Michigan's southern basin and of frequent reversals in direction along northern shores.

Hanson, C.R. 1974. SGL
Bibliography of Wisconsin geology: Wis. Geol. and Nat. Hist. Survey, in preparation.

This report consists of a complete bibliography of all published work pertaining to the geology of Wisconsin.

Harrison, S.S. 1970. UW-GL
Note on the importance of frost weathering in the disintegration and erosion of till in east-central Wisconsin: G.S.A. Bull., v. 81, no. 11, p. 3407-3410, illus., (abs.) Abs. North Am. Geol., p. 767, May, 1971.

Frost weathering of glacial till exposed in east-central Wisconsin results in extensive disintegration and dehydration of the till. Erosion of the till granules produced by this weathering accounts for much of the stream-bank erosion in this area. Till granules carried by streams are usually transported as bedload and frequently from bar deposits.

Hindall, S.M.; Fling, R.F. 1970. USGS
Sediment yields of Wisconsin streams: U.S.G.S., Hydrol. Inv. Atlas, HA-376, scale about 1 inch to 7 miles, text; (abs.) Abs. North Am. Geol., p. 420, March, 1971.

This report presents a text and maps describing the surficial geology and soils of Wisconsin. In addition, a map and text present sediment yield data for many of Wisconsin's river basins.

Hobbs, W.H. 1911. UW-GL
The late glacial and post glacial uplift of the Michigan Basin: Mich. Geol. and Biol. Survey, Pub. 5, p. 1-96, illus.

This early publication discusses the post glacial uplift of the Michigan Basin. Particular emphasis is placed on the action of this uplift with regard to the shoreline features of Lake Michigan.

Horton, J.W. (and others). 1968.
Interdisciplinary study of a selected area of Lake Superior - Progress report in Inst. Lake Superior Geology, 14th Ann., 1968, Tech. Sess. Abs.: Superior, Wis., Wis. State Univ., p. 30-32.

Horton, J.W. (and others). 1971. UW-ML
Sedimentological and chemical parameters of the Lake Superior neritic zone, south shore, Wisconsin: Wis. Acad. Sci., Arts, Letters, Trans., v. 59, p. 67-77, illus.

Data indicates a standard distribution of the Lake Superior clastics within the area studied which is not unusual considering the high energy conditions of the lake shoreward of the six-fathom depth. The few anomalous zones recorded are attributed to small lake floor surface pockets of clay being transported to lower depths. Derived from gravity slumping along the South Shoreline, such clays were initially deposited in the area as lacustrine sediments during the Wisconsin sub-epoch in Lake Duluth, the ancestral glacial high-watermark of Lake Superior.

Generally, the specific conductance average value decreases from shoreline to the thirty foot area and also decreases from surface to bottom. pH values obtained were quite uniform except for a few anomalies which may have some significance. Dissolved oxygen values were nearly constant with average values ranging from 10.5 to 10.8 parts per million. The average of random samples for total dissolved solids was determined to be 71.5 parts per million.

Hotchkiss, W.O. 1923. UW-GL
The Lake Superior geosyncline: G.S.A., Bull., v. 34, no. 4, p. 669-678, illus.

The purpose of this paper is to discuss the major rock types and a hypothesis dealing with the geologic history of the Lake Superior geosyncline.

Hough, J.L. 1935. UW-GL
The bottom deposits of southern Lake Michigan: Jour. Sed. Pet., v. 5, no. 2, p. 57-80, illus.

Quantitative data on the sediments are presented, along with a discussion of their environment, sources, and agents of transportation. Maps show bottom topography and aerial distribution of sediments, and diagrams illustrate relations between mechanical composition and bottom topography.

Bottom sands of both the eastern and western shore terraces of the lake show a coarsening in size as the depth of water and distance from shore increase. A gravel-veneered till bottom is common in the western and southern parts of the lake; the gravel is interpreted as a lag concentrate of the coarser constituents of the till, produced by wave and current action. Sand derived from the till is apparently carried toward shore in most localities, while the finer fraction of till is deposited as a soft gray clay in the deeper parts of the lake.

Hough, J.L. 1952. UW-GL

Fathogram indications of bottom materials in Lake Michigan: Jour. Sed. Pet., v. 22, p. 162-172, illus.

Fathograms recorded by a commercial sonic sounding apparatus used in a study of the bottom sediments of Lake Michigan show characteristic traces for sand, till, and clay bottom. Multiple traces obtained in some areas were correlated with specific clay strata. The effects of rough water, and of variation of signal strength are illustrated, and reflections from objects in the water, probably fish, localized in relation to the thermocline are noted.

Hough, J.L. 1952. UW-GL

Post-Cary glacial substages and lake levels of the Lake Michigan basin (abs.): Geol. Soc. America Bull., v. 63, no. 12, pt. 2, p. 1382.

A sequence of lake stages in the Lake Michigan basin is set up, covering the time since the Cary glacial substage. Recent revisions in the lake history made by Stanley, Bretz, and the writer are incorporated in this sequence. Dates of events occurring in post-Cary time, obtained by two radiocarbon dating methods and reported by Libby, by Urry, and by the writer are accepted.

During this sequence of lake stages two separate glacial substages, the Mankato and Valders, occurred with their climaxes at 15,000 and at 11,000 years ago. Between the Mankato and Valders the lake basin was free of ice, the lake was extremely low, and something, possibly invading marine water, gave a red color to the lake clays. Over-riding the red clay by Valders ice gave the Valders drift its red color. Ice was present north of LakeHuron and in the LakeSuperior basin at the time of the highest Algonquin lake stage, only 3500 years ago. When recession of the ice cleared the North Bay outlet there was another low stage in which the lake surface fell to 350 feet below present lake level. Upward of the land to the northeast, beginning at this date, raised the lake surface to the level of the Port Huron outlet, producing the Nipissing Great Lakes.

Hough, J.L. 1952. UW-GL

Postglacial low water stage of Lake Michigan indicated by bottom sediments: (abs.) Geol. Soc. America Bull., v. 63, p. 1265.

Core samples taken from the deeper parts of Lake Michigan show a complete sequence of clay deposits from glacial to present time, whereas samples taken from depths less than 350 feet show that a part of this deep-water sequence is missing and is replaced by a shallow-water deposit of sand and shells. The sand and shells are overlain by normal deep-water clays. The shells are of species of gastropods and pelecypods whose living representatives inhabit 1 to 15 feet deep.

The level of this low-water stage is placed at 350 feet below the present lake surface, and the time of the low-water stage is believed to be post-Algonquin and pre-Nipissing. This low-level Lake Michigan would have drained through the Straights of Mackinac into a low-level Lake Huron, which was proposed by G.M. Stanley in 1936.

Hough, J.L. 1953. UW-GL

Final report on the project of Pleistocene chronology of the Great Lakes region: Univ. Illinois; Office of Naval Research, Contract no. N6ori-07133, Project no. NR-018-122. 105 p., illus.

The object of this report is to work out a complete time scale for the later part of the Pleistocene glacial and post-glacial time for known events in the Great Lakes region. The objective was obtained by counting varves or annual sediment layers associated with the glacial drift.

Hough, J.L. 1954.

Geologic history of the Great Lakes beaches in Johnson, J.W., ed.: Coastal engineering; Proc., 4th Conf., Oct. 1953, p. 79-100, illus.

Hough, J.L. 1955. UW-GL

Lake Chippewa, a low stage of Lake Michigan indicated by bottom sediments: G.S.A., Bull., v. 66, no. 8, p. 957-968, illus.

Core samples taken from deeper parts of Lake Michigan show a complete sequence of clay deposits from glacial to present time, whereas samples taken from depths less than 350 feet show that a part of this deep water sequence is missing and replaced by a shallow-water deposit of sand and shells, overlain by normal deepwater clays. The shells are of a species of gastropods whos living representatives inhabit water 1-15 feet deep.

The level of this low-water stage is placed at 350 feet below the present lake surface, and the time of the low-water stage at post-Algonquin and pre-Nipissing. This low-level Lake Michigan drained through the Straits of Mackinac into a low-level Lake Huron, as was proposed by G.M. Stanley in 1936.

Features of the low-water stage in the Lake Michigan Basin are named Southern Lake Chippewa, Grand Haven River, Lake Chippewa, and Mackinac Lake. The low-water stage in the Lake Huron basin is named Lake Stanley.

Hough, J.L. 1958. UW-GL

Geology of the Great Lakes: Univ. Illinois Press, Urbana, 313 p., illus., maps.

Part 1 of this book contains material which forms a frame of reference for the history of the Great Lakes. It includes descriptions of the present lakes and of the processes operating in them, summaries of the events in the region which led up to the formation of the earliest lakes, and a review of the methods which are used to date the events of lake history.

Part 2, the history of the lake stages, has been prepared primarily for the professional geologist and for specialists in related fields such as archeology. It contains some original material which has not been published elsewhere, and it includes a detailed review and re-evaluation of the extensive literature on the Great Lakes. The Great Lakes history is summarized in a correlation chart with an absolute time scale in years.

Howard, Needles, Tammen and Bergendorf, (consulting engineers). 1957.
Duluth-Superior Interstate Bridge project in 390-3 (2): Subsurface exploration report, boring logs and laboratory test data. Kansas City, Mo.

Hubbard, H.A. 1968.
Stratigraphic relationships of some Keweenawan rocks of Michigan and Wisconsin (abs.) in Inst. Lake Superior Geology, 14th Ann., 1968, Tech. Sess. Abs.: Superior, Wis. State Univ., p. 35-37.

Huels, F.W. 1915. SGL
The peat resources of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 45 (econ. ser. 20) 274 p., illus., maps.

The purpose of this report is to describe the location, extent, and character of the peat beds of the state and to determine the value of the peat for various purposes. It indicates some of the uses to which peat may be put and gives information showing how peat has been and is being used elsewhere.

Institute on Lake Superior Geology. 1973. SGL
Precambrian geology of northeastern and northcentral Wisconsin: Wis. Geol. and Nat. Hist. Survey, Guidebook, 19th Ann. Inst., 86 p., illus., maps.

This report is a guidebook to the Precambrian geology of northeastern and northcentral Wisconsin. It contains special papers on the chronology of Precambrian Rocks in Wisconsin, the Wolf River Batholith, and the Precambrian Geology of Marathon County.

Irving, R.D. 1880. UW-GL
The geologic structure of northern Wisconsin in Geology of Wisconsin: Wis. Geol. Survey, v. 3, pt. 1, p. 1-24, illus., map.

This paper describes the structural geology of Wisconsin's Lake Superior region. It contains detailed discussions of the Laurentian, Huronian, and Keweenawan Systems of northern Wisconsin.

Iverson, D.L. 1951. UW-GL
Geomorphology of the Lake Superior region in Field trip to the Lake Superior region, May 5 to 12, 1951: U.W., Madison, Dept. Geology, 6 p., map.

There are two major factors in the geomorphic history of the Lake Superior area. One is the development of a widespread peneplain and the other is the invasion of the continental glaciers. These two factors combine to produce most of the topographic features observed in the area.

Jenkins, R.A. 1973. SGL
The geology of Beecher and Pembine townships, Marinette Co., Wisconsin in Inst. Lake Superior Geology, 19th Ann., 1973, Technical program and abstracts: Wis. Geol. and Nat. History Survey, U.W., Geology Depts., p. 15-16.

Four metavolcanic formations, separated by major faults, occur in Beecher and Pembine townships in northeastern Marinette County. The formations are the Quinnesec Formation, the McAllister Formation, the Beecher Formation, and the Pemene Formation. The relative ages are uncertain but the order of naming is suggested as the order of decreasing age. All the formations have been folded and regionally metamorphosed to greenschist facies. In general the rocks have not been strongly sheared or altered, and primary structures are well preserved. The volcanics have been intruded by granite, granodiorites, quartz diorites, and ultramafics.

Johnson, R.W.; Meyer, J.T., Jr. 1969.
The geology of the South Range quadrangle, Douglas Co., Wisconsin (abs.) in Inst. Lake Superior Geology, 15th Ann., 1969, Tech. Sess. Abs.: Oshkosh, Wis., Wis. State Univ., Dept. Geology, p. 20-21.

Jones, J.A. 1931. UW-ML
Notes on the late Ordivician strata of the Green Bay - Lake Winnebago region: Wis. Acad. Sci., Arts, and Letters, Trans., v. 26, p. 121-126.

The late Ordovician strata are generally known as the Richmond group, representing the uppermost part of the Cincinnatian series. In this region, the Richmond is divided into six formations. Given in ascending order they are: Arnheim, Waynesville, Liberty, Saluda, Whitewater, and Elkhorn.

Keyes, C.R. 1915. UW-GL
Lake Superior highlands; their origin and age: Jour. Geol., v. 23, p. 569-574, illus.

The dominant relief feature of the highland region about Lake Superior is an even, distinctly elevated plain in which rivers are deeply intrenched. The genesis of this broad plain is a question of long standing. Its settlement involves the derivation and facial expression of the landscape over more than one-quarter of the entire North American continent

Knox, J.C.; Mickelson, C.M., eds. 1974. SGL
Late Quaternary environments of Wisconsin: Amer. Quat. Assoc., Third Biennial Meeting, field guide, 243 p., illus., maps.

This field guide contains a road log pertaining to the glacial geology and pedology in central and northeastern Wisconsin. Special papers are included pertaining to the following subject matter: The Two Creeks buried forest, Valderan type locality, A reevaluation of the lobation and red till stratigraphy in part of eastern Wisconsin, and Large scale involutions in red till in

the Manitowoc-Two Rivers-Two Creeks area of Wisconsin - Periglacial features or load structures.

Kohler, M.L., Moore, J.R. 1972. UW-GL
Sedimentation and scour off nuclear power plants, U.W., Sea Grant Program WIS-SG-73-331, p. 1-21, illus.

The purpose of this study was to define the sedimentary regimes which interact in the nearshore zone of Lake Michigan, surrounding the Point Beach power plant near Two Creeks. Furthermore, the study hoped to determine the short term effects of the power plant upon the coastal sediments, and to provide a base line study which could be used in future years to evaluate the possible long-term effects.

Kowalke, O.L.; Kowalke, E.F. 1938. UW-ML
Topography of abandoned beach ridges at Ellison Bay, Door Co., Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 31, p. 547-553, illus.

The abandoned shore lines and beach ridges near the village of Ellison Bay, Wisconsin indicate that the waters of Green Bay and of Lake Michigan were once joined by the route of Rogers Lake, locally called Mink River.

Kowalke, O.L. 1947. UW-ML
Highest abandoned beach ridges in northern Door Co., Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 38, 1946, p. 293-298, illus., map.

A topographic survey in 1935 at Ellison Bay disclosed abandoned beach ridges at 588, 604, and 650 feet above sea level, whereas the water in Green Bay stood at 578 feet. Consideration of the locations of those beach ridges at the 650 foot level, or Algonquin stage, together with other topographical features, indicated that at one time there were islands where there is now consolidated land.

Kowalke, O.L. 1952. UW-ML
Location of drumlins in the town of Liberty Grove, Door Co., Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 41, p. 15-16, map.

The author describes the location of drumlins in the Town of Liverty Grove, Door Co., Wisconsin.

Krumbein, W.C.; Griffith, J.S. 1938. UW-GL
Beach environment in Little Sister Bay, Wisconsin: G.S.A., Bull. v. 49, no. 4, p. 629-652, illus., maps; (abs.) G.S.A., Proc., 1936, p. 84, 1937.

Headbands of Niagara limestone occur along both sides of Little Sister Bay, Wisconsin. Water-level outcrops yield small angular blocks by cracking along joints and bedding planes. Wave-action and ice-shove move these blocks along the shore into the bay,

reducing them in size and wearing off the corners. The bay has a pebbly beach composed almost entirely of remarkably rounded limestone pebbles.

The detailed maps of pebble variation show that the degree of variation and the complexity of the sediments are perhaps more pronounced than has usually been assumed in beach deposits. In addition, the influence of ice-shove is brought out by several sharp breaks in the contours, which clearly shows the effect of this process on the equilibrium between wave-action and pebble distribution.

Landon, R.E. 1930. UW-GL
An analysis of beach-pebble abrasion and transportation: Jour. Geol., v. 38, no. 5, p. 437-446, illus.

On the west shore of Lake Michigan between Racine, Wisconsin, and Waukegan, Illinois, beach pebbles derived entirely from a cliff of glacial till at Racine travel southward. The pebbles in the till are angular. At a point seven miles south the pebbles are spheroidal. From this point southward the beach pebbles are progressively flatter. This difference in shape is attributed to two processes, namely wear and selective transportation. It is proved that angular pebbles become round, and round pebbles become flat. By laboratory experiments it is shown that flat pebbles travel more readily by wave action than round pebbles because of differences in behavior due to differences in shape, and to the fact that round pebbles seek deeper water and are consequently more readily buried.

Lapham, I.A. 1847. UW-ML
On the existence of certain lacustrine deposits in the vicinity of the Great Lakes, usually confounded with the "drift": Am. Jour. Sci., v. 3 (2) p. 90-94, illus.

This article describes the occurrence and origin of red lacustrine clays in the Great Lakes region. These red clays are explained as the result of lake deposition following glaciation in the area.

Lapham, I.A. 1860.
Discovery of Devonian rocks near Milwaukee, Wisconsin: Acad. Sci., St. Louis, Trans., v. 1, p. 684; Am. Jour. Sci., v. 29 (2) p. 145.

Lasca, N.P. 1970. SGL
Pleistocene geology from Milwaukee to kettle interlobate moraine in Pleistocene geology of southern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Inf. Circ., no. 15 (part C) 14 p., illus.

This paper includes the description and discussion of the glacial geology at three stops along a transect from Milwaukee to the kettle interlobate moraine. Topics of discussion include the "red drift", the drift of the Lake Michigan glacial differences in the two tills, a Twocreekan Forest locality, and the kettle interlobate moraine.

Lasca, N.P. 1970. SGL
The drumlin field of southeastern Wisconsin in Pleistocene geology of southern Wisconsin: Wis. Geol. and Nat. Hist. Survey Inv. Circ., no. 15 (Part E) 13 p., illus.

The author describes the distribution and origin of the drumlin fields in southeastern Wisconsin. Sections of the paper deal specifically with distribution and orientation, structure and composition, origin, and till fabric of the drumlins in southeastern Wisconsin.

Lasca, N.P. 1970. SGL
The Pleistocene geology of southeastern Wisconsin; an introduction in Pleistocene geology of southern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Inf. Circ., no. 15 (part B) 7 p., map.

The Pleistocene deposits of southeastern Wisconsin are primarily Wisconsinan in age, although recent studies by Bleur report Illinoian and possible Kansan deposits further west in southern Wisconsin. The early Pleistocene history of the area is inferred from Bleuer's work and published studies done in the surrounding states.

Until recently the principal concerns of the glacial geologists in eastern Wisconsin were: (1) the Two Creeks forest bed and (2) the problems of the ancestral lakes of the Lake Michigan basin. Although Chamberlin discussed the Quaternary geology of eastern Wisconsin, it was left to Alden to map and interpret the glacial geology of southeastern Wisconsin. Since Alden's work, only a few specialized studies have been done, and no general mapping has been attempted.

League of Women Voters. 1974. SGL
Shoreline erosion: Lake Michigan Inter-League Group, 12 p., illus.

This report describes the formation of the Great Lakes, causes of erosion, erosion damage, erosion control methods, management techniques and planning procedures.

Lee, G.B.; Kanke, W.E.; Beaver, A.J. 1962. UW-ML
Particle-size analysis of Valders drift in eastern Wisconsin: Science, v. 138, no. 3537, p. 154-155, illus.

Analysis of the fraction of Late Wisconsin deposits less than 2 mm in diameter has shown a wide range in textural composition of glacial tills. Massive lake sediments were high in clay content and contained less sand than the till of the same textural class. Glacio-fluvial and eolian deposits were loamy to sandy and sandy, respectively.

Leighton, M.M.; Brophy, J.A. 1966.
Farmdale glaciation in northern Illinois and southern Wisconsin: Jour. Geol., v. 74, no. 4, p. 478-499, tables, illus.

Leith, C.K.; Lund, R.J.; Leith, A. 1935. UW-GL
Pre-Cambrian Rocks of the Lake Superior Region; a review of newly discovered geologic features with a revised geologic map: U.S.G.S., Prof. Paper 184, 34 p., illus., map.

Principal changes from the map accompanying monograph 52 are summarized, the most striking of which, aside from changes resulting from shifts in correlations, are found in Canada, northern Minnesota, and northern Wisconsin.

Leverett, F. 1889. UW-GL
The Illinois glacial lobe: U.S.G.S. Mon. 38, 817 p., illus., maps.

The Illinois glacial lobe formed the southwestern part of the great ice field that extended from the high lands east and south of Hudson Bay southward over the basins of the Great Lakes and the north-central states as far as the Mississippi Valley. It overlapped a previously glaciated region on the southwest, whose drift was derived from an ice field that moved southward from the central portion of Canada as far as the vicinity of the Missouri River. This southwestern part of the eastern ice field, being mainly within the limits of the State of Illinois, has received the name Illinois Glacial Lobe.

This early paper contains detailed chapters on physical features, glacial succession, drift extent, soils, ice thicknesses, glacial lake beaches, and drainage development associated with the Illinois Glacial Lobe.

Leverett, F. 1897. UW-GL
Pleistocene of Indiana and Michigan and the history of the Great Lakes: U.S.G.S., Mon. 53, p. 316-518, illus., map.

The basins of the Great Lakes were once valley with free drainage and not lakes, like the present Ohio Valley. The events that changed them into water-filled basins were apparently associated with the glacial epoch and are therefore of relatively recent data.

The preglacial history of the Great Lakes is the geologic history of the region. For convenience it may be divided into three stages, each dominantly characterized by a particular phase of development. The first was the stage of sedimentation or Paleozoic strata building - the constructional stage; the second was the epoch of land elevation, causing increase of altitude and starting erosion - the stage of emergence; and the third was the stage of erosion or valley making - the destructional stage.

Leverett, F. 1899. UW-ML
Raised beaches of Lake Michigan: Wis. Acad. Sci., Arts, and Letters, Trans., v. 7, p. 177-192.

Several raised beaches and sea cliffs exist around the head of Lake Michigan. The beach lines vary in number at different points, but around the head of the lake there seems to be three lines which are maintained distinctly for great distances.

Leverett, F. 1917. UW-ML
Glacial lakes and their correlative ice borders in the Superior basin (abs.): Mich. Acad. Sci., 19th Ann. Rpt. p. 101-102.

This paper deals only with the final recession of the ice from the Superior Basin, and from what appears to be the Port Huron morainic

system in that basin. There seems to have been considerable ice recession preceding the Port Huron readvance with a corresponding enlargement of glacial lakes in the basin as well as in the Huron and Michigan basins. The readvance overrode and completely obliterated the glacial lake in the western Superior basin. There was probably an interglacial lake in the Superior basin following the Illinoian glaciation.

Leverett, F. 1929. UW-GL
Moraines and shorelines of the Lake Superior region: U.S.G.S., Prof. Paper 154-A, p. 1-72, illus., map.

The area discussed in this report involves the entire northern peninsula of Michigan and the parts of northern Wisconsin and northeastern Minnesota that were covered by a readvance of the Superior lobe of theLabrador ice sheet late in the Wisconsin stage of glaciation.

Lineback, J.A. (and others). 1970. UW-GL
Preliminary stratigraphy of unconsolidated sediments from the southwestern part of Lake Michigan: Ill. State Geol. Survey, Environmental Geol. Notes no. 30, Studies of Lake Michigan Bottom Sediments no. 1, 20 p., illus.

This report describes lacustrine sediments cored at 4-mile intervals from 12 to 32 miles due east from Waukegon, Illinois. The cores illustrate a local stratigraphy for the unconsolidated sediments that floor the southwestern part of Lake Michigan. The sediment sequence includes, from the top, a few centimeters of sandy silty clay on the lake floor; 0.5 to 1.0 meter of dark gray silty clay alternating with thin black clay layers; 0.5 meter of brownish gray silty clay containing thin dark layers; 0.75 meter of orangish brown clay in which there is a traceable gray clay bed 0.15 meter thick; and a homogeneous, pink clay more than 1.0 meter thick that overlies glacial outwash and till. The black layers in the upper part of the cores have yielded a radiocarbon date of 6920 $\pm$ 200 years B.P.

Within the lacustrine sediments, grain size decreases with depth. Water content ranges from 100 percent to more than 200 percent of dry weight Illite, chlorite, Kaolinite, and expandable clay minerals are mixed throughout the cores, although expandables decrease downward and Kaolinite decreases upward.

Lineback, J.A. (and others). 1970. UW-GL
Stratigraphy of unconsolidated sediments in the southern part of Lake Michigan: Ill. State Geol. Survey, Environmental Geol. Notes no. 35, Studies of Lake Michigan Bottom Sediments no. 3, 35 p., illus.

Unconsolidated sediments of late Pleistocene age in southern Lake Michigan can be divided into two major lithologic units. The upper unit is dominantly lacustrine clay of high water content that is soft and variably fossiliferous. The lower unit consists of compact sand sediments of glacial origin.

Lineback, J.A. (and others). 1971. UW-GL
High-resolution seismic profiles and gravity cores of sediments in southern Lake Michigan: Ill. State Geol. Survey, Environmental Geol. Notes no. 47, Studies of Lake Michigan Bottom Sediments no. 8, 41 p., illus.

Seismic reflection combined with gravity coring were used as tools to correlate the stratigraphy of three main sedimentary units in the southern Lake Michigan Basin. The main sedimentary units recognized in most of the profiles were: lacustrine clays (Lake Michigan Formation), glacial deposits (Wedron Formation), and Paleozoic bedrock. Three separate episodes of sedimentation in the Lake Michigan Formation were also recognized.

Lineback, J.A.; Grass, D.L.; Meyer, R.P. 1972. UW-GL
Geologic cross sections derived from seismic profiles and sediment cores from southern Lake Michigan: Ill. State Geol. Survey, Environmental Geology Notes no. 54, Studies of Lake Michigan Bottom Sediments no. 9, 43 p., illus.

High-resolution seismic profiles and gravity cores of bottom sediments were used to construct 13 geologic cross sections of the major stratigraphic units of the Pleistocene and the surface of the underlying Paleozoic bedrock of southern Lake Michigan.

Cross sections in the northern part of southern Lake Michigan cross the Mid-Lake High. They show high relief on the bedrock surface, differentiate a thick glacial till and indicate that in this area the Lake Michigan Formation is confined to low spots on the lake floor. A north-south cross section of the area shows a thick terminal moraine-like accumulation of till south of Milwaukee that pinches out southward.

Cross sections across the central part of the southern lake basin show that the Lake Michigan Formation is thick in the deep central part of the basin and in a band along the eastern shore. Cross sections in the extreme southern part of the lake indicate the Lake Michigan Formation thins southward. They also show that the formation is thick along the eastern shore but absent in the southwestern corner of the lake.

Log descriptions are given for 608 gravite cores.

Lines, E.F. 1905. UW-GL
Well records in Fuller, M.L.; Veatch, A.C., Record of deep well drilling for 1904: U.S.G.S. Bull. 264, p. 76.

Location, owner, and contractor are cited for deep wells drilled during 1904 in Brown and Racine Counties.

Loy, W.G. 1962.
The coastal geomorphology of western Lake Superior: Unpublished M.S. Thesis, University of Chicago.

Loy, W.G. 1963. UW-Geog
The evolution of bay-head bars in western Lake Superior: Great Lakes Res. Div., pub no. 10, p. 150-157, illus.

Stretching across the head of western Lake Superior are two parallel bay-head sand bars, both bisected by the St. Louis River. The inner pair of points are referred to as Rice's and Conner's and the outer set, which make up the longest fresh water bar in the world, as Minnesota and Wisconsin Points. The 85-89% quartz sand for these bars was derived primarily from wave disintegration of till bluffs which contain 4-8% sand to the east along the south shore. It was moved to the lakehead by beach drifting. Accretion of dredgings has added a 100 to 200 foot wide sand bench to the face of Minnesota Point.

Loy, W.G. 1963. UW-ML
The formation of the Duluth-Superior harbor: Minn. Acad. Sci., Proc., v. 31, no. 1, p. 28-35, illus.

This paper discusses some of the theories pertaining to the development of the Duluth-Superior harbor. The author suggests that the two parallel bay-mouth bars were formed of sand derived from and drifted along the south shore. Prograding wave action shaped this material into sand spits and, finally, above water bars.

Lukowicz, L.J. 1972. UW-GL
Nearshore sedimentary structures off Terry Andrae-Kohler State Park, Wisconsin (Western Lake Michigan((abs.): G.S.A., Abs. with Programs, v. 4, no. 5, p. 334.

Four sets of fathometer profiles of longshore bar and trough topography in western Lake Michigan of Terry Andrae-Kohler State Park, Wisconsin, were made during the interval between June 10, 1968 and August 19, 1969. The bar and trough topography extends lakeward a maximum of 1,100 feet and is located in water depths ranging from 2 to 15 feet. The number of longshore bars present in the breaker zone varied from 1 to 4 but averaged 2.

Sediment in the longshore bar and trough zone consists of very well-sorted, medium to fine-grained sand primarily composed of quartz and dolomite. The external geometry of the sand body as determined by refraction seismograph profiles and coring is wedge shaped in cross-section, attaining a maximum thickness of 30 to 35 feet on shore and lensing out lakeward at a water depth of about 35 feet.

The profiles show that the average position of the bars and troughs is relatively stable with respect to distance from the swash line. However, violent wave action associated with storms in spring produced small crest-to-crest distance, greatest crest-to-trough relief, and narrow width across the crests of the bars. Decreasing wave action in late summer resultes in greatest crest-to-crest width, least crest-to-trough relief, and greatest width across the crests of the bars.

Maher, L.J., Jr. 1970. SGL
Two Creeks Forest, Valders glaciation, and pollen grains in Pleistocene geology of southern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Inf. Circ. no. 15 (Part D) 8 p., illus.

Few Pleistocene sites in the United States have acquired more prominence in the geological literature than Two Creeks. At the type site and at numerous other localities in the Green Bay-Fox River Lowland, organic materials found beneath the till provide undoubted evidence of an ice border fluctuation of considerable distance. The Twocreekan Substage is now given a major position in the Wisconsin Stage.

Marsden, R.W. 1955. UW-GL
Precambrian correlations in the Lake Superior region in Michigan, Wisconsin, and Minnesota in Derry, D.R., Symposium on Precambrian correlations and dating: Geol. Assoc. Canada, Proc., v. 7, pt. 2, p. 107-116.

Correlations of Precambrian rocks in Michigan, Wisconsin, and Minnesota have been modified to conform with results of recent work. The recognition of sedimentary facies changes in Huronian rocks of the Marquette Range seems to require changes in the correlation of these formations. A revised sequence for the Marquette Range is proposed in which the Palmer Series is classed as Lower Huronian and the Mesnard formation as basal Middle Huronian. A period of orogeny followed by extensive erosion is indicated between Lower and Middle Huronian rocks. Results of accessory mineral studies support this correlation and show a similar occurrence and relationship throughout the South Shore Region and eastward into the Huronian rocks north of Lake Huron.

Martin, L. 1911. UW-GL
Physical geography of the Lake Superior region in The geology of the Lake Superior region: U.S.G.S., Mon. 52, p. 91-117.

This early article contains detailed descriptions of the physical geography of the Lake Superior Region. The area is divided into three broad physiographic provinces: uplands, lowlands, and lake basin.

Martin, L. 1911. UW-GL
The Pleistocene of the Lake Superior region in Van Hise and Leith, The geology of the Lake Superior region: U.S.G.S., Mon. 52., p. 427-459.

A generalized Pleistocene history of the Great Lakes region is presented. The region is divided into four areas: driftless area, area of older drift, area of last drift, and areas of glacial lake deposits.

Martin, L. 1932. SGL
The physical geography of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 36 (ed. ser. 4) 608 p., illus., maps.

The author summarizes the physical geography of Wisconsin by the discussion of five natural regions. Regions pertinent to Wisconsin's Great Lakes shorelines include the Lake Superior lowland and the eastern ridges and lowlands.

Mathieson, J.T. 1940.
The Pleistocene of part of northwestern Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 32, p. 251-272, illus.

Mattis, A.F. 1971. UW-GL
Lower Keweenawan sediments of the Lake Superior region *in* Inst. Lake Superior Geology, 17th Ann., 1971, Abs. and Field Guides: Duluth, Minn., Univ. Minn., p. 44-46.

Exposures of lower Keweenawan sediments along both limbs of the Lake Superior Syncline suggest the deposition of a thin sheet of sediment throughout the region. The cross-bedded, ripple-marked, well-sorted, quartz-rich sediment composed of well rounded grains suggests a shallow water environment. Cross-bedding, ripple mark, and parting lineation measurements in these sedimentary rocks indicate a general southerly direction of sediment transport, with the sediments being derived from the Pre-Keewenawan rocks to the north. Thus these Lower Keweenawan sediments were probably deposited during the northward transgression of a sea into the region and were apparently the final sediment deposited in the Lake Superior region prior to formation of the Lake Superior Syncline.

Mattis, A.F. 1972. UW-GL
Correlation of Lower Keweenawan sandstones of the Lake Superior region (abs.): G.S.A., Abs. with Programs, v. 4, no. 5, p. 336.

The Sioux, Baraboo, Barron, Ruckwunge, and Sibley Formations were deposited during a northward marine transgression in a shallow-water, near shore, tectonically stable environment before the outbreak of Keweenawan igneous activity in their depositional areas, whereas deposition of the time-equivalent Bessemer Formation was interrupted by extrusion of the Keweenawan lavas.

Mengel, J.T., Jr. 1970. UW-Sup
Geology of the western Lake Superior region: a guide book for visitors: U.W., Superior, Geology Dept., 86 p., illus.

This guide book summarizes the geology of western Lake Superior. Specific sections of the report are concerned with the bedrock record, the glacial and post-glacial record, Lake Superior, South Shore geology and North Shore geology.

Mengel, J.T., Jr. 1971. UW-Sup
Geology of the Twin Ports Area, Superior-Duluth *in* Tri-State Geological Field Conference, 35th Ann., Guidebook; Wis. State Univ.-Superior, Dept. Geology, 82 p., illus., maps.

This field trip log is intended to serve as an introduction to the geology of the Twin Ports area which is part of a basement rigt system correlative with the Mid-Continent Gravity High. The larger structure consists of a thick sequence of basaltic lava flows cut by high angle faults into steep-sided blocks, adjacent to which, or above lie a thick sequence of red clastic rocks. Lake Superior occupies a basin eroded into these red clastics.

The report examines the geologic setting of the Middle Precambrian, Late Precambrian and Quaternary of the area.

Mengel, J.T., Jr. 1972. UW-GL
Subsurface geology of the Duluth-Superior area, Minn.-Wis. (abs.) in Lake Superior Geology, 18th Ann., 1972, Agenda and abstracts: Houghton, Mich., Michigan Tech. Univ., pt. 1, paper 14, 4 p.

Study of about 300 bore hole records indicates that the Quaternary succession in the western end of the Superior lowland consists of glacial, lake, and river deposits which record stages in the development of Lake Superior which are not presently evident in the high-level shore around the rim of the basin to the west or in deeper water lake deposits to the east. Preliminary interpretation of the sequence suggests two times of deep water red clay accumulation separated by a low water stage during which sands and gravels were laid down across an unconformity. A prominent boulder bed overlies the youngest red clay deposit, suggesting a late pulse of ice development during about Nippissing time.

Meyer, R.P.; Moore, J.R. 1969. UW-GL
Progress report on the geological-geophysical survey of Green Bay, 1968: U.W., Sea Grant Program, Tech. Rpt. 1, p. 1-16.

A progress report on the geological-geophysical survey of Green Bay. Precision acoustic profiling indicates significant depositional increases in lower Green Bay since 1950, suggesting enhanced eutrophication. Depositional increases exceed four feet in some locations.

Michigan Basin Geological Society. 1960. UW-GL
Lower Paleozoic and Pleistocene stratigraphy across central Wisconsin, annual field excursion, May 1960: Ann Arbor, Mich., guidebook, 34 p., map.

The main objective of this field trip log is to study the Lower Paleozoic and Pleistocene geology along a transect from Prairie du Chien to Two Creeks. Discussion of the geology at 19 stops is included.

Mickelson, D.M. 1973. UW-GL
Glacial stratigraphy of the Two Rivers lowland, Wisconsin: Midwest Friends of the Pleistocene, 22nd Ann. Field Conf., 6 p.

A sequence of glacially-related events is suggested in the Two Rivers lowland. (1) The deposition of pink to purple-gray, fine grained till. (2) Deposition of 2-6 m. of laminated lacustrine silts and clays. (3) Development of a drainage net on lake sediments and downcutting of streams at least to their present levels. (4) Deposition of red clayey till over lake sediment. (5) Deposition of sand locally on the red till.

Mickelson, D.M.; Evenson, E.B. 1974. SGL

Large scale involutions (convolutions?-pots?) in red till in the Manitowoc-Two Rivers-Two Creeks area of Wisconsin-Periglacial features or load structures in Late Quaternary Environments of Wisconsin: Amer. Quat. Assoc., Third Biennial Meeting, field guide, p. 182-187.

Numerous large involutions were observed in freshly exposed sections along the lake bluff between Manitowoc and Two Creeks, Wisconsin. Two typical, but particularly well developed and well exposed features are described in this paper. They are located approximately 180 meters north of the Manitowoc-Kewaunee County line, just north of the type Two Creeks forest bed.

Moerlin, G.A. 1963. UW-GL

Structure and stratigraphy of the upper Keweenawan rocks in northwestern Wisconsin (abs.) in Inst. Lake Superior Geol., 9th Ann., 1963: Duluth, Minn., Univ. Minn., Dept. Geology, p. 8.

Between the summer of 1955 and winter of 1960, Bear Creek Mining Company explored the western tip of the Lake Superior Syncline in quest of possible copper-bearing Nonesuch formation. The area covered includes portions of Ashland, Bayfield, Douglas, Washburn, and Burnett Counties, Wisconsin. Field mapping, extensive magnetic and gravity surveys, some refraction seismic work, and diamond drilling each played a part in outlining the geology of the area.

The normal sequence of Keweenawan sediments, Copper Harbour, Nonesuch, and Freda formations was recognized.

Moore, J.R.; Meyer, R.P.; Morgan, C.L. 1973. UW-GL

Investigation of the sediments and potential manganese nodule resources of Green Bay, Wisconsin, U.W., Sea Grant Program, Tech. Rpt. WIS-SG-73-218, 144 p., illus.

During the period of June 1968 to August 1972, with Sea Grant support, staff personnel of the University of Wisconsin conducted a comprehensive survey of the sediments, sub-lake geological structures and manganese nodule resources of Green Bay, Wisconsin. The objectives of the investigation were largely confined to mapping and assessing the sediments and manganese mineral resources, to determine sub-lake structures of concern to engineering development or source of metals, to characterizing the polluted muds and their sources, and to provide an environmental base line.

Murphy, W.G.; Heim, G.E., Jr. 1968. UW-GL

Slope stability problems, Lake Michigan bluff, Milwaukee, Wisconsin (abs.): G.S.A., Sp. Paper 101, p. 148.

Stability of the 100-foot high Lake Michigan bluff in the vicinity of Milwaukee, Wisconsin, has been a problem for many years. More than 100 years of records indicate that the yearly loss of ground ranges from less than 1 foot to 3 feet. The instability is commonly attributed to wave erosion. Geological studies indicate that the stratigraphic sequence and groundwater conditions are the primary factors causing slides in the mid-bluff area. Instability is greater in the spring.

Murray, R.C. 1953. UW-GL
The petrology of the Cary and Valders tills of northeastern Wisconsin: Am. Jour. Sci., v. 251, no. 1, p. 140-155, illus.

The Cary and Valders tills in northeastern Wisconsin are described mineralogically and various grain size accumulation curves are reported. The Valders tills in this area is shown to be finer textured and more calcareous than the earlier Cary till. The heavy mineral assemblages of the two tills, however, are essentially identical. The name glacial Lake Keweenaw is here proposed for the glacial lake held in the Lake Superior basin by the Cary ice. The Valders till is thought to represent the deposits of glacial Lake Chicago which were removed and redeposited by the Valders ice. The red color is believed to have been imparted by these lake sediments and hence to the later Valders till by the transfer of fine red clastics from glacial Lake Keweenaw to Lake Chicago prior to the advance of the Valders ice.

Myers, W.D., II. 1971. UW-GL
The sedimentology and tectonic significance of the Bayfield Group, Wisconsin and Minnesota (abs.) in Inst. Lake Superior Geology, 17th Ann., 1971, Abs. and Field Guides: Duluth, Minn., Univ. Minn., p. 54-55.

A study of the mineralogical and physical characteristics of the Bayfield Group was made to determine (1) depositional environment, paleogeography, and source terrane during Bayfield time, (2) the nature of the contact of the Bayfield Group with the older Oronto Group, and (3) the early history of the Douglas fault.

Nelson, K.G.; Lasca, N.P. 1970. UW-GL
Milwaukee, its geological setting: Geotimes, v. 15, no. 8, p. 12-18, illus.; (abs.) Abs. North Am. Geol., p. 978, June 1971.

Milwaukee, site of the Geological Society of America, 1970 meetings, offers a setting on Lake Michigan, Pleistocene glacial topography, Paleozoic exposures, and variable character and thickness of surficial deposits creating erosion and foundation problems. The wide Menomonee Valley was once a glacial spillway. Bedrock is masked by glacial, fluvial, and lacustrine deposits, but the underlying rocks determined movement of Pleistocene ice. Beds dip east and southeast, and erosion has formed a series of north-south ridges. The Wisconsin ice sheet divided into the Lake Michigan and Green Bay lobes as it crossed the Niagara escarpment, large quantities of drift were deposited. Thicknesses of Pleistocene sediments in the Milwaukee area range from a few inches to 400 feet, causing foundation problems. Principal aquifers are the Cambrian-Ordivician beds, Niagara Dolomite, and Pleistocene sands and gravels.

Newberry, J.S. 1865.
Notes on the surface geology of the basin of the Great Lakes: Boston Soc. Nat. Hist., Proc., v. 9, p. 42-46.

Painter, W.T. 1973. SGL
Problems of Great Lakes shore erosion: paper presented at First World Congress on Water Resources, Chicago, Illinois, September 1973, 21 p., illus.

This paper gives guidelines for lakeshore stabilization and reviews pertinent aspects of geology, soil mechanics, groundwater flow, and slope stability analysis which are fundamental to planning remedial measures. Some stabilization procedures which the author is using in Milwaukee on the Lake Michigan shore are reviewed and discussed.

Peterson, G.W.; Lee, G.B.; Chesters, G. 1968. UW-ML
A comparison of red clay glacio-lacustrine sediments in northern and eastern Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans. 1967-1968, v. 56, p. 185-196, illus., tables; (abs.) Abs. North Am. Geol., p. 1849, Dec., 1968, Geographical Abs. (A) 1969, v. 6, p. 548.

Selected red, clayey, glacio-lacustrine sediments from the southern shores of Lake Superior in northern Wisconsin and from the Fox and Wolf river drainage basins in eastern Wisconsin were compared because field observations suggested that a similarity exists between these sediments, and also between the soils formed from them.

Close similarities were found in the particle size distribution of the carbonate-free clay fraction, supporting the theory that the finer fractions of these sediments in both areas were derived from a common source and were deposited in a similar manner. The source of the noncarbonate clay fraction is most likely the Lake Superior basin which is believed to have discharged fine-grained sediments into the Lake Michigan basin during the retreat of Cary ice. Differences between the sand, silt, carbonate, iron oxide, and feldspar contents of the sediments from the two areas are likely due to the influence of local bedrock and earlier drift. The lower carbonate content of deposits in northern Wisconsin may account for the greater leaching depth and degree of podzolization observed in these soils.

Piette, C.R. 1963. UW-ML
Geology of Duck Creek Ridges, East Central Wisconsin: M.S. Thesis, U.W., Madison, 87 p., illus., maps.

The Duck Creek Ridges, located in Brown and Outgamie Counties, are twin crevasse fills oriented northeast-southwest, parallel to ice advance in the area. The main ridge lies on the southeast side of Duck Creek; the other lies on the northwest side. Both ridges decrease in elevation toward the northeast as the region also decreases. They generally vary between 20 and 60 feet in height above the surrounding countryside.

Powers, W.E. 1958. SGL

Final report on the geomorphology of the Lake Michigan shoreline: Office of Naval Research, Contract no. Nonr-1228(07), Project no. NR-387-015, 103 p., illus., maps.

This project was initiated with four objectives in mind. Specifically, the objectives are: (1) to identify the diverse shoreline features of Lake Michigan, (2) to appraise and measure shore developments now going on, including the total past changes due to such processes, (3) to summarize and present in appropriate reports information on shore features and processes so that future changes can be anticipated, and (4) to develop methods of applying the findings concerning the Lake Michigan shoreline to an understanding of the shores of large inland lakes in other parts of the world.

Quimby, G.I. 1958.

Fluted points and geochronology of the Lake Michigan basin (Mich.-Wis.): Am. Antiquity, v. 23, no. 3, p. 247-254, illus.

Raasch, G.O. 1935.

Devonian of Wisconsin: Kan. Geol. Soc., 9th Ann. Field Conf., Guidebook, p. 261-267, illus.

Read, W.F.; Weis, L.W. 1962. UW-GL

Northeastern Wisconsin: Tri-State Geological Field Conference, 26th Ann., Guidebook, Appleton, Wis., Lawrence College, 22 p., map.

This guidebook presents a field tour log of the general geology of northeastern Wisconsin. The McCaslin syncline and the Tigerton anorthosite are described in some detail.

Red Clay Inter-Agency Committee. 1972. WRC

Erosion and sedimentation in the Lake Superior basin: Wisconsin Red Clay Inter-Agency Committee, 81 p., illus.

The sediment problems of the Lake Superior Basin result from natural forces and from man-made changes in the physical system. This area covers 1,975,640 acres of land located in Ashland, Bayfield, Douglas and Iron Counties.

The red clays form a plain sloping imperceptibly northward. Post glacial streams, generally draining north, have cut deep, steep-sided gullies and created a characteristic ridge and valley topography.

Sections of this report deal specifically with agricultural lands, highways, Lake Superior shoreland, stream banks, forest lands, recreation, urban and industrial development, and recommendations.

Ries, H. 1903. UW-GL
The clays of the United States east of the Mississippi River: U.S.G.S., Prof. Paper 11 (A, econ. geol. ser. 21; B, descriptive geol. ser. 24), p. 67, 262-267, maps.

A general discussion of the clay deposits of Wisconsin is presented. The Pleistocene clays of the state are grouped as follows: (1) Lacustrine deposits; (2) stream deposits; (3) estuarine deposits; (4) glacial clays. The location of these clay deposits as well as their chemical analysis are presented.

Ries, H. 1906. UW-GL
The clays of Wisconsin and their uses: Wis. Geol. and Nat. Hist. Survey, Bull. 15, (econ. ser. 10) 258 p., illus., map.

This publication discusses the origin, mineralogy, and uses of Wisconsin's clay deposits. Mineralogy and physical properties are discussed with regard to specific localities around the state.

Rominger, C.L. 1862.
True position of the so-called Waukesha limestone of Wisconsin: Am. Jour. Sci., v. 34 (2), p. 136.

Savage, T.E. 1916. UW-GL
Alexandrian rocks of northeastern Illinois and eastern Wisconsin: G.S.A., Bull., v. 27, p. 305-324.

The Silurian rocks of northeastern Illinois and eastern Wisconsin occur over a belt 350 miles long and from 20 or less to 50 miles wide, extending from below Kankakee, Illinois, northward to the extremity of Green Bay Peninsula, in Wisconsin. This area is on the east side of the La Salle anticline and the highland of central Wisconsin, away from which the strata dip gently toward the east; so that the older Silurian rocks reach the surface at intervals only along the west border.

Schwartz, G.M.; Theil, G.A. 1954. UW-GL
Geology of the Duluth Metropolitan Area: Minn. Geol. Survey, Bull. 33, 136 p., illus., map.

The author describes the geology of the Duluth Metropolitan Area. Chapters include discussion of the following topics: general features of the region, economic geography, description of the formations, geologic structure of the Duluth Area, origin of Lake Superior, geologic history of the region, geology of the City of Duluth, township descriptions, and economic geology.

Shepard, F.P. 1937. UW-GL
Origin of the Great Lakes basins: Jour. Geol., v. 45, no. 1, p. 76-88, maps. Smithsonian Inst., Ann. Rpt. 1937, pub. 3451, p. 269-277, maps, 1938; (abs.) Ill. State Acad. Sci., Trans., v. 25, no. 4, p. 152, 1933.

Attention is called to a growing tendency to overlook the hypothesis of glacial excavation as the primary cause of the Great Lakes. Alternate hypothesis, particularly diastrophism, are compared with the glacial hypothesis and it is concluded that the evidence is much more favorable to glaciation. Points favoring glacial erosion include: the great depths of the basins, the finding of similar basins widespread over other glaciated areas, the absence of any evidence of recent diastrophism in the vicinity except that owing to isostatic recoil following deglaciation, the similarity of the basins to other features which are clearly the result of glaciation, and the thickness of the drift to the south of the Great Lakes.

Shrock, R.R. 1939. UW-GL

Geological aspects of Washington Island, Wisconsin (abs.): G.S.A., Bull., v. 50, no. 12, pt. 2, p. 2009-2010.

Washington Island is the largest of the islands strung across the entrance to Green Bay and is important geologically because it is a connecting link between Door Peninsula of the Wisconsin mainland and the Garden Peninsula of Michigan. The island is a southeasterly sloping tabular mass of Silurian dolomite rising some 300 feet above a foundation of Ordovician (Richmond) shale and having an area of about 23 square miles. The strata, constituting a succession over 300 feet thick, belong to the Mayville, Burnt Bluff (Byron and Hendricks dolomites), Manistique (Schoolcraft and Cordell dolomites), and Racine formations (in ascending order), and dip southeasterly 25 to 35 feet per mile. The Niagara Escarpment is conspicuous along the western edge of the island where it has a height of about 300 feet. The upper half of the precipitous cliff rises above the waters of Green Bay; the lower half extends below water and is well known on bathymetric maps of the bay.

The island was sculptured into a sloping tableland before being overridden by the Pleistocene glaciers. It was almost completely covered by the waters of the glacial Lake Algonquin and today is still about half submerged beneath Green Bay and Lake Michigan. Prominent wave-cut benches and caves and wave-built beach ridges of cobbles and roundstones are well developed at numerous places. These mark four prominent water planes: Lake Algonquin levels at 680 to 670, 650, and 630 feet above sea level, Lake Nipissing at 600 feet. The mean elevation of Lake Michigan is 580± feet, and benches and cobble ridges are now developing at that general level.

Shrock, R.R. 1940. UW-ML

Geology of Washington Island and its neighbors, Door Co., Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 32, p. 199-227, illus., maps.

This report deals exclusively with the islands south of the Wisconsin-Michigan boundary in Door County. The bedrock geology of the islands consists entirely of the Silurian system except for gravels, sands, and silts that are of Pleistocene age. The geologic setting of Washington, Rock, Plum, Pilot, Detroit, and Fish Islands are described in detail.

Shrock, R.R. 1953. UW-GL
Silurian geology of Wisconsin (abs.): G.S.A., Proc., 1934, p. 107-108.

Wisconsin Silurian consists of the following lithologic units in ascending order: (1) Mayville, massively-bedded, cherty, fossiliferous dolomite, 60-90 feet thick; (2) Byron, thin-bedded, mud-cracked and ripple-marked, slightly fossiliferous dolomite, approximately 100 feet thick; (3) Coral beds, consisting of thin and irregularly-bedded, somewhat cherty coralline dolomite, 150 feet or more thick; (4) Waukesha, thin-bedded, unfossiliferous, somewhat cherty dolomite, thought to represent the southern lateral equivalent of (2) and (3), 25 feet or more thick; (5) Racine-Guelph massively-bedded, dense to granular, fossiliferous dolomite, approximately 100 feet thick; (6) Waubakee, poorly exposed, thin bedded dolomite with few fossils, 10 feet thick.

Smith, M.C. 1947.
Copper deposits of Douglas Co., Wisconsin in: U.S. Bureau of Mines, Rpt. Inv. 4088, 7 p., illus.

Sommers, L.H.; Josephson, P.D. 1968. UW-GL
Bottom sediments of southwestern Lake Michigan: Inter. Assoc., Great Lakes Res., 11th Conf. Great Lakes Research, Proc., p. 245-252, illus., tables.

As a part of a comprehensive study of Lake Michigan, 256 surficial sediment samples systematically collected in southwestern Lake Michigan were quantitatively studied to determine variation of textural properties with relation to depth, distance from shore and lake bottom topography. Samples were described or classified in the field and later examined in the laboratory under a microscope. The samples were analyzed by both standard sieve and hydrometer techniques. Size frequency distribution was determined, and measures of central tendency, dispersion, and skewness were calculated, sand, silt, and clay percentages are given.

In the area of study there is a variable assemblage of sediments. In general, bottom sands north of the Chicago area become coarser as the water depth and distance from shore increase.

Spencer, J.W. 1891. UW-GL
Origin of the basins of the Great Lakes of America: Am. Geologist, v. 7, p. 86-97.

The valleys of the Great Lakes are the result of the erosion of the land-surfaces by the ancient St. Lawrence River and its tributaries, during the long period of continental elevation, until the streams had reached their baselines of erosion, and the meteoric agents had broadened the valleys. This condition was at a maximum just before the Pleistocene period.

The closing of portions of the old Laurentian valley into water basins occurred during and particularly at the close of the Pleistocene period due, in part, to drift filling some portions of the original valley, but more especially to terrestrial warping of the earth's crust, which is measureable to some degree.

Spencer, J.W. 1894. UW-GL

Review of the history of the Great Lakes: Am. Geologist, v. 14, p. 289-301, illus.

The author presents a brief review of the history of the Great Lakes. Buried valleys, basin glaciation, drainage pattern changes, and former lake levels are described.

Steidtmann, E. 1924. UW-GL

Limestones and marls of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 66 (econ. ser. 22), 208 p., illus., map.

The author describes in general the origin of carbonate rocks and the general geology of Wisconsin. A detailed discussion of the carbonate rocks of the state is presented by county.

Sweet, E.T. 1878. SGL

Report on Douglas and Bayfield Counties: Wis. Geol. and Nat. Hist. Survey, Ann. Rpt., 1877, p. 4-9.

The author describes the general geology of Douglas and Bayfield Counties as examined during a summer field trip in 1877.

Sweet, E.T. 1880. UW-GL

Geology of the western Lake Superior district in Geology of Wisconsin: Wis. Geol. Survey, v. 3, pt. 5, p. 303-362, illus., maps.

This early paper discusses in detail the bedrock geology of the western Lake Superior region. The topography, glacial geology, and hydrology of the region are also briefly examined.

Taylor, F.B. 1894. UW-GL

A reconnaissance of the abandoned shore lines of Green Bay: Am. Geologist, v. 13, p. 317-327.

The highest abandoned beach along the Green Bay coast has an elevation of about 170 feet above Lake Michigan. The highest shore line constitutes an absolute criteria for determination of the amount of change in land attitude.

Taylor, F.B. 1894. UW-GL

A reconnaissance of the abandoned shore lines of the south coast of Lake Superior: Am. Geologist, v. 13, p. 365-383, map.

Two strongly developed abandoned shorelines were recognized along the south shore of Lake Superior. The highest extends from Duluth to Marquette and ranges between 535 to 590 feet above Lake Superior. The lower beach exists at an elevation of about 50 feet above Lake Superior.

Taylor, F.B. 1915. UW-GL

History of the Great Lakes: U.S.G.S., Mon. 53, p. 231, 326-328, 431, 459, 509, 510, illus.

This publication presents a detailed outline of the glacial and postglacial history of the Great Lakes region. A general discussion of the glacial lake levels and their associated beaches in the Michigan and Superior Basins is presented.

Teller, E.E. 1900. UW-ML

The Hamilton formation at Milwaukee, Wisconsin: Wis. Nat. Hist. Soc., Bull., v. 1, (n.s.) p. 47-56, illus.

The geological formation exposed in the quarries of the Milwaukee Cement Company, belongs to that period known as the Hamilton, and is part of the Devonian Age. This compact fossiliferous limestone is clearly identified by its fossils.

Thwaites, F.T. 1911. SGL

Geologic map of the west end of Lake Superior: Wis. Geol. and Nat. Hist. Survey, scale 1 in.: 3 miles.

This map depicts the bedrock geology of parts of northern Wisconsin, Upper Michigan and northeastern Minnesota.

Thwaites, F.T. 1912. UW-GL

Sandstones of the Wisconsin coast of Lake Superior: *Wis. Geol. and* Nat. Hist. Survey, Bull. 25 (sci. ser. 8), 117 p., illus., map.

The sandstones and shales of the Wisconsin coast of Lake Superior comprise an enormous thickness of sediments amounting possibly to 25,000 feet. In composition they show a progressive change, with minor alterations, from sediments composed of poorly sorted and almost unaltered fragments of igneous rocks, to dominantly siliceous sandstone, which represents a marked degree of weathering and sorting of original material.

Thwaites, F.T. 1923. UW-GL

The Paleozoic rocks found in deep wells in Wisconsin and northern Illinois: Jour. Geol., v. 31, no. 7, p. 529-555, illus.; (abs.) G.S.A., Bull., v. 34, no. 1, p. 73.

This paper discusses the formations in deep wells from the lithologic standpoint only. References to published material on the paleontology are given. The formation names given to the subdivisions of the Cambrian by Ulrich are defined. Brief notes are given on the surface exposures of the formations. All formations from the Devonian down to the Precambrian are discussed, with special emphasis on the water-bearing Cambrian. The methods by which the deeply covered formations were correlated with those in central Wisconsin are explained in detail. Several cross-sections illustrate the paper.

Thwaites, F.T. 1935. UW-GL
Sublacustrine topographic map of the bottom of Lake Superior: Kan. Geol. Soc., Guidebook, 9th Ann. Field conf., p. 226-228, map.

A map is presented showing the sublacustrine topography of Lake Superior. In addition the general geology of the Lake Superior region is described.

Thwaites, F.T. 1937. UW-GL
Pleistocene of part of northeastern Wisconsin (abs.): G.S.A., Proc., 1937, p. 108-109.

The report treats the Pleistocene deposits first as sediments and second as land forms. Both criteria were employed in much of the district which embraces that portion of the Green Bay Lobe in Wisconsin west of Lake Winnebago, Fox River, and Green Bay north of the area surveyed by Alden, the forest and brush cover prevents this ideal.

Drift of the pre-Wisconsin age occurs in the western part of the district and is thought to be Illinoian age. The Wisconsin drift consists of deposits made during the Third or Cary substage overlain in much of the district by drift of the Fourth substage without much alteration of an older topography. A marked change of ice direction between the two substages is noted.

Thwaites, F.T. 1940. UW-ML
Buried pre-Cambrian of Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 32, p. 233-242, illus., map.

This article presents and describes a contour map of the surface of the buried pre-Cambrian of Wisconsin.

Thwaites, F.T. 1943. UW-GL
Pleistocene of part of northeastern Wisconsin: G.S.A., Bull. v. 54, no. 1, p. 87-144, illus., maps.

The portion of northeastern Wisconsin discussed comprises that portion of the Green Bay lobe which lies north of the district described by Allen, west of Lake Winnebago, Fox River, and Green Bay, and a portion of the Langlade lobe to the northwest. Outside of the drift which is bordered by the terminal moraine, long recognized as of Wisconsin age, is a thin, patchy drift almost devoid of glacial topography. Although this drift has long been called "old" or "pre-Wisconsin" it is now thought that most, if not all, the extramorainic deposits are Iowan, although some may be Illinoian.

Thwaites, F.T. 1949. UW-ML
Geomorphology of the basin of Lake Michigan: Mich. Acad. Sci., Arts and Letters, Papers, v. 33, p. 243-251, map.

The form of the basin of Lake Michigan seems to support very strongly the hypothesis that glacial erosion was a very important process in its formation. The vast amount of bedrock removed may be due both to erosion of the breccias, which resulted from Devonian wolution, and to direct ice erosion of undisturbed strata. The slopes toward the east and southeast are recognized as dip slopes of cuestas, and those to the west and northwest as escarpments. But the great depth, the irregular bottom, and the relation of the basins to thin-bedded strata, soluble materials, and to solution brecciation are the dominant evidences of glacial excavation on a grand scale.

Thwaites, F.T. 1953. UW-GL
Northeastern Wisconsin: Friends of the Pleistocene, Upper Midwest Div., 4th Ann., Field Guide, 26 p., illus., maps.

This book served as a field guide for the 1953 field trip on the Pleistocene of northeastern Wisconsin. Stop locations and descriptions are cited.

Thwaites, F.T.; Bertrand, K.J. 1957. UW-GL
Pleistocene geology of Door Peninsula, Wiconsin: G.S.A., Bull., v. 68, no. 7, p. 831-879, illus., maps.

The area described completes the detailed mapping of the glacial geology of the Green Bay lobe. The drift belongs to two substages of the Wisconsin stage of glaciation. The major topographic features due to glaciation are the result of the Cary substage. Above this drift lies a till of a later substage, tentatively named Valders because its relation to the Mankato drift of Minnesota is unknown. Separating the two drifts is the Forest Bed which indicates a retreat of the ice margin far enough to free from ice both the straits of Mackinac and the entire St. Lawrence Valley. The advance of the Valders ice buried the Two Creeks Forest Bed with lake deposits formed in front of the ice. The age of this deposit by dating is about 11,400 years. The Valders till is red and is high in clay and silt because the ice readvanced over red lake clays formed during the Two Creeks interval of recession. Valders till smoothed and almost obliterated Cary landforms but was so thin over wide areas that it is no longer identifiable. These areas were not nunataks. When the Valders ice receded, lakes were again formed in front of it. Four outlets of Lake Oshkosh in the Green Bay lowlands across the Niagara cuesta to Lake Chicago in the Lake Michigan basin are described. Opening of the last outlet caused the two lakes to merge into Lake Algonquin. Ice was not far away then since varved clays accumulated in this lake. Further recession of the ice margin uncovered an outlet to the northeast which caused the water level to fall about 350 feet below that of the present. Evidence of this low level, now named Lake Chippewa, is described from this area. Rise of the land to the northeast caused the water to rise to the level of Lake Nipissing, about 20 feet above the present. Erosion of the modern outlet of Lake Huron caused the fall to present conditions.

Twenhofel, W.H.; Raasch, G.O.; Thwaites, F.T. 1935. UW-GL
Cambrian strata of Wisconsin: G.S.A., Bull., v. 46, no. 11, p. 1687-1743, illus., (abs.) G.S.A., Proc., 1933, p. 114.

The general picture of the lithologic and faunal succession of the Upper Cambrian of Wisconsin is presented, and some consideration is given to the environmental conditions controlling the deposition of various units. Strata of the Upper Cambrian of Wisconsin are placed in three, possibly four, formations, and each of these is subdivided into members on the basis of lithology and a fauna. Several of these have previously been given formational status.

Each member is briefly described, the faunal characteristics are given, and the possible environemental background is portrayed. Consideration of the sequence is supplemented by a diagrammatic cross-section and by descriptive sections taken from specific locations.

Uber, H.A. 1962. UW-ML
The kettle moraines of eastern Wisconsin: Wis. Acad. Review, v. 9, no. 4, p. 161-165, illus.

The author describes the origin and occurrence of the kettle moraine region of eastern Wisconsin. Associated features of the area such as kames, lakes, eskers, and drainage are discussed.

Upchurch, S.B. 1972. UW-GL
Natural weathering and chemical loads in the Great Lakes: Internat. Assoc. Great Lakes Res., 15th Conf. Proc., p. 401-415, tables, illus.

Natural and cultural chemical loads can be estimated by comparing the lithology of the surficial material and the material exposed at the pre-Pleistocene erosional surface to water quality and discharge data from streams with little cultural contamination. Extrapolation is made to unsampled basins of similar discharge and geology. Correlation studies of the Raquette and Maumee Rivers exemplify the response of chemical loads to temporal changes and to lithologic control and provide a basis for relating loading to weathering. Natural loads are based upon historical data.

Upham, W. 1894. UW-GL
The western Superior glacial lake and the later glacial lakes Warren and Algonquin: Minn. Geol. and Nat. Hist. Survey, 22nd, Ann. Rpt., p. 54-66.

This report contains a brief description of the geologic history of the glacial lakes of the Lake Superior basin. In addition, descriptions of the abandoned shorelines of the western Lake Superior area are described.

U.S. Army Corps of Engineers. 1946. SHL
Beach erosion study, Lake Michigan shoreline of Milwaukee Co., Wisconsin: U.S., 79th Cong., 2d sess., House Doc. 526, 27 p., maps.

This report contains sections on: (1) description of the area, (2) existing structures, (3) geology, (4) shore line and offshore changes, (5) recession of the bluff line, (6) wind, (7) shore currents and littoral drift, (8) waves, (9) desired improvements, and (10) conclusions.

Maps include: (1) index, (2) existing structures, (3) shoreline changes and offshore depths, (4) beach profiles, (5) beach samples, and (6) a plan of improvement.

U.S. Army Corps of Engineers. 1952. SHL
Racine County, Wis., Beach Erosion Control Study: U.S. 83rd Cong., 1st sess., House Doc., no. 88, 34 p., maps.

Chapters of this report pertain to: (1) general setting, (2) statement of the problem, (3) physical factors pertinent to the problem, (4) analysis of principal features of the problem, (5) plans of protection, (6) economic analysis, (7) conclusions, and (8) recommendations.

Appendices include: (1) basic data, (2) design analysis, and (3) estimated costs and benefits.

Maps contain: (1) general map, (2) shoreline and offshore changes, (3) beach profiles, (4) existing structures and suggested improvements, and (5) suggested plans of improvement.

U.S. Army Corps of Engineers. 1953. SHL
Beach erosion study, Illinois shore of Lake Michigan: U.S., 83rd Cong., 1st sess., House Doc. no. 28, 104 p., illus., maps.

This beach erosion report contains sections pertaining to: (1) general description of the area, (2) natural sources of beach material, (3) manner of beach supply and loss, (4) rate of beach supply and loss, (5) methods of modifying rates of beach supply and loss, (6) design of remedial structures, (7) improvements desired, (8) plan of improvement, economic analysis, and conclusions, (9) general discussion, and (10) conclusions.

Illustrations include: (1) index map, (2) hydrographs, (3) changes in shore lines and offshore depths, (4) profiles, (5) present shore and existing structures, (6) proposed plan of improvement, and (7) typical structures.

Appendices include: (1) a description of shore features and beaches, (2) pollution along the Illinois shore, (3) shore and lake bottom samples, (4) volumetric changes in the offshore area, (5) volumetric changes at selected structures, (6) existing structures, (7) improvements desired, (7) elevation of the clay line, (8) improvement cost, (9) damages, (10) recreational benefits, and (11) ownership and value of lake shore property.

U.S. Army Corps of Engineers. 1955. SHL
Beach erosion study, City of Kenosha: U.S., 84th Cong., 2nd sess., House Doc., no. 273, 40 p., maps.

Sections of this report pertain to the following subject matter: (1) the problem and improvements desired, (2) physical factors pertinent to the problem, (3) analysis of the problem, (4) plans of protection, (5) economic analysis, and (6) conclusions and recommendations.

Appendices contain: (1) basic data such as profiles and bluff erosion, offshore accretion and erosion, composition and analysis of bluff, beach, and offshore material, wind, lake levels, and waves, (2) design analysis, and (3) estimates of costs and benefits.

Van Hise, C.R. 189. UW-GL

An attempt to harmonize some apparently conflicting views of Lake Superior stratigraphy: Am. Jour. Sci., v. 41 (3) p. 117-137; reviewed by A.C. Lawson, Am. Geologist, v. 7, p. 320-327, 388.

This early article attempts to compile an accurate stratigraphic column for the Precambrian of the Lake Superior Region. Stratigraphic columns are described for Western Ontario, Northern Minnesota, Michigan, Wisconsin, Iowa, South Dakota, andSouthern Minnesota.

Van Hise, C.R.; Leith, C.K. 1911. UW-GL

The geology of the Lake Superior region: U.S.G.S., Mon. 52, 641 p., illus., maps; (abs.) Wash. Acad. Sci. Jour., v. 1, no. 5, p. 157-160.

This early paper presents a detailed discussion of the geology of the Lake Superior region. Specific chapters deal with the geography, drainage, and relief of the area. The greater part of the paper deals with the bedrock geology and the ore deposits of the region.

Webb, W.M.; Smith, R. 1961. UW-Geog

The bedrock geology of Lake Michigan (abs.) in Conference on Great Lakes Res., 4th, Proc.: Univ. Mich., Ann Arbor, Great Lakes Research Div., pub. 7, p. 146.

The floor of Lake Michigan can be divided topographically into three sections: (1) a northern area from the Mackinac Straits south to Manistee, with a prominent central depression bordered on the east and north by irregular topography; (2) a mid-lake region from Manistee to Milwaukee, with a N.E. trending central depression paralleled on the north by a poorly defined ridge, and on the south by a triangular shaped elevated area; (3) a southern section which is a large, regular basin.

Weidman, S. 1911. UW-ML

The glacial lake of the Fox River Valley and Green Bay and its outlet (abs.): Science, v. 33 (n.s.) p. 467.

Recently discovered shore lines in the Fox River Valley and around Green Bay occur at about 20, 40, 70, 95, 150 and 250 feet above the present level of Green Bay. The higher shore lines are at 800 and 830 feet above sea-level, developed on the outlet to the Mississippi

River by way of the Wisconsin River. The lower shorelines marked stages in the lake with outlets probably first through Lake Chicago and later through to the Atlantic.

Whitbeck, R.H. 1915. UW-GL

Geography of the Fox-Winnebago Valley: Wis. Geol. and Nat. Hist. Survey, Bull. 42 (educ. ser. 5), 105 p., illus.

The author describes the physical and cultural geography of the Box-Winnebago Valley. The geologic origin of the valley is presented, as well as a discussion of the origin of Lake Winnebago.

Whitbeck, R.H. 1920. UW-GL

The geography and economic development of Southeastern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 58 (educ. ser. 6), 252 p., illus.

The physical and cultural geography of Southeastern Wisconsin is described. Part of the bulletin deals with the bedrock and surficial geology of the area.

White, W.S. 1972. UW-GL

The base of the Upper Keweenawan, Michigan and Wisconsin: U.S.G.S., Bull. 1354-F, 23 p., illus.

The top of the Copper Harbor Conglomerate (base of Nonesuch Shale) is a more satisfactory boundary between upper and middle Keweenawan rocks in northern Michigan and adjacent parts of Wisconsin than the various horizons that have been used hitherto without stratigraphic consistency from place to place. Irvings original boundary (1883) cannot be followed away from the Keweenaw Peninsula. The top of the Copper Harbor Conglomerate comes closer to marking the close of Keweenawan volcanism than other major boundaries and actually adheres more closely to Irvings original concept than the boundary that he himself chose. The top of the Copper Harbor Conglomerate is also more satisfactory from a practical standpoint because, thanks to exploration for copper at the base of the Nonesuch Shale, no other major stratigraphic boundary in the Keweenawan province is so precisely located over so large a fraction of its total outcrop trace. This paper proposes that the top of the Copper Harbor Conglomerate be adopted as the base of the upper Keweenawan and of the Oronto Group.

Whitney, C.S. 1936. SGL

Stabilizing a Lake Michigan Bluff: reprint from Civil Engineer for May 1936, p. 309-313, illus.

In 1927 it was discovered that a section of high bluff in a residential suburb of Milwaukee had separated itself from the adjacent soil and was sliding downward and outward into Lake Michigan at a of several inches a day. To protect this bluff a retaining wall was constructed, which depended for its support upon ties extending underground to concrete blocks in stable ground.

Whittlesey, C. 1852. UW-GL
Geological report on that portion of Wisconsin bordering on the south shore of Lake Superior in Owen, D.D., Report of a geological survey of Wisconsin, Ioea, and Minnesota: Philadelphia, p. 421-473, map.

This report presents the principal features of the geology of Wisconsin's south shore of Lake Superior. Descriptions of the sedimentary, volcanic, metamorphic, and granitic rocks of the area are presented.

Whittlesey, C. 1876.
Physical geology of Lake Superior (abs.): Am. Assoc. Adv. Sci., Proc., v. 24, sec. B, p. 60-72, map.

Wilson, L.R. 1932. UW-ML
The Two Creeks forest bed, Manitowoc County, Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 27, p. 31-46, illus.

There was an interglacial interval of considerable duration between the Late and Middle Substages of the Wisconsin glaciation. This is shown by the position of the Two Creeks Forest Bed between tills of characteristic lithologic nature. The plants and animals of the forest bed are today arctic, subarctic, and northern in distribution.

Winchell, N.H. 1871. UW-ML
The glacial features of Green Bay of Lake Michigan with some observations on a probable former outlet of Lake Superior: Am. Jour. Sci., v. 2 (3), p. 15-19.

The author describes the history of glaciation, and the glacial geology of the Green Bay area. He describes a probable former outlet of Lake Superior through Little Bay de Noc.

Wisconsin Conservation Department. 1960. SGL
Wetland inventory of Racine and Kenosha Counties: Wisconsin Wetland Inventory, 92 p., illus., tables, maps.

This report, which combines data for Racine and Kenosha Counties, is one of a series of county summaries which presents an inventory of wetland resources. It attempts to show the extent of present wetlands and the amount that has been lost through drainage.

Wisconsin Geol. and Nat. Hist. Survey. 1911. SGL
Geology and road map of Wisconsin: Baltimore, A. Hoen and Co., printer, scale 6 miles = 1 inch.

A generalized geologic map of Wisconsin.

Wisconsin Geol. and Nat. Hist. Survey. 1963. SGL
Geologic map of Wisconsin: scale, approx. 1:2,700,000, text.

A generalized geologic map of the state with a one page explanatory text.

Wisconsin Geol. and Nat. Hist. Survey. 1964. SGL
Glacial deposits of Wisconsin: scale approx. 1:2,700,000, text.

A generalized map of Wisconsin's glacial geology with a one page explanatory text.

Wisconsin Geol. and Nat. Hist. Survey. 1968. SGL
Aeolian silt and sand deposits of Wisconsin: scale approx. 1:2,700,000, text.

A generalized map of aeolian silt and sand deposits with a one page explanatory text.

Wisconsin Geol. and Nat. Hist. Survey. 1971. SGL
Geologic map of Wisconsin: scale approx. 1:2,700,000, text.

A generalized geologic map of the state with a one page explanatory text.

Woodward, D.A. 1972. SGL
Landforms of Wisconsin: Wis. Geol. and Nat. Hist. Survey, one sheet, scale 1:1,000,000.

A generalized landform map of Wisconsin.

Wright, C.E. 1878.
Preliminary survey report of the Pine River Iron District in Oconto County: Wis. Geol. Survey, Ann. Rpt. 1877, p. 33-36, illus.

This early report describes the bedrock geology and iron resources of the Pine River District in Oconto County. Three beds of ore are described.

Zube and Dego Associates. 1964. SHL
Wisconsin's Lake Superior shoreline: Wis. Dept. Resource Development, Bull. no. 3, 42 p., illus., maps.

This report is intended to present a clear understanding of the visible, physical features of the south shore of Lake Superior. The physical features used in analyzing the shoreline were the slope and material of the wet beach, dry beach, bluff and upland, evidence of erosion, type of vegetation, soils and water quality. On the basis of differing physical features, thirteen shore types were recognized.

Zumberge, J.H.; Patzer, J.E. 1956. UW-GL

Late Wisconsin chronology of the Lake Michigan Basin correlated with pollen studies: G.S.A., Bull., v. 67, no. 3, p. 271-288, illus.

Geological and radio carbon dating of an excellent exposure in a wave-cut cliff on the shore of Lake Michigan near South Haven, Michigan, permits the establishment of the following absolute chronology of events for the Lake Michigan Basin: Two Creeks-Bowmanville low water stage, 11,000 years ago; end of Lake Algonquin, 8000 years ago; Lake Chippewa low water stage, 5000 years ago; and beginning of the Nipissing Great Lakes, a little less than 4000 years ago.

HYDROLOGIC REFERENCES

Anderson, B.A.; Ham, C.B. 1968. UW-GL
Index of surface-water records to September 30, 1967, part 4: U.S.G.S. Circ. 575, 39 p.

This report lists the streamflow and reservoir stations in the St. Lawrence River Basin for which records have been published in reports of the Geological Survey for periods through September, 1967.

Andrews, L.M.; Threinen, C.W. 1969. DNR
Surface water resources of Iron County: Wis. Dept. of Natural Resources, Lake and stream classification project, 184 p., tables, maps.

This inventory is an extensive survey designed to provide a summary of the quality, quantity and character of the surface waters of Iron County.

The land use, geography, geology, soils, climate, runoff, economy, and population of the county are also presented.

Audini, R.E. 1959. UW-GL
Ground-water levels in the United States, 1956- Wisconsin: U.S.G.S. Water Supply Paper 1456, p. 64-76.

Well locations and water level measurements for 1955 are cited for observation wells in Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, and Racine Counties.

Audini, R.E.; Berkstresser, C.F.; Knowles, D.B. 1959. UW-GL
Water levels in observation wells in Wisconsin through 1957: Wis. Geol. and Nat. Hist. Survey, Inf. Circ. 4, 192 p., illus.

The purpose of this report was to summarize the long and short term trends in Wisconsin's ground water levels, as monitored in wells throughout the state. Hydrographs of the years of observation are given for each well. Observation wells in counties boarding Wisconsin's Great Lakes are listed for the counties of: Ashland, Brown, Douglas, Iron, Kenosha, Marinette, Milwaukee, Oconto, and Racine.

Audini, R.E.; Erickson, R.M. 1964. UW-GL
Groundwater levels in the United States, 1957-61- Wisconsin: U.S.G.S., Water Supply Paper 1781, p. 122-148, map.

Well locations and water level measurements for the perior 1957-61 are cited for the counties of Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, and Racine.

Bergstrom, R.E.; Hanson, G.F. 1962. UW-GL
Ground-water supplies in Wisconsin and Illinois adjacent to Lake Michigan (abs.): G.S.A., Bull., v. 70, no. 12, pt. 2, p. 1799.

Ground-water reservoirs in Wisconsin and Illinois adjacent to Lake Michigan presently supply about 200,000,000 gallons of water a day for municipal, industrial, and farm supplies. These reservoirs include the glacial drift, shallow dolomites mainly of Silurian and Devonian age, and deeper sandstone and dolomite formations of Cambrian and Ordovician age.

Most municipal and industrial groundwater supplies in the region are obtained from deeper permeable sandstone and intervening, locally creviced dolomite formations. Withdrawal of water from these aquifers, mainly in the large industrial districts has brought about considerable decline in artesian pressures over wide areas. Recharge to the deep aquifers is through the drift and shallow dolomite in the area to the west beyond the limits of the Maquoketa formation of Ordivician age.

The glacial drift and shallow dolomite are sources of water for most farm and many municipal and industrial supplies. High yields due to favorable formation characteristics and recharge conditions are obtained from the shallow aquifers locally, although the overall ground-water potential is unknown.

Borrows, H.K.; Horton, A.H. 1907. UW-GL
Surface water supply of the Great Lakes and St. Lawrence River drainages, 1906: U.S.G.S., Water Supply Paper 206, 92 p.

Drainage basin descriptions and stream flow records are cited for 1906. The rivers of Wisconsin tributary to the Great Lakes include the Oconto, Peshtigo, and Wolf.

Browzin, B.S. 1966. UW-Geog
Annual runoff in the Great Lakes - St.Lawrence basin: Univ. Mich., Great Lakes Res. Div., Ann Arbor, Pub. no. 15, p. 203-219.

Bruce, J.P.; Rodgers, G.K. 1962.
Water balance of the Great Lakes system in Great Lakes Basin: Am. Assoc. Advancement Science, Washington, D.C., Pub. no. 71, p. 41-69.

Chamberlin, T.C. 1883. UW-GL
Artesian wells in Geology of Wisconsin: Wis. Geol. Survey, v. 1, pt. 3, chap. 6, p. 689-701,

The geologic setting for artesian flow systems is described. A belt along Lake Michigan, southward from Manitowoc county, and the Green Bay Valley are described as favorable regions in which to obtain flowing wells.

Cheetham, R.N.; Wilke, R.F. 1969. UW-AL

The watershed and Green Bay shore drainage of Brown Co., Wis.: U.S.D.A., Soil Cons. Service,Southeastern Wisconsin Rivers Basin, Tech. rpt. no. 3, 54 p., illus., maps.

Using current topographic maps and aerial photographs, thirty-three watersheds and bay shore drainage areas were delineated in Brown County, Wisconsin.

Each of the drainage areas and watersheds is reproduced on a separate sheet mostly on a scale of 1:62,500, which is the scale of the 15 minute U.S. Geological Survey topographic quadrangles.

Descriptive material below each map consists of location, area, topographic coverage, drainage, relief ration, and slope.

A general section on location, area, climate, soils, geology, land use, PL-566 projects, and methodology precedes the detailed maps.

Conger, D.H. 1971. USGS

Estimating magnitude and frequency of floods in Wisconsin: U.S.G.S., open-file report, 200 p., tables.

This report provides methods for estimating flood characteristics at most sites where flood information may be needed for planning and design and summarizes the significant flood data and related information on Wisconsin streams.

Flood data is contained for the following streams tributary to Lake Superior and Lake Michigan: Stoney Brook, Pearson Creek, Bois Brule, Sand, Sioux, Spillerberg, Bad, Trout Brook, Pearl Creek, White, Montreal, West Branch Montreal, Boomer Creek, Black, Presque Isle, Middle Branch Ontonagon, East Branch Ontonagon, Sturgeon, Otter, Allen Creek, Brule Point, Menomonee, Woods Creek, Pine, West Branch Sturgeon, Sturgeon, Cole Creek, Pike, McCall Creek, Armstrong Creek, Peshtigo, Oconto, North Branch Little Pensaukee, Bird Creek, Fox, Hunting, Evergreen Creek, Wolf, Embarrass, Spaulding Creek, Little Wolf, Waupaca, Sawyer Creek, West Branch Fond du Lac, East Branch Fond du Lac, Apple Creek, East, Kewaunee, Neshota, Killsnake, Sheboygan, Milwaukee, Cedar Creek, Little Menomonee, Honey Creek, Menomonee, Oak Creek, West Branch Root, Pike and the Lake Michigan Tributary at Winthrop Harbor.

Deakyne, H. 1930. SHL

Brule River, Wisconsin: U.S., 72d Cong., 1st sess., House Doc. 227, 39 p., illus., maps.

This report covers navigation, flood control, power development, and irrigation on the Brule River, Wisconsin. The hydrology of the river is described.

Devaul, R.W. 1967. SGL

Trends in ground-water levels in Wisconsin through 1966: Wis. Geol. and Nat. Hist. Survey, Inf. Circ. 9, 109 p., illus., tables; (abs.) Abs. North Am. Geol., p. 184, Feb., 1968.

The purpose of this report is to present ground-water level data through 1966 in a graphic form and also to relate some of these data, as examples, to changes in precipitation, lake levels, storage in ground-water reservoirs, and pumpage.

Hydrographs for the duration of record are given for observation wells in the counties of Douglas, Ashland, Iron, Marinette, Oconto, Brown, Door, Sheboygan, Ozaukee, Milwaukee, Racine, and Kenosha.

Devaul, R.W. 1969. UW-GL

Ground-water levels in the United States, 1962-1966- Wisconsin: U.S.G.S. Water-Supply Paper 1976, p. 94-117.

Location, depth, water bearing formation, and water levels are given for observation wells in the counties of Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, and Racine for the years 1962-1966.

Doyel, W.W.; Curtis, W.F.; Chase, E.B. 1969. USGS

Catalog of information on water data, Edition 1968, Index to areal investigations and miscellaneous activities: U.S.G.S., p. 42-44, 80-82, 160.

This publication is an index to the areal investigations and miscellaneous activities pertaining to water data. It contains references to data collected by 33 federal agencies.

Drescher, W.J. 1953. UW-GL

Ground-water conditions in artesian aquifers in Brown County, Wisconsin: U.S.G.S. Water-Supply Paper 1190, 49 p., illus.

The principal water-bearing rocks underlying Brown County are thick sandstone units of Cambrian and Ordovician age. Other aquifers include limestone and dolomite of Ordovician age, dolomite of Silurian age, and sands and gravel of Pleistocene and Recent age. Underlying the water bearing formations are crystalline rocks of pre-Cambrian age which contain little or no water.

Ground water is the source of all public and most private and industrial supplies in the county. Several of the large industries use quantities of surface water also. Most of the water is pumped from wells that penetrate the Cambrian sandstones where the water occurs under artesian conditions.

The piezometric level, which was about 100 feet above the land surface in 1886, was about 300 feet below the land surface in 1949. About 200 feet of this decline took place after 1938.

Probable declines of water levels by 1960 were computed. The additional decline in water level will be 15 to 150 feet in the center of the pumped area, depending upon the amount of increased pumping and its distribution relative to the present pumped area and to the recharge area.

The water from the sandstone is a hard calcium magnesium bicarbonate water. Further work is needed to determine whether there is danger of contamination by salt water which occurs down dip in the same formation.

It is concluded that the rate of withdrawal from the area can be increased to 15 mgd by 1960 without dangerously lowering water levels, provided that the new wells are properly spaced. In order to avoid excess lowering of water levels, it is recommended that new wells be located west of Green Bay toward the recharge area.

Drescher, W.J.; Dreher, F.C.; Brown, P.N. 1953. UW-GL
Water resources of the Milwaukee area, Wisconsin: U.S.G.S. Circ. 247, 42 p., illus., map.

This report summarizes and interprets all available water resources information for all of Milwaukee County and the east half of Waukesha County. The quantity, quality, and present use of all surface and ground water supplies are discussed in detail.

Drescher, W.J. 1956.
Ground water in Wisconsin: Wis. Geol. and Nat. Hist. Survey, Inf. Circ. 3, 37 p., illus.

Ericson, D.W. 1961. USGS
Floods in Wisconsin - Magnitude and frequency: U.S.G.S., open-file report, 109 p.

Flood data from gaging stations on Wisconsin rivers and streams are listed in this report. From these data, composite frequency curves were defined which express the ratio of floods of various recurrence intervals to the mean annual flood. By combining the results from the mean annual flood formulas with the regional frequency curves, the flood-frequency relationship can be determined for most sites in the State where the drainage basin exceeds 20 square miles. The curves and formulas are not applicable to: main stems of several of the larger rivers, highly regulated streams where it is possible for man to alter flood peaks, and drainage basins under 70 square miles in a part of west-central Wisconsin.

Flood data is contained for the following streams tributary to Lake Superior and Lake Michigan: Bois Brule, Bad, White, Montreal, West Branch Montreal, Presque Isle, Middle Branch Ontonagon, Iron, Brule, Paint, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, West Branch Fond du Lac, East Branch Fond du Lac, Sheboygan, Milwaukee, and Cedar Creek.

Erickson, R.M. 1972. SGL
Trends in ground-water levels in Wisconsin, 1967-71: Wis. Geol. and Nat. Hist. Survey, Inf. Circ. 21, Supplement to Inf. Circ. 9, 40 p., graphs, maps.

The purpose of this report is to present ground-water level data from 1967 to 1971 for the state of Wisconsin.

Hydrographs for the duration of record from 1967 to 1971 are given for observation wells in the counties of Douglas, Bayfield, Ashland, Marinette, Oconto, Brown, Kewaunee, Door, Manitowoc, Sheboygan, Ozaukee, Milwaukee, Racine, Kenosha.

Foley, F.C. 1952. UW-GL
Sources of recharge to deep artesian aquifers in southeastern Wisconsin (abs.); G.S.A. Bull., v. 63, no. 12, pt. 2, p. 1380.

An essential part of a detailed study of the ground water resources of the Milwaukee-Waukesha area, Wisconsin, was the location of recharge to the Ordovician and Cambrian artesian aquifers that are deeply buried near Lake Michigan. Analysis of pumping-test data in the Milwaukee-Waukesha area and study of piezometric profiles from Milwaukee to central Wisconsin, the areas of outcrop of the aquifers, show that water in deep aquifers in southeastern Wisconsin enters the sandstones through the overlying Galena-Platteville dolomite where the dolomite is the bedrock immediately below the glacial drift cover. The piezometric profile slopes very gently westward from a crest in the area of outcrops of the Galena-Platteville. Recharge to the deep aquifers in southeastern Wisconsin does not take place in the areas of outcrop of those aquifers in Central Wisconsin.

Foley, F.C.; Walton, W.C.; Drescher,W.J. 1953. UW-GL
Ground-water conditions in the Milwaukee-Waukesha area, Wisconsin: U.S.G.S. Water-Supply Paper 1229, 96 p., illus.

Three major aquifers underlie the Milwaukee-Waukesha area: sandstones of Cambrian and Ordovician age, Niagara dolomite of Silurian age, and sand and gravel deposits of Pleistocene age. The Maquoketa shale of Ordovician age acts as a more or less effective seal between the Pleistocene deposits and Niagara dolomite above and the sandstone aquifer below. Crystalline rocks of pre-Cambrian age form an impermeable basement complex below the Paleozoic sedimentary rocks. The Paleozoic strata dip east at 25 to 30 feet to the mile. There is no evidence of any faults and folds known or surmised to be present as a barrier to the movement of ground water.

Gebert, W.A. 1971. USGS
Low-flow frequency of Wisconsin streams: U.S.G.S., Hydro. Inv. Atlas, HA-390, 1 sheet, scale 1:750,000, text.

The purposes of this report are to present current low-flow information for selected sites on numerous streams throughout Wisconsin, to describe low-flow characteristics and low-flow

variability, and to demonstrate the application of low-flow information on the management of water resources. This report presents the results of the first phase of a study of low-flow characteristics of 320 streamflow stations within Wisconsin.

Gerrard, L.P. 1950.
The Brule River of Wisconsin: Winnetka, Ill., Westerners Brand Book, v. 7, no. 1, 7 p.

Green, J.H.; Hutchinson, R.D. 1965. UW-GL
Ground-water pumpage and water level changes in the Milwaukee-Waukesha area, Wisconsin, 1950-1961: U.S.G.S., Water Supply Paper 1809-I, p. II, 1-19, illus., maps.

Artesian water pressure in the deep sandstone aquifer continued to decline throughout most of the Milwaukee-Waukesha area, Wisconsin between 1950 and 1961. Areas of greatest water-level decline were in northeast Waukesha County and in northwest Milwaukee County. The chief cause of the decline was continued heavy pumpage.

The major aquifers of southeastern Wisconsin are the Niagara aquifer which is primarily Niagara Dolomite of Silurian age, and the sandstone aquifer, which consists of sandstones of Cambrian and Ordovician ages. Locally, the glacial sands and gravels of Pleistocene age also are important aquifers. In the Milwaukee-Waukesha area, the sandstone aquifer is completely artesian, confined by the Maquoketa Shale. The Niagara aquifer is generally unconfined.

Hendricks, E.L. 1964. UW-GL
Compilation of surface water records of the United States, October 1950 to September 1960 - pt. 4, St. Lawrence River Basin: U.S.G.S., Water Supply Paper 1727, 379 p.

This report summarizes the streamflow records in the St. Lawrence River basin from 1950-1960. Stream data includes station location, drainage area, type of gage, average discharge, extreme discharges, monthly and yearly mean discharges, and monthly and yearly mean runoff. Wisconsin streams tributary to Lake Superior include the Bois Brule, Bad, White, Montreal, and Black Rivers. Wisconsin streams tributary to Lake Michigan include the Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Suamico, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Sheboygan, Milwaukee, and Cedar Rivers.

Hendrickson, G.E.; Knutilla, R.L.; Doonan, C.J. 1973. SGL
Hydrology and recreation of selected coldwater rivers of the St. Lawrence River basin in Michigan, New York, and Wisconsin: U.S.G.S., Water Resources Investigations 8-73, 73 p., illus.

The recreational potential of 10 cold-water streams is described in terms of esthetic attractiveness, suitability for boating, camping opportunity, and fishing opportunity. Descriptions of the physical hydrology of the streams are presented. Wisconsin streams included in this report are the Bois Brule and the Pine.

Herron, W.H. 1917. UW-GL
Profile survey of rivers in Wisconsin: U.S.G.S., Water-Supply Paper 417, 48 p., maps.

This report contains profile surveys of Wisconsin's rivers. The maps show the outlines of the river banks, islands, rapids, falls, shoals, dams, crossings, and the contours of banks to an elevation high enough to indicate the possibility of using the stream for water power.

Streams tributary to the Great Lakes include Pestigo and Fox Rivers.

Holt, C.L.R., Jr.; Knowles, D.B. 1963. UW-GL
Ground water in Wisconsin in McGuinness, C.L., The role of ground water in the national water situation: U.S.G.S., Water-Supply Paper 1800, p. 943-960.

This article discusses in general the ground water situation in Wisconsin. The state is discussed with respect to ground water provinces.

Holt, C.L.R., Jr.; Young, K.B.; Cartwright, W.H. 1964. SGL
The water resources of Wisconsin: Wil. Geol. and Nat. Hist. Survey, 21 p., illus.

This report describes in general the conditions of Wisconsin's water resource. The occurrence and use of surface and ground waters within the state are described.

Horton, R.E.; Johnson, E., Jr.; Hoyt, J.C. 1905. UW-GL
Report of progress of stream measurements for the calendar year 1904, pt. 6: U.S.G.S., Water Supply Paper 129, p. 25.

Stream gage location and daily mean gage height on the Fox River at Wrightstown, Wis. are cited for January, February, and March of 1904. The gage was destroyed on March 25, 1904.

Horton, R.E.; Hanna, F.W.; Hoyt, J.C. 1906. UW-GL
Report of progress of stream measurements for the calendar year 1905, pt. 6: U.S.G.S., Water Supply Paper 170, p. 17-18.

Gage location stream geometry, and daily gage heights for the Wolf River at Northport, Wisconsin are cited for the ice-free months of 1905.

Horton, R.E.; Grunsky, C.E. 1927.
Hydrology of the Great Lates: Report of the Engineering Board of Review, part III, Appendix II, Chicago, Illinois, 432 p.

Hoyt, J.C. 1904. UW-GL
Report of progress of stream measurements for the calendar year 1903, pt. 1: U.S.G.S., Water Supply Paper 97, p. 464-472.

Gage location, stream geometry, and daily gage heights for 1903 are cited for the Fox, Wolf, and Fond du Lac Rivers.

Hutchinson, R.D. 1970. UW-GL
Water resources of Racine and Kenosha Counties, southeastern Wisconsin: U.S.G.S., Water-Supply Paper 1878, 63 p., illus., maps.

The purpose of this report is to describe the water resources of Racine and Kenosha Counties, Wisconsin. This report includes description of the hydrogeology, the ground- and surface-water system, the quality of the water, and the adequacy of the dependability, for present and future needs. Special emphasis is given to the ground-water resources because of their expected heavy use in the future.

Johannes, S.I.; Sather, L.M.; Threinen, C.W. 1970. DNR
Surface water resources of Bayfield County: Wis. Dept. Nat. Resources, Lake and stream classification project, 372 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Bayfield County as well as the present and potential use of the water resource. In addition, short sections describe the history, geography, geology, soils, climate, hydrology and land use within the county.

Jones, D.M.A. 1972. WRC
Great Lakes Hydrology by months, 1946-1965: Univ. Ill., Water Resources Center, Res. Rpt. no. 53, 59 p., illus.

Monthly estimates of precipitation on each lake, evaporation from each lake surface, and runoff into each lake from surrounding land areas are developed for the Great Lakes for calendar years 1946 through 1965. The monthly and annual net basin supplies for each lake are determined from the estimated values of runoff, precipitation, and evaporation and are compared with the monthly and annual net basin supplies as reported by the U.S. Army Corps of Engineers.

Kirchoffer, W.G. 1937.
Report on underground water survey, Manitowoc, Wisconsin: Wis. Geol. and Nat. Hist. Survey, open file report, 20 p.

Knowles, D.B. 1964. UW-GL
Ground-water conditions in the Green Bay area, Wisconsin, 1950-1960: U.S.G.S., Water-Supply Paper 1669-J, J1-J37, illus., tables.

This progress report presents information on ground water conditions in the Green Bay area in 1950-60, with particular reference to the recovery of water levels during the period 1957-60 in wells tapping the sandstone aquifer. Special emphasis was placed on estimating the hydraulic characteristics of the sandstone aquifer by relating the reduction in pumpage in 1957 to the recovery of water levels in observation wells in 1957-60.

Knowles, D.B.; Dreher, F.C.; Whetstone, G.W. 1964. UW-GL
Water resources of the Green Bay area: U.S.G.S., Water-Supply Paper 1499-G, p. G1-G67, illus., maps.

The report contains information on the source, availability, use, and quality of the water resources of the Green Bay area. It includes information on the ground- and surface-water sources of supply, the chemical character of selected ground and surface waters, water supply systems, use of water, emergency water supplies, and the possibility of further development.

Knox, C.E. 1956. UW-GL
Index of surface-water records to September 30, 1955, pt. 4: U.S.G.S., Circ. 384, p. 2-4.

This index lists the streamflow and reservoir stations in the St. Lawrence River basin for which records have been published in reports of the Geological Survey to September 30, 1955. Periods of record for the same station published by other agencies are listed only when they contain more detailed information or are for periods not reported in publications of the Geological Survey.

Law, A.B. 1960. UW-ML
Rainfall and runoff in the Wolf River basin, Wisconsin: M.S. Thesis, U.W., 85 p., illus.

The purpose of this thesis is to investigate the precipitation and streamflow characteristics of the Wolf River basin. Sections include discussion of the physical characteristics of the basin, precipitation, stream flow, rainfall-runoff relationships, and floods.

Mackenthun, K.M.; Scott, R.H.; and Schraufnagel, F.H. 1958.
Report on the investigation of the East River in the city of Green Bay, and vicinity: Wisconsin Committee on Water Pollution, 25 p.

Marter, J.H.; Cheetham, R.N. 1971.
Areal measurements and nomenclature of watersheds in the southeastern Wisconsin rivers basin: U.S.D.A. Soil Cons. Service, Southeastern Wis. Rivers Basin, reference rpt. no. 10, 78 p.

McGuinness, C.L. 1964. USGS
Generalized map showing annual runoff and productive aquifers in the conterminous United States: U.S.G.S., Hydrol. Inv. Atlas, HA-194, 1 sheet.

This map depicts the productive aquifers and the annual runoff in the continental United States.

Mead, D.W. 1893. UW-EL
The geology of Wisconsin water supplies: Am. Water Works Assoc., 13th Ann. Mtg., Proc., p. 63-79.

This article describes the geology of Wisconsin's major aquifers. The general water quality of the principal water-bearing units is also discussed.

Meinzer, O.E. 1923. UW-GL
The occurrence of ground water in the United States: U.S.G.S. Water-Supply Paper 489, p. 215-216, 309-311.

A small section of this paper deals directly with Wisconsin. A columnar section of the Paleozoic rocks of Wisconsin, with descriptions of their water supplies is cited. In addition, the ground water provinces of the state are described

Meredith, D.D. 1974. WRC
Hydrologic models of the Great Lakes: Univ. of Ill., Urbana, Water Resources Center, research rpt. no. 81, 35 p.

It is demonstrated that net basin supply values obtained from water balance studies without accounting for the thermal expansion and contraction of water may be in error by as much as 100 percent during some months for each lake.

The individual hydrologic components are assumed to be normally distributed for each month and linear regression equations are estimated for predicting the value of the hydrologic components for downwind lakes are dependent upon hydrologic events for the upwind lakes. This is particularly so for precipitation in the downwind lake basins which appear to be highly dependent upon evaporation values for upwind lakes.

Modlin, R.F.; Beeton, A.M. 1970. UW-GL
Dispersal of Fox River water in Green Bay,Lake Michigan: Internat. Assoc. Great Lakes Res., 13th Conf. Proc., p. 468-475, illus.

Two synoptic surveys were made of the southern half of Green Bay, July 1968 and August 1968, to determine the distribution, flushing rates, and importance of Fox River water in the Bay. Circulation in the southern end was counter-clockwise, with river water extending northward for almost 40 km along the east shore. Lake Michigan water occupied the western part of the Bay. A progressive decrease in conductivity from the river mouth lakeward reflected the dilution of the river water as it moved through the Bay. The August 1969, flushing time was 160 days in the southern end and 36 days in the northern part of the study area. Lakeward transport was 199 m/day and 1130 m/day respectively. Transport rates and flushing rates in the southern end were a function of the volume of river discharge while in the northern end they appeared to be determined by the magnitude of in-flowing lake current.

Mortimer, C.H. 1969. UW-GL
Exploration and theoretical study of circulation in large basins, gulfs, and estuaries with particular reference to Green Bay: U.W., Sea Grant Program, Public Inf. Rpt. 2, p. 27-37, illus.

This study delineates the main features of large-scale motion in Green Bay and provides a framework for other studies in Green Bay such as investigation of circulation and diffusion on a smaller scale.

Muegge, O.J. (chairman) 1954. SGL
Ground water in Wisconsin: Wis. Nat. Resources Committee of State Agencies, Water Subcommittee, Ground Water Working Group, rpt., 23 p., illus.

The purpose of this report is to present in a general way the occurrence, source, movement, and use of ground water in Wisconsin in such a way that problems may be understood and the potential ground water available may be studied and evaluated. Areas with specific problems are cited in some detail.

Nelson, L.M.; Fassbender, R.L. 1972. DNR
Surface water resources of Brown County: Wis. Dept. of Natural Resources, Lake and stream classification project, 44 p., tables, maps.

This report presents the quality, quantity, and character of the water resources of Brown County with respect to its use for renewable resource production and recreation.

Each lake is described by location, area, maximum depth, and water clarity. Streams are described by the location of their mouths, area, length within the county, and gradient. In addition the general topography, drainage, geology, soils, groundwater, climate, runoff, population, area, and land use of the county is described.

Newell, F.H. 1903. UW-GL
Report of progress of stream measurements for the calendar year 1902, pt. 2: U.S.G.S. Water-Supply Paper 83, p. 297-300.

Gaging station locations and daily gage heights on the Fox and Wolf Rivers are cited for part of 1902.

Oakes, E.L.; Hamilton, L.J. 1973. USGS
Water resources of Wisconsin-Menominee-Oconto-Peshtigo River basins: U.S.G.S., Hydro. Inv. Atlas, HA-470, 4 sheets, scale 1:1,000,000.

This report summarizes the water resources of Wisconsin's Menominee, Oconto, and Peshtigo River Basins. Sheet no. 1 presents an introduction, the physical setting, and the hydrologic budget. Sheet no. 2 describes the ground-water surface-water relationships. Sheet no. 3 presents surface water data. Sheet no. 4 summarizes the area and describes water use.

Oehmcke, A.A.; Truax, W.C. 1964. UW-ML
The Wolf River: Wis. Acad. Trans., v. 53, part A, p. 9-20, map.

This article presents the physical setting of the Wolf River, its tributaries, and the lakes within its drainage basin. The problems and potential of the river are also discussed.

Olcott, P.G.; Dreher, F.C. 1967-1971. SGL
Water conditions in Wisconsin: Wis. Geol. and Nat. Hist. Survey in cooperation with the U.S.G.S., 4 p., semi-annual.

The purpose of these reports is to summarize the ground and surface-water conditions of the state on a semi-annual basis. Maps and hydrographs are used to illustrate ground and surface water conditions in four geographical provinces within Wisconsin.

Olcott, P.G. 1968. USGS
Water resources of Wisconsin - Fox-Wolf River basins: U.S.G.S., Hydro. Inv. Atlas, HA-321, 4 sheets, scale 1:1,000,000.

This report summarizes the water resources of Wisconsin's Fox-Wolf River basins. Sheet no. 1 describes the physical setting and water systems of the area. Sheet no. 2 presents ground-water data. Sheet no. 3 describes the surface-water of the area. Sheet no. 4 presents a summary, water use, and water problems.

Pettis, C.R. 1939. UW-EL
Typical quantitative analysis as applied to Lake Superior in Hydrology of the Great Lakes; a symposium: Am. Soc., Civil Engineers, Proc., v. 65, no. 4, p. 584-595.

A method of making a quantitative analysis of the hydrology of Lake Superior, is presented in this paper. Certain deductions are made, based on evidence from available data. By means of these deductions, values are obtained for the evaporation from the lake surface. Knowing the evaporation, the underground flow to the lake and the land losses can be computed.

The conclusion reached is that the evaporation and the underground flow are greater, and the losses are less than the values that have been generally accepted.

Poff, R.J.; Threinen, C.W. 1961. DNR
Surface water resources of Kenosha County: Wis. Cons. Dept., Lake and stream classification project, 37 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Kenosha County as well as the present and potential use of the water resource.

Poff, R.J.; Threinen, C.W. 1961. DNR
Surface water resources of Racine County: Wis. Cons. Dept., Lake and stream classification project, 37 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Racine County as well as the present and potential use of the water resources.

Poff, R.J.; Threinen, C.W. 1964. DNR
Surface water resources of Milwaukee County: Wis. Cons. Dept., Lake and stream classification project, 39 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Milwaukee County as well as the present and potential use of the water resource. In addition, short sections describe the relief, geology, soils, climate, and land use of the county.

Poff, R.J.; Gernay, R.; Threinen, C.W. 1964. DNR
Surface water resources of Ozaukee County: Wis. Cons. Dept., Lake and stream classification project, 53 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Bayfield County as well as the present and potential use of the water resource. In addition, short sections describe the topography, geology, soils, climate, and drainage systems of the county.

Poff, R.J.; Threinen, C.W. 1965. DNR
Surface water resources of Door County: Wis. Cons. Dept., Lake and stream classification project, 66 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Door County as well as the present and potential use of the water resources. In addition, the geography, climate, geology, drainage, and soils of the county are described.

Poff, R.J.; Threinen, C.W. 1966. DNR
Surface water resources of Kewaunee County: Wis. Cons. Dept., Lake and stream classification project, 50 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Kewaunee County as well as the present and potential use of the water resource. In addition, short sections describe the geography, geology, glacial features, drainage, climate, and soils of the county.

Ragotzkie, R.A.; Ahrnsbrak, W.F.; Synowiec, A. 1969. UW-SG
The hydrolography of Chequamegon Bay: Marine Studies Center, U.W., Tech. Rpt. 1, 56 p., illus.

The primary purpose of this report is to investigate: (1) the thermal structure of Chequamegon Bay, and (2) the circulation of Chequamegon Bay. The second of these objectives consisted of two types of measurements: (a) recording of seiches in the Bay, and (b) direct measurements of currents in the Bay.

Rapp, J.R.; Doyel, W.W.; Chase, E.B. 1969. USGS
Catalog of information on water data, index to ground water stations: U.S.G.S., edition 1968, p. 634-638.

This publication is an index to ground water stations at specific locations which have been monitored for more than three years. It contains references to data collected by 33 Federal agencies.

Raymore, D.K. 1966.
Wisconsin rivers and lakes, workhorses for power, for transport, for pleasure: Milwaukee Wis. Advertising Service (Wideview pub.) 64 p., illus.

Rostvedt, J.O. 1965. UW-GL
Summary of floods in the United States during 1960: U.S.G.S., Water-Supply Paper 1790B, p. 27B-29B, 53B-57B, map.

This report describes the most outstanding floods in the United States during 1960. Snowmelt in March and April supplemented by rains caused severe flooding in Wisconsin.

Sather, L.M.; Threinen, C.W. 1966. DNR
Surface water resources of Ashland County: Wis. Dept. Nat. Resources, Lake and stream classification project, 129 p., tables, maps.

This inventory is intended to provide a summarization of the quantity, quality, and character of the surface water resources of Ashland County, including both lakes and streams. The report contains sections on the geography, geology, soils, climate, and land use of Ashland County as well as detailed descriptions of the quantity and quality of the county's surface waters.

Schraufnagel, F.H. 1966.
Green Bay stream flows and currents in Lake Michigan Pollution: Gov. Conf. Proc., p. 178-182.

Schultz, A.R. 1905.
The underground water supply of Wisconsin, northern Illinois, and the northern peninsula of Michigan: Ph.D. Thesis - Geology, Univ. of Chicago.

Schultz, A.R. 1905. UW-GL
(Underground waters of) Wisconsin district in Fuller, M.L., Underground water of the United States: U.S.G.S., Water-Supply Paper 114, p. 233-241.

This article discusses the ground water systems in Wisconsin. The topography, geology, and bedrock aquifers of the state are described.

Simons, J.T. 1973. WRC
Development of three dimensional numberical models of the Great Lakes: Canada Centre for Inland Waters, Burlington, Ontario, Inland Waters Directorate (scientific series no. 12) 26 p., illus.

This report describes a generalized numerical model for computing the water levels and the three-dimensional circulation and temperature structure of the Great Lakes. The mathematical-numerical framework is borrowed from numerical weather prediction, storm surge forecasting, and ocean circulation models. In view of the prominence of the boundary-value problem in the modeling of relatively shallow basins, emphasis is placed on the proper treatment of the bottom topography.

Skinner, E.L.; Borman, R.G. 1973. USGS
Water resources of Wisconsin - Lake Michigan basin: U.S.G.S., Hydro. Inv. Atlas, HA-432, 4 sheets, scale 1:1,000,000.

This report summarizes the water resources of the Wisconsin Lake Michigan basin. Sheet no. 1 presents an introduction, the physical setting, and the hydrologic cycle of the area. Sheet no. 2 describes the groundwater, and the groundwater - surface-water relationships. Sheet no. 3 describes the surface water. Sheet no. 4 presents water use information, potential areas for irrigation, and a summary.

Skinner, E.L.; Borman, R.G. 1973. USGS
Water resources of Wisconsin - Lake Superior basin: U.S.G.S., Hydro. Inv. Atlas, HA-524, 3 sheets, scale 1:1,000,000.

This report summarizes the water resources of the Wisconsin Lake Superior basin. Sheet no. 1 describes the physical setting, water use and water systems within the area. Sheet no. 2 describes the groundwater and groundwater - surface-water relationships of the area. Sheet no. presents surface water data, selected references, agency information and a summary of the area.

Smith, L.S. 1906. UW-GL
Water powers of northern Wisconsin: U.S.G.S., Water-Supply Paper 156, 145 p., illus.

This early paper describes the water power resources of northern Wisconsin. The geology, topography, hydrology, climatology, water powers, soils, and vegetation are described for the Fox, Menominee, Peshtigo, Oconto, Wolf, and Lake Superior River systems.

Smith, L.S. 1908. UW-GL
Water powers of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 20 (econ. ser. 13), 354 p., illus.

This bulletin describes the water power resources of Wisconsin. The geology, topography, hydrology, climatology, water powers, soils and vegetation are described for the Fox, Menominee, Peshtigo, Oconto, Wolf, Lake Superior, Milwaukee, Manitowoc, and Sheboygan River Systems.

Southeastern Wisconsin Regional Planning Commission. 1966. UW-EL
Water quality and flow of streams in southeastern Wisconsin: SEWRPC, Tech. rpt. 4, 342 p., illus., maps.

This report documents stream water quality and quantity within the southeastern Wisconsin region. It relates the present condition of stream water quality within the region to existing major sources of pollution, assesses the effect of stream water quality on various water uses, and explores the interrelationships between stream water quality and land use patterns.

Southeastern Wisconsin Regional Planning Commission. 1971. UW-EL
A comprehensive plan for the Milwaukee River watershed: SEWRPC, Planning rpt. 13, 2 vol., 1139 p., illus., maps.

This planning report consists of two volumes. The first volume presents a summary of the required inventory findings, as well as forecasts of future growth and development within the watershed. These inventories and forecasts provide the basis for an in-depth analysis of the resource-related problems and, as such, the basis for the preparation of alternative watershed plan elements.

The second volume presents the alternate land use, natural resource protection, park and outdoor recreation, parkway and scenic drive, flood control, stream and lake pollution abatement, and water elements considered: describes the recommended comprehensive plan for the watershed, and sets forth detailed recommendations on the means for carrying out the plan.

Threinen, C.W. 1962. DNR
Wolf River watershed: Wis. Cons. Dept., 55 p., tables, maps.

This report is an inventory of the quantity and types of water available within the Wolf River watershed. The 424 lakes in the watershed provide approximately 49,665 acres of water and 520 miles of frontage. The watershed has about 1,355 miles of streams of all sizes.

Threinen, C.W.; Poff, R.J. 1964. DNR
Supply and demand of surface water resources of southeastern Wisconsin: Wis. Cons. Dept., misc. rpt. 12, 48 p., illus.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Kenosha, Racine, and Walworth Counties as well as the present and potential use of the water resources.

Trippe, H.M. 1932. SHL
Examination of the Fox River, Wisconsin: U.S., 72d. Cong., 1st. sess., House Doc. 212, 24 p., map.

This report presents a plan for flood control on the Fox River. Information concerning flood problems on the river and methods of solving them is contained.

Trippe, H.M. 1932. SHL
Wolf River, Wisconsin: U.S., 72d Cong., 1st sess., House Doc. 276, 104 p., tables, maps.

This report covers navigation, flood control, power development, and irrigation on the Wolf River, Wisconsin. The hydrology of the river is described.

U.S. Army Corps of Engineers. 1922. SHL
Survey of the Fox River: U.S. 67th Cong., 2d sess., House Doc. 146, 170 p., maps.

This report deals with the possibility of the improvement of the Fox River. Sections of the report include: (1) general description, (2) present project, (3) history, (4) navigation, (5) water power, (6) drainage, and (7) hydrology.

U.S. Army Corps of Engineers. 1959.
Water resources development in Wisconsin: Chicago District, 33 p., illus., maps.

U.S. Army Corps of Engineers. 1960.
Head of Green Bay including Fox River below DePere, Wis.: Great Lakes Division, U.S. Lake Survey chart 725.

U.S. Army Corps of Engineers. 1960.
Lake Michigan, Jacksonport to Kewaunee, Wis., and Green Bay, south to Peshtigo Point: Great Lakes Division, U.S. Lake Survey Chart 703.

U.S. Army Corps of Engineers. 1960.
Lake Winnebago and Fox River: Great Lakes Division, U.S. Lake Survey Chart.

U.S. Army Corps of Engineers. 1970.
Flood plain information, Manitowoc Co., Wisconsin: Chicago District, 67 p., illus., tables, maps.

U.S.D.A., Soil Conservation Service. 1961.
Report for flood control in the Milwaukee River watershed: 15 p., maps.

U.S. Department of the Interior. 1972. WRC
Lake Michigan, a bibliography: U.S. Department of the Interior, Office of Water Resources Research, 127 p.

This report is one of a series of bibliographies in water resources. It contains abstracted bibliographies pertaining to the water resources of Lake Michigan.

U.S. Department of the Interior. 1972. WRC
Lake Superior, a bibliography: U.S. Department of the Interior, Office of Water Resources Research, 125 p.

This report is one of a series of bibliographies in water resources. It contains abstracted bibliographies pertaining to the water resources of Lake Superior.

U.S.G.S. 1910-1971. UW-GL
Surface water supply of the United States, St. Lawrence River Basin 1907-1965: U.S.G.S., Water-Supply Papers 244, 264, 284, 304, 324, 354, 384, 404, 434, 454, 474, 504, 524, 544, 564, 584, 604, 624, 644, 684, 699, 714, 729, 744, 759, 784, 804, 824, 854, 874, 894, 924, 954, 974, 1004, 1034, 1054, 1084, 1114, 1144, 1174, 1207, 1237, 1277, 1377, 1387, 1437, 1507, 1557, 1627, 1707, 1911.

These papers list gaged lakes and rivers, gage locations, and gage heights or discharges for Wisconsin's coastal zone drainage basins.

Year	WSP	Gaged drainage basins
1907-1908	244	Menominee, Peshtigo, Oconto, Wolf.
1909	264	Menominee, Peshtigo, Oconto, Wolf.
1910	284	Menominee, Wolf.
1911	304	Menominee, Wolf.
1912	324	Wolf.
1913	354	Menominee.
1914	384	Amnicon, Bois Brule, Bad, Menominee, Brule, Pine, Pike, Oconto, Wolf, Little Wolf, Milwaukee.
1915	404	Amnicon, Boix Brule, Bad Menominee, Brule, Pine, Pike, Peshtigo, Oconto, Wolf, Little Wolf, Milwaukee.
1916	434	Amnicon, Bois Brule, Bad, Menominee, Brule, Pine, Pike, Peshtigo, Oconto, Wolf, Little Wolf, Waupaca, Sheboygan, Milwaukee.
1917	454	Bois Brule, Bad, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Little Wolf, Waupaca, Sheboygan, Milwaukee.
1918	474	Bad, Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Little Wolf, Waupaca, Sheboygan, Milwaukee.
1919-1920	504	Bad, Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee.
1921	524	Bad, Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee.
1922	544	Bad, Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee.
1923	564	Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee.

Year	WSP	Gaged drainage basins
1924	584	Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee.
1925	604	Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee.
1926	624	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee.
1927	644	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee.
1928	664	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee.
1929	684	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee.
1930	699	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee.
1931	714	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek.
1932	729	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek.
1933	744	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek.
1934	759	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek.
1935	784	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek.
1936	804	Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek.
1937	824	Amnicon, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek, Wheeler Lake near Lakewood, Boat Lake, Silver Lake, Little Green Lake, Lucerne Lake, Lake de Neveu, Cedar Lake near Kiel.
1938	854	Amnicon, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Milwaukee, Cedar Creek, Mamie Lake, Big Lake, Palmer Lake, Tenderfoot Lake, Wheeler Lake, Little Green Lake, Lucerne Lake,Lake de Neveu, Cedar Lake.
1939	874	Amnicon, Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Tenderfoot Lake, Palmer Lake, Big Lake, Mamie Lake, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu, Cedar Lake.

Year	WSP	Gaged drainage basins
1940	894	Amnicon, Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Fond du Lac, Milwaukee, Cedar Creek, Tenderfoot Lake, Palmer Lake, Big Lake, Mamie Lake, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu, Cedar Lake.
1941	924	Amnicon, Montreal, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Big Lake, Wheeler Lake, Boat Lake, Lake Winnebago, Silver, Lake, Little Green Lake, Lake de Neveu, Cedar Lake.
1942	954	Amnicon, Montreal, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Big Lake, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu, Cedar Lake.
1943	974	Amnicon, Bois Brule, Montreal, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Big Lake, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu, Cedar Lake.
1944	1004	Amnicon, Montreal, Brule, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Big Lake, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu.
1945	1034	Amnicon, Bois Brule, Montreal, Brule, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Big Lake, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu.
1946	1054	Amnicon, Bois Brule, Montreal, Brule, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Lake de Neveu.
1947	1084	Amnicon, Bois Brule, Montreal, Brule, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu.
1948	1114	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu, Cedar Lake.

Year	WSP	Gaged drainage basins
1949	1144	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu, Cedar Lake.
1950	1174	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Lake Winnebago, Silver Lake, Little Green Lake, Lake de Neveu, Cedar Lake
1951	1207	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Oconto, Suamico, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1952	1237	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Pine, Pike, Menominee, Oconto, Suamico, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1953	1277	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1954	1337	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1955	1387	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1956	1437	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1957	1507	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.

Year	WSP	Gaged drainage basins
1958	1557	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1959	1627	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1960	1707	Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee, Cedar Creek, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.
1961-1965	1911	Bois Brule, Sioux River, Bad, White, Montreal, Brule, Menominee, Pine, Popple, Pike, Peshtigo, Oconto, Fox, White, Wolf, Evergreen Creek, Embarrass, Little Wolf, Spaulding Creek, Waupaca, Kewaunee, Sheboygan, Milwaukee, Oak Creek, Root, Amnicon Lake, Long Lake, Wheeler Lake, Boat Lake, Silver Lake, Little Green Lake, Lake Winnebago, Lake de Neveu, Cedar Lake.

U.S.G.S., 1937-1957. UW-GL

Water levels and artesian pressures in observation wells in the United States, 1935-1955 - Wisconsin: U.S.G.S., Water-Supply Papers 777, 817, 840, 845, 886, 908, 938, 946, 988, 1018, 1025, 1073, 1098, 1128, 1158, 1167, 1193, 1223, 1267, 1323, 1406.

Well locations and water level measurements are cited for observation wells in counties bordering the Great Lakes.

Year	WSP	Counties with observation wells
1935	777	None.
1936	817	Marinette.
1937	840	Douglas, Marinette.
1938	845	Douglas, Marinette.
1939	886	None.
1940	908	None.
1941	938	None.
1942	946	None.
1943	988	Ashland.
1944	1018	Ashland.
1945	1025	Ashland.
1946	1073	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Ozaukee, Racine.
1947	1098	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Ozaukee, Racine.
1948	1128	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Racine.

Year	WSP	Counties with observation wells
1949	1158	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Octonto, Racine.
1950	1167	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Racine.
1951	1193	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Racine.
1952	1223	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Racine.
1953	1267	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Racine.
1954	1323	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Racine.
1955	1406	Ashland, Brown, Door, Douglas, Kenosha, Marinette, Milwaukee, Oconto, Racine.

U.S.G.S. 1951. USGS

Index of surface-water records to September 30, 1950, pt. 4, St. Lawrence River Basin: Circ. 123, p. 2-4.

This index lists the stream flow and reservoir stations in the St. Lawrence River Basin for which records have been published for periods prior to September 30, 1950. The stations are listed in downstream order.

U.S.G.S. 1958. UW-GL

Compilation of records of surface-waters of the United States through September 1950, pt. 4: Water-Supply Paper 1307, p. 21-152.

This volume presents monthly and yearly summaries of streamflow and reservoir data collected by the Geological Survey for the St. Lawrence River Basin through September 1950. Wisconsin rivers include the Amnicon, Bois Brule, Bad, White, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Fond du Lac, Sheboygan, Milwaukee, and Cedar Creek.

U.S.G.S. 1961-64. USGS

Surface water records of Wisconsin: annual.

These reports list streamflow records and related data on a yearly basis for the State of Wisconsin. They contain daily stream discharges and lake levels for the following lakes and streams tributary to Lake Superior and Lake Wisconsin.

Water Year	Lakes and Rivers
1960-61	Amnicon Lake, Bois Brule R., Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonogon R., West Branch Ontonagon R., South Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Boat Lake, Oconto R., Fox R., Silver Lake, Grand R., Little Green Lake, Wolf R., Embarrass R., Little Wolf R., Waupaca R., Lake Winnebago, de Neveu Creek, Lake de Neveu, Sheboygan R., Milwaukee R., and Cedar Creek.

Water Year	Lakes and Rivers
1961-62	Amnicon Lake, Bois Brule R., Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., South Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Boat Lake, Fox R., Silver Lake, Grand R., Little Green Lake, Wolf R., Embarrass R., Little Wolf R., Waupaca R., Lake Winnebago, De Neveu Creek, Lake de Neveu, Sheboygan R., Cedar Lake, Sheboygan R., Milwaukee R., Cedar Creek, and Menominee R.
1962-63	Amnicon Lake, Bois Brule R., Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., South Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Boat Lake, Fox R., Silver Lake, Grand R., Little Green Lake, Wolf R., Embarrass R., Little Wolf R., Waupaca R., Lake Winnebago, De Neveu Creek, Lake de Neveu, Sheboygan R., Cedar Lake, Milwaukee R., Cedar Creek, and Menominee R.
1963-64	Amnicon Lake, Bois Brule R., Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., South Branch Ontonagon R., West Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Peshtigo R., Oconto R., Wheeler Lake, Boat Lake, Fox R., Silver Lake, Grand R., Little Green Lake, White R., West Branch White R., Wolf R., Embarrass R., Little Wolf R., Lake Winnebago, De Neveu Creek, Lake de Neveu, Sheboygan R., Cedar Lake, Milwaukee R., Menominee R., Oak Creek, and Root R.

U.S.G.S. 1965-1973. USGS

Water resources data for Wisconsin: annual.

These reports list water year surface-water records for gaging stations, partial-record stations, and miscellaneous sites within the State of Wisconsin. They contain daily stream discharges and lake levels for the following lakes and streams tributary to Lake Superior and Lake Michigan:

Water Year	Rivers and Lakes
1964-65	Bois Brule R., Iron R., Long Lake, Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., South Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., White R., West Branch White R., Wolf R., Embarrass R., Little Wolf R., Lake Winnebago, Sheboygan R., Cedar Lake, Milwaukee R., Oak Creek, and Root R.

Water Year	Rivers and Lakes
1965-66	Bois Brule R., Iron R., Long Lake, Sioux R., Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., Wolf R., Evergreen R., Evergreen Creek, Embarrass R., Little Wolf R., Spaulding Creek, Waupaca R., Lake Winnebago, Kewaunee R., Sheboygan R., Cedar Lake, Milwaukee R., Oak Creek, and Root R.
1966-67	Bois Brule R., Iron R., Long Lake, Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., South Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., Wolf R., Evergreen R., Evergreen Creek, Embarrass R., Little Wolf R., Lake Winnebago, Kewaunee R., Sheboygan R., Cedar Lake, Milwaukee R., Cedar Creek, Oak Creek, and Root R.
1967-68	Bois Brule R., Iron R., Long Lake, Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., South Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., Montello Creek, Lawrence Creek, Grand R., Wolf R., Evergreen Creek, Embarrass R., Little Wolf R., Lake Winnebago, Kewaunee R., Sheboygan R., Cedar Lake, Milwaukee R., Oak Creek, and Root R.
1968-69	Bois Brule R., Iron R., Long Lake, Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., Montello Creek, Lawrence Creek, Grand R., Wolf R., Evergreen R., Evergreen Creek, Wolf R., Embarrass R., Little Wolf R., Waupaca R., Crystal R., Emmons Creek, Lake Winnebago, Kewaunee R., Sheboygan R., Cedar Lake, Milwaukee R., East Branch Milwaukee R., North Branch Milwaukee R., Cedar Creek, Oak Creek, and Root R.
1969-70	Bois Brule R., Iron R., Long Lake, Bad R., White R., Montreal R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Pike R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., Montello Creek, Lawrence Creek, Grand R., Wolf R., Evergreen R., Evergreen Creek, Embarrass R., Little Wolf R., Waupaca R., Crystal R., Emmons Creek, Lake Winnebago, Kewaunee R., Sheboygan R., Cedar Lake, Milwaukee R., Cedar Creek, Menominee R., Oak Creek, and Root R.

Water year	Rivers and Lakes
1970-71	Bois Brule R., Iron R., Long Lake, Bad R., White R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., Montello Creek, Lawrence Creek, Grand R., Wolf R., Evergreen R., Evergreen Creek, Embarrass R., Waupaca R., Crystal R., Emmons Creek, Lake Winnebago, Kewaunee R., Sheboygan R., Cedar Lake, Milwaukee R., East Branch Milwaukee R., North Branch Milwaukee R., Oak Creek and Root R.
1971-72	Bois Brule R., Iron R., Long Lake, Bad R., Alder Creek, White R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Peshtigo R., Oconto R., Wheeler Lake, Fox R., Montello Creek, Lawrence Creek, Grand R., Wolf R., Evergreen R., Evergreen Creek, Embarrass R., Waupaca R., Crystal R., Emmons Creek, Lake Winnebago, Kewaunee R., Sheboygan R., Cedar Lake, Sheboygan R., Milwaukee R., East Branch Milwaukee R., North Branch Milwaukee R., Oak Creek, and Root R.
1972-73	Bois Brule R., Iron R., Long Lake, Bad R., Alder Creek, Bad R., White R., Black R., Presque Isle R., Middle Branch Ontonagon R., West Branch Ontonagon R., Cisco Branch Ontonagon R., Brule R., Menominee R., Pine R., Popple R., Peshtigo R., Oconto R., Wheeler Lake, Pensaukee R., Fox R., Montello Creek, Lawrence Creek, Grand R., Wolf R., Evergreen R., Evergreen Creek, Embarrass R., Waupaca R., Crystal R., Emmons Creek, Lake Winnebago, Kewaunee R., East Twin R., Manitowoc R., Sheboygan R., Cedar Lake, Milwaukee R., East Branch Milwaukee R., North Branch Milwaukee R., Menomonee R., Oak Creek, Root R., and Pike R.

U.S.G.S. 1968. USGS
Water resources in Wisconsin: U.S.G.S., Rpt. Inv. Folder, 8 p.

This folder contains a brief description of the water resources investigations in Wisconsin in which the U.S. Geological Survey has participated through 1968. In addition, a list of selected references is included.

U.S.G.S. 1970. USGS
The national atlas of the United States of America: U.S.G.S., pt. Water, p. 117-127.

This atlas presents a series of maps that summarize the water resources of the United States.

U.S.G.S. 1971. UW-GL
Index of surface-water records to September 30, 1970, pt. 4: Circ. 654, p. 5-11.

This report lists streamflow and reservoir stations in the St. Lawrence River basin for which records have been published in reports of the Geological Survey for periods through September 30, 1970.

U.S.G.S. 1972. USGS
Water resource investigations in Wisconsin, 1972: U.S.G.S., Rpt. Inv. Folder, 8 p.

This report summarizes the water resources investigations of the U.S.G.S. through July 1972. It contains a bibliography of U.S.G.S. publications pertaining to Wisconsin's water resources.

U.S.G.S. 1975. USGS
Water resources investigations in Wisconsin: U.S.G.S., Rpt. Inv. Folder, 45 p., map.

This report describes the water resources projects and activities of the U.S. Geological Survey in Wisconsin for the 1975 fiscal year. The included map shows the locations of areal studies (other than statewide); statewide basic-record sites; low-flow, partial-record sites; and crest-stage, partial-record sites. The report also contains a listing of all publications that have been prepared or contributed to by the Wisconsin District.

U.S. National Resources Planning Board. 1937. SHL
Drainage basin committees reports: Committee rpts., Wis. nos. 44, 45, p. 1-20.

This publication contains reports on the Lake Superior and Lake Michigan drainage basins. The reports were prepared by a Drainage Basin Committee in cooperation with the Water Resources Committee, and are intended to present the needs and objectives of a program for each basin.

U.S. National Resources Planning Board. 1938. SHL
Drainage basin problems and programs, 1937: Committee rpt., p. 41-46.

A report is presented on the Great Lakes - St. Lawrence Drainage Basin. The purpose of the report is to: (1) determine the principal water problems in the basin, (2) to outline an integrated pattern of water development and control designed to solve problems, and (3) to present specific construction projects and investigation projects as elements of the integrated plan, with priorities of importance and time.

Uttormark, P.D.; Nunnelee, L.J.; Utter, L.C. 1969. WRC
Selected water resources index for Wisconsin: U.W., Water Resources Center, 203 p.

This index was prepared by searching the libraries of the University of Wisconsin-Madison for information pertaining to water and related resources of Wisconsin. References were located, appropriate key words were selected, and the information was organized to form an index using the computer-based University of Wisconsin Index System.

Waller, R.M. 1971. USGS
Ground water - the Great Lakes Basin's hidden resource: Great Lakes Basin Commission Communicator, v. 1, no. 11, 2 p.

The author describes the general state of ground water in the Great Lakes Basin. A description of the main ground water aquifers of the region is presented.

Weber, J.J.; Desparate, M.; Threinen, C.W. 1968. DNR
Surface water resources of Manitowoc County; Wis. Dept. Nat. Resources, Lake and stream classification project, 97 p., tables, maps.

This report presents information regarding the number, size, physical, and chemical characteristics of lakes and streams in Manitowoc County as well as the present and potential use of the water resource. In addition, short sections describe the topography, geology, soils, climate, drainage systems, area, and population of the county.

Weber, J.J.; Poff, R.; Threinen, C.W. 1968. DNR
Surface water resources of Sheboygan County: Wis. Dept. Nat. Resources, lake and stream classification project, 81 p., tables, maps.

This report presents information regarding the number, size, physical and chemical characteristics of lakes and streams in Sheboygan County as well as the present and potential use of the water resource. In addition, short sections describe the topography, geology, soils, climate, drainage systems, area and population, and land use of the county.

Weidman, S.; Schultz, A.R. 1915. UW-GL
The underground and surface water supplies of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 35 (econ. ser. 17) 664 p., illus., map.

This paper describes the quantity and quality of Wisconsin's surface and underground water supplies. The geological and geographical influences on the state's water resources are discussed. The water resources of each of Wisconsin's counties are described.

Wiitala, S.W. 1965. UW-GL
Magnitude and frequency of floods in the United States - pt. 4: U.S.G.S. Water-Supply Paper 1677, 375 p.

Flood magnitude-frequency relations applicable to streams in the St. Lawrence River basin are presented in this report. For the most part, the relations are based on flood data collected at gaging stations having 5 or more years of records unaffected by regulation. Wisconsin's rivers cited include the Bois Brule, Bad, White, Montreal, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Hunting, Fond du Lac, Sheboygan, Milwaukee, and Cedar and Oak Creeks.

Williams, G.R.; Crawford, L.C. 1940. UW-GL
Maximum discharges at stream measurement stations through Dec. 31, 1937: U.S.G.S., Water-Supply Paper 847, 272 p.

This report is a compilation of the highest known discharges at most gaging stations in the United States and at several places on boundary streams in Canada and Mexico. Wisconsin's St. Lawrence River Basin streams include the Amnicon, Bois Brule, Bad, Montreal, Brule, Menominee, Pine, Pike, Peshtigo, Oconto, Fox, Wolf, Embarrass, Little Wolf, Waupaca, Sheboygan, Milwaukee, and Cedar Creek.

Williams, W.G. 1846. SHL
Report of the survey of Green Bay: U.S. 29th Cong., 1st sess., Exec. Doc. 170, 1 p., map.

This report consists of a map of the Green Bay area. Water depths are depicted along a number of transects through the bay.

Wisconsin State Planning Board. 1938. UW-Geog
The Fox River Valley; a study of the Fox-Wolf watershed as it is affected by the river and its fluctuations: Bull. no. 5, 69 p., illus., maps.

This report is a study of all data available with reference to recurrent losses of property and business resulting from the violent fluctuations in the flow of the Fox, Wolf, and Fond du Lac River systems. The report presents the causes of this wide variation in stream flow, and the methods available for regulating stream flow and minimizing floods and flood peaks.

Wisconsin State Planning Board. 1940. UW-Geog
The Milwaukee River basin - a study of rainfall and runoff, floods and the possibility of flood control: Bull. no. 10, 69 p., maps.

The purpose of this report is to present the principal facts with reference to conditions on the Milwaukee River as they affect flood conditions, the facts with reference to floods that have occurred within the period of record, and the probability as to future gloods, the various methods of flood control that have been proposed, what would probably occur if flood control works should be constructed, how their construction would affect the people of the locality where they would be constructed, and their probable cost.

Witzel, S.A. 1930. UW-ML
Hydrology of six Wisconsin rivers and the Lake Superior drainage area: M.S. Thesis, U.W., 70 p., illus.

This study has been made to determine what error may be expected when using a short period of record in estimating the average flow over a long period of time. The study deals with annual hydrographs and duration curves for the Apple, Fox, Menominee, St. Croix, and Wisconsin rivers as well as Lake Superior at Sault St. Marie.

Young, K.B. 1963. USGS

Flow characteristics of Wisconsin streams: U.S.G.S., open-file report, 151 p.

The purpose of this report is to present the results of streamflow data analysis by electronic computers. The report contains data in summarized form for 70 of the nearly 130 stream-gaging stations that were operated in Wisconsin through 1960. It contains data for gaging stations on rivers that are not significantly affected by regulation or diversion that had five or more years of computed record through water year 1960. For each station for its period of record, flow duration, low flow, and high flow data are summarized in tabular form.

Streams tributary to the Great Lakes include: Bois Brule R., Bad R., White R., W. Br. Montreal R., Pine R., Oconto R., Wolf R., Embarrass R., Little Wolf R., Waupaca R., W. Br. Fond du Lac R., E. Br. Fond du Lac R., Cedar Creek, and Milwaukee River.

Young, K.B. 1965. USGS

Supplement to report on flow characteristics of Wisconsin streams: U.S.G.S., open-file report, 81 p.

This report is a supplement to the report, Flow characteristics of Wisconsin Streams, 1963. It contains data for 28 other gaging stations which have been compiled since 1963. These data are arranged in tables similar to the November 1963 report.

Streams tributary to the Great Lakes include: Montreal R., Brule R., Menominee R., Peshtigo R., Fox R., Wolf R., and Sheboygan River.

Zaporozec, A. 1971. WRC

Ground-water investigation index of Wisconsin: U.W., Water Resources Center, Hydraulic and Sanitary lab., 29 p., illus.

This index is intended to help those concerned with ground water problems within the state to locate known published hydrogeologic activities. In general, information concerning ground water, its occurrence, movement, and relationship to the environment, quantity and quality, and use and management, are listed.

Zaporozec, A. 1974. WRC-SGL

Bibliography and index of Wisconsin ground water 1851-1972: Wis. Geol. and Nat. Hist. Survey in cooperation with Wisconsin D.N.R., 100 p.

This bibliography incorporates, and is an expansion of, Ground Water Investigation Index of Wisconsin published by the University of Wisconsin Water Resources Center in 1971. The bibliography contains 529 entries covering the period 1851 through 1972.

SOIL REFERENCES

Ableiter, J.K.; Hole, F.D. 1961 SGL

Soil Survey of Bayfield Co., Wisconsin: U.S.D.A., Soil Cons. Service, no. 30 (series 1939) 77 p., maps.

This report describes the location and characteristics of 69 soil associations and miscellaneous land types in Bayfield County. In general, red clays, calcareous below 2 to 3 feet and overlain in places by sand, occur in the lowlands on either side of the Bayfield Peninsula ridge. The ridge is largely occupied by level and rolling to hilly sands, with intervening lakes and bogs. There is a large area of wet land, the Bibon Marsh, in eastern Bayfield County. A nearly level outwash plain occurs along the central part of the western boundary. The southern part of the county has soils of finer texture. About a third of the county is occupied by red clay soils, a third by sands and loamy sands, and a third by generally stony sandy loams, loams, and silt loams.

Anderson, A.C. (and others) 1931

Soil survey of Manitowoc County, Wisconsin: U.S.D.A., Bureau of Chemistry and Soils, no. 34 (series 1926) 28p., tables, map.

Manitowoc County comprises an area of 590 square miles. The land surface ranges from level to rough and hilly. The most conspicuous feature is the Kettle Range, a glacial moraine crossing the county from southwest to northeast. The highest elevation in the county is about 359 feet above Lake Michigan. Drainage is all into Lake Michigan.

Manitowoc County lies wholly within the timbered region, and the soils have developed under a heavy forest cover. The soils naturally fall into two major groups, the mature soils and the immature soils. The first group includes the well-drained upland soils and the better-drained soils on old glacial lake areas and alluvial terraces. These soils are mapped in the Kewaunee, Bellefontaine, Fox, Plainfield, and Superior series. The immature soils, which do not show a complete profile, are mapped in the Genesee, Ewen, Wabash, Poygan, Clyde, Maumee, Granby, Saugatuck, Bridgman, Coloma, and Longrie series, and in the miscellaneous classifications, rough broken land, dune sand, muck, and peat.

Anderson, A.C. (and others) 1933 UW-AL

Soil survey of Brown County, Wisconsin: U.S.D.A., Bureau of Chemistry and soils, no. 17 (series 1929) 27p., illus., map.

Brown county consists largely of a glacial till plain somewhat modified by erosion. Five belts, or physiographic divisions extend across the county from southwest to northeast, parallel with Fox River and the Niagara Escarpment, as follows: (1) An undulating or rolling till plain in the southeastern half of the county (2) a narrow strip of hilly broken land along the Niagara Escarpment, extending from the southwestern corner to the northeastern corner, (3) a belt of level terraces along Fox River and Green Bay, (4) a series of ill-defined benches and eroded slopes about 2 miles wide west of Fox River Valley including many sandy benches and old beach lines, and (5) a level to undulating till plain or shallow old lake bottom in the northwestern corner of the county.

Thirty-eight soil types are mapped and described.

Beaver, A.J. 1967 UW-ML
Characteristics and genesis of some bisequal soils in eastern Wisconsin: Ph.D. Thesis, U.W., Madison, 233p., illus.

Certain soils in the Vladers Drift region of eastern Wisconsin have bisequal character. Upper sequa have the horizon sequence of a Podzol or Brown Podzolic soil while lower sequa resemble those of associated Gray-Brown Padzolic or Gray Wooded soils.

Results of field studies suggest that the genesis of bisequal soils in eastern Wisconsin is a dynamic process, controlled on a regional basis by climatic and biotic factors but locally by natural drainage and kind of parent material.

Brunk, I.W. 1962
Precipitation estimates in the Great Lakes drainage basin. Monthly Weather Review, 90 : 79-82.

Caine, T.A.; Lyman, W.S. 1905 UW-AL
Soil Survey of the Superior area, Wisconsin-Minnesota: U.S.D.A., Bureau of Soils, 22p. maps.

There are generally three topographic divisions in Douglas County. Beginning at the lake, the first is a plain. This plain is made up of lacustrine deposits of silt and clay that were laid down at the close of the Glacial period, at which time the waters of the Superior Lake basin stood at a considerably higher level than at present. The second topographic division of the area consists of basic lava flows. On the Wisconsin side these lava flows constitute a wide belt of country to the south. The third topographic division of the area includes rolling topography with numerous swampy areas and small lakes.

The soils have been classified into eight types. The soil types are: (1) Superior clay, (2) Miami sandy loam, (3) Muck, (4) Superior sandy loam, (5) Rough stoney land, (6) Rock outcrop, (7) Miami sand, and (8) Dunesand.

Chamberlin, T.C. 1883 UW-GL
Soils and subsoils of Wisconsin in Geology of Wisconsin: Wis. Geol. Survey, V. 1, Pt. 3, Chap. 5, p. 678-688.

The origin, erosion, drainage, and occurrence of Wisconsin's soils are described. The difficulties involved in soil mapping are discussed.

Ciolkosz, E.J. 1968 UW-ML
I. The mineralogy and genesis of the Dodge catena of southeastern Wisconsin, II. Rhizosphere weathering and synthesis of soil minerals: Ph.D. Thesis, U.W., Madison, 143p., illus.

Geib, W.J.; Jones, G.B. 1905 UW-AL

Soil Survey of the Carlton Area, Minnesota-Wisconsin: U.S.D.A., Bureau of Soils, 7th Rpt., p. 815-835, maps.

The Nemadji Valley occupies the southeastern part of the mapped area extending north to the St. Louis River and west to a line drawn from Thompson through Wrenshall to a point 6 miles east of Barnum, Minnesota. This division is a lacustrine plain underlain by stratified clay and fine sand and is the most westward extension of the valley of Lake Superior. Its westward boundary is distinctly marked by the abrupt change which takes place in the contours in passing to the drift area proper. The surface is nearly flat, but slopes gently toward the Nemadji River. The streams have excavated canyon-like valleys in this deposit to a depth of from 40 to 100 feet.

Twelve soil types are recognized in the mapped area.

Geib, W.J. (and others) 1929 SGL

Soil survey of Sheboygan County, Wisconsin: U.S.D.A., Bureau of Chemistry and Soils, no. 18 (series 1924) 45p. tables, map.

The relief in Sheboygan County varies from level to rolling and hilly. The most conspicuous physiographic feature of the county is the Kettle Range of hills, which crosses the county from northeast to southwest. Elevations range from the level of Lake Michigan, which is about 600 feet above sea level, to about 1,200 feet above sea level in the high parts of the Kettle Range.

In the mapping of the soils of Sheboygan County, 20 mineral soil series, 2 organic soils, and 2 miscellaneous classes of material, dunesand and rough broken land were recognized.

Geib, W.J. (and others) 1961 SGL

Soil survey of Bayfield County, Wisconsin: U.S.D.A., Bureau of Chemistry and Soils, no. 30 (series 1939) 77p. illus., map.

Bayfield County lies in the Superior upland which is subdivided into the Superior Lowland and the Northern or Superior Highland. The Superior Lowland in Bayfield County is a very gently sloping to very gently rolling plain. It extends from the foot of the Superior Highland to Lake Superior. This plain extends under water to about 300 feet below sea level, where Lake Superior is about 900 feet deep.

Red clays, calcareous below 2 to 3 feet and overlain in places by sand, occur in the lowlands on either side of the Bayfield Peninsula ridge. The ridge is largely occupied by level and rolling to hilly sands, with intervening lakes and bogs. There is a large area of wetland, the Bibon Marsh in eastern Bayfield County. A nearly level outwash plain occurs along the central part of the western boundary. The southern part of the county has soils of finer texture. About a third of the county is occupied by red clay, a third by sands and loamy sands, and a third by generally stony, sandy loams, loams, and silt loams. Sixty-eight soil associations are recognized in the county.

Hole, F.D.; Lee, G.B. 1955 SGL
Introduction to the soils of Wisconsin: Wis. Geol. & Nat. History Survey, Bull. 79 (ed. ser. no. 10) 48p., illus., maps.

This report contains an introduction to the genesis, classification, and morphology of the major soils of Wisconsin. In addition, an appendix contains state maps of bedrock geology, glacial geology, aeolian and sand deposits, native vegetation and climatic factors.

Hole, F.D.; Beatty, M.T. 1957 SGL
Soils of Wisconsin: Wis. Geol. & Nat. History Survey, scale, approx. 1:2,700,000.

A generalized soil map of Wisconsin with a one page explanatory text.

Hole, F.D.; Beatty, M.T.; Lee, G.B. 1966
Soils map of Wisconsin: Wis. Geol. & Nat. History Survey, Misc. Rpt., 1p., map, text.

Hole, F.D. (and others) 1968 SGL
Overlay soil maps of Wisconsin: Wis. Geol. & Nat. History Survey, Misc. Rpt., 41p. explanatory text, 11 maps, scale 1:250,000.

This report consists of eleven soil map sheets showing the distribution of 190 soil groupings for Wisconsin. The sheets are at a scale of 1:250,000 and are designed to be laid over the standard topographic maps of the same scale published by the U.S. Geological Survey. A 41 page mimeographed state soil map legend is available to accompany the overlay soil maps.

Hole, F.D.; Beatty, M.E.; Klingelhoets, A.J. 1968 SGL
Soil map of Wisconsin: Wis. Geol. and Nat. Hist. Survey, colored wall map, scale 1:710,000.

A generalized map of Wisconsin's soils.

Hole, F.D. 1974 SGL
Soil regions of Wisconsin: Wis. Geol. and Nat. Hist. Survey, scale, approx. 1:2,700,000.

A generalized soil map of Wisconsin with a three page explanatory text.

Horn, Merlin E. 1960 UW-ML
A pedological study of red clay soils and their parent material in eastern Wisconsin: Ph.D. Thesis, U.W., Madison, 238 p., illus., maps.

The purpose of this study is to define the boundaries of the red clay region of central and eastern Wisconsin and to characterize and classify the important soils and their parent materials found within the limits of this region.

Many of the important qualities of the red clay soils are thought to have been pre-determined during the sedimentary history of their parent materials. Special effort has therefore been given to a study of the features of glaciation, inasmuch as the soil parent materials of the red clay region are chiefly of glacial origin.

Janke, W.E. 1962 UW-ML
Characteristics and distribution of soil parent material in the Valderan Drift region of eastern Wisconsin: Ph.D. Thesis, U.W. Madison, 152p., illus., maps.

Soil parent material of Late Wisconsinan (Valderan) age in eastern Wisconsin was studied both in the field and laboratory in order to 1) characterize and classify the various kinds of soil parent material in this region, and 2) determine where these various kinds of parent materials exist and their areal extent.

Kellogg, C.E. 1930 SGL
Preliminary study of the profiles of the principal soil types of Wisconsin: Wis. Geol. & Nat. Hist. Survey, Bull. 77A (soil series 54) 112p., illus.

This report covers a brief description of the profiles of the chief soil types of the state as they have been mapped in detailed soil surveys. A brief description of the geology, climate and native vegetation of the state is presented. Twenty-six soil series are described.

Lee, G.B.; Janke, W.E.; Horn, M.E. 1972 UW-GL
Characteristics and genetic relationships of soils and soil parent materials in the Valderan drift region of eastern Wisconsin: Internat. Assoc. Great Lakes Res., 15th Conference Proc., p. 371-382, maps, tables.

The purpose of this study was to determine the characteristics of soils and their parent materials in the Valderan drift region. Soils in this geologically young area bear a strong relationship to the glacial deposits from which they formed.

Major parent materials include glacial till and glacio-lacustrine deposits. Glacial tills are mainly clayey to loamy, but include sandy types. Glacial-lacustrine deposits are gravel-free; some are stratified.

Results of this study should enable more accurate prediction of the composition of modern sediments eroded from this area and deposited in Green Bay or Lake Michigan.

Lee, G.B.; Horn, M.E. 1972 UW-ML
Pedology of the Two Creeks section, Manitowoc Co., Wisconsin: Wis. Acad. Sci., Arts, and Letters, Trans., v. 60, p. 183-199, illus.

The Two Creeks Forest Bed of eastern Wisconsin is a well known marker of the interval of deglaciation between the Cary and Valders glacial advances. Near the village of Two Creeks, Wisconsin, the Two Creeks horizon consists of a thin paleosol, in which long-dead trees and other plants are rooted, and the overlying, broken over remains of the Two Creeks forest. Both are buried beneath younger drift. At the surface a modern soil has been formed. While the age of the buried horizon, its paleobiological nature, and geologic history have been the subject of considerable study, little has been written about the site from a pedological point of view.

The modern soil at the Two Creeks site was formed partially in Valders deposits, the latter likely laid down in front of the melting Valders ice and later reworked in part by wind.

Link, E.C.; Demo, O.R. 1970 UW-AL
Soil survey of Kenosha and Racine Counties, Wisconsin: U.S.D.A., Soil Cons. Ser., 113p., maps.

The soils of Kenosha and Racine Counties formed mainly in material that was laid down through glaciation. Most of the area between Lake Michigan and the Fox River is occupied by soils having a high content of clay. Loamy, rolling soils lie chiefly west of Fox River. Sixty-eight soil series are mapped and described.

Link, E.C.; Demo, O.R. 1974 UW-AL-SGL
Soil Survey of Brown County, Wisconsin: U.S.D.A., Soil Cons. Ser., 119p., maps.

The topography of Brown County is modified by glaciation and is influenced, to a large extent, by underlying bedrock. Gently sloping topography is dominant. The Niagara escarpment is the most conspicuous topographic feature in the county. It extends in an almost continuous line from the northeastern corner of the county to the southwestern corner. The Fox River, a few miles to the west, is parallel with the escarpment. An area of steep hills and kettles is in the southeastern corner of the county. Most of the soils of the county formed in glacial till and lake sediment that are high in content of clay. The characteristic subsoil and substratum are reddish-brown, slowly permeable clay loam to clay.

Other soils of Brown County formed in loamy or sandy glacial till, outwash sand and gravel, and lacustrine sediment. The moderate to rapid permeability and friable consistence of these soils provide, for the most part, slight to moderate limitations for most uses in residential and industrial development.

Ten soil associations are mapped in the county.

Musbach, F.L. (and others) 1914 SGL
Reconnaissance soil survey of the north part of northwestern Wisconsin: Wis. Geol. & Nat. Hist. Survey, Bull. 32 (soil ser. 6) 92p., illus., maps.

The area discussed in this report comprises about 6600 square miles, located in the northwestern part of the state. The area includes Sawyer, Washburn, Burnett, Douglas, Bayfield and nearly all of Ashland County.

Deposits of glacial material form an almost complete covering of varying depth over the entire section, so the underl rocks are exposed in only a relatively small area. Eighteen soil types in addition to five miscellaneous soil types are recognized in the area.

Ows, D.W. 1968
Some characteristics of glacial till soil parent materials and their influence on soils in the Cary Drift region of southeastern Wisconsin: M.S. Thesis, U.W., Madison.

Parker, D.E.; Kuer, D.C.; Steingraeber, J.A. 1970. UW-AL
Soil survey of Ozaukee Co., Wisconsin: U.S.D.A., Soil Cons. Ser., 92 p., maps.

The soils in Ozaukee County are mostly nearly level to rolling. They are suitable for many different crops. Corn, oats, and alfalfa are the chief crops, but truck crops and canning crops are grown in some areas. Wooded areas are mainly on the steeper soils and on wet soils in low areas.

Five soil associations are described in Ozaukee County.

Pederson, E.J. 1954. UW-ML
Correlation and genesis of the Elliot series on Cary and Tazewell tills in southeastern Wisconsin: M.S. Thesis, U.W., Madison, 84 p., illus., maps.

This investigation includes: (1) a detailed correlation of the Elliot series of Wisconsin and Illinois, (2) an investigation of the surface textural differences indicated by earlier soil mapping, (3) a comparison of depths of leaching of carbonates in the Elliot soils in Wisconsin and Illinois, (4) a study of the factors involved in the weathering of carbonate materials in an attempt to discover why there is only a slight difference in leaching between the Cary and Tazewell tills, (5) a determination by means of chronosequence, of some of the variations in soil profile characteristics that may be related to age, (6) a description of the Elliot soil landscapes and (7) a discussion, in the light of the findings, of the genesis of the Elliot series.

Pollack, S.S. 1956. UW-ML
The mineralogy of a gray-brown podzolic soil and a humic-gley soil of southeastern Wisconsin: Ph.D. Thesis, U.W., Madison, 107 p., illus., maps.

The detailed descriptions, carbon and nitrogen contents, particle size distributions, bulk densities, and silt and clay mineralogy of the horizons of two Wisconsin soil profiles are presented. One profile is representative of the Miami silt loam, a well drained gray-brown podzolic soil developed from two feet of loess over highly dolomitic glacial till. The other represents the Elba silty clay loam, a very poorly drained humic-gley developed from over forty-two inches of silty clay loam material over the till. From the data, interpretations were made concerning the origin of the loess, and changes resulting from soil farming processes.

Southeastern Wisconsin Regional Planning Commission. 1966. UW-EL
Soils of southeastern Wisconsin: SEWRPC, Planning Rpt. 8, 403 p., illus., maps.

This report provides detailed operational soil surveys for the entire seven-county southeastern Wisconsin planning region. This report is unique with respect to the emphasis placed on providing soil interpretations for land use and public facilities planning.

Steingraeber, J.A.; Reynolds, C.A. 1971. UW-AL
Soil Survey of Milwaukee and Waukesha Counties, Wisconsin: U.S.D.A., Soil Cons. Service, 177 p., illus., map.

The soils in Milwaukee and Waukesha Counties have formed mainly in material that was laid down through glaciation. Those in the eastern part have a rather high content of clay. They warm up slowly in spring, are easily compacted, and are likely to puddle if worked when wet. Most of the soils in the central and western parts tend to be droughty, and the sandy ones are subject to blowing. Seventy soil series are mapped in the area.

U.S.D.A., Soil Conservation Service. 1964. UW-AL
Engineering test data and interpretations for major soils of Wisconsin: Madison, Wis., 70 p.,

This report consists of a series of tables which lists the engineering, physical, and chemical properties for representative soils in Wisconsin.

Watson, B.G. 1961. UW-ML
Characterization and classification of Morley and associated soils in southeastern Wisconsin: M.S. Thesis, U.W., Madison, 113 p., illus., maps.

The primary purpose of this study is to: (1) characterize and compare the Morley and so-called "Pink Morley" soils of southeastern Wisconsin and, (2) define their geographic areas of occurrence.

Watterson, K.G. 1964.
Effect of ground cover vegetation on soil moisture in sandy soils of Bayfield upland: U.W., Madison, Soils Dept. and Wis. Cons. Dept., Tech. Notes no. 81, 4 p.

Weidman, S.; Wood, P.O. 1911. SGL
Reconnaissance soil survey of Marinette County: Wis. Geol. and Nat. Hist. Survey, Bull. 24 (soil ser. 1) (econ. ser. 15) 44 p., illus., maps.

The surface of Marinette County varies from nearly level plains to low undulating hills. The altitude adjacent to Green Bay is 580 feet, and in the northwest part of the county about 1,500 to 1,600 feet. The drainage is through the Menominee and Peshtigo Rivers.

The soils are of glacial and alluvial origin, derived from limestone, sandstone, and granite debris. Seven types of soils exclusive of Muck, Peat, and Rock outcrop or stony land, were mapped. The types include Miami fine sandy loam, coloma loam, Superior fine sandy loam, Dunkirk fine sand, Coloma fine sand, Plainfield sand, and Coloma fine sandy loam.

Whitson, A.R. (and others). 1914. SGL
Soil survey of Bayfield Area, Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 31, (soil ser. 5) 51 p., illus., maps.

The soils of the Bayfield area are all of glacial or lacustrine origin, being either deposits from the waters during interglacial periods or formed of the morainic material that marks the course of ice advance. Soil types of BayfieldCounty include Superior clay, Superior sandy loam, Superior silt loam, Coloma gravelly sand, Genesee loam, beach sand, and marsh.

Whitson, A.R. (and others). 1914. SGL
Soil survey of Kewaunee County, Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 39 (soil ser. 9) 84 p., illus., map.

The surface area of Kewaunee County varies from level to rough and the most pronounced feature is the Kettle Moraine, which begins near the center of Casco Township and extends southward. The bluffs along the lake range from 50 to 100 feet in elevation and the highest points in the county are over 150 feet above the lake level. With the exception of a small area in the northeastern part of the county, the drainage is into Lake Michigan, chiefly through the Kewaunee River and its tributaries. There are 20 soil types in Kewaunee County, although a number of these are of small extent and of little importance.

Whitson, A.R. (and others). 1915.
Soil survey of Vilas and portions of adjoining counties, Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 43 (soil ser. 11) 77 p., illus., map.

Whitson, A.R. (and others). 1916. SGL
Reconnaissance soil survey of part of north central Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 50 (soil ser. 15) 78 p., illus., map.

The area covered by this report includes Vilas, Oneida, Iron, Pierce, and parts of Ashland and Rusk Counties. The surface features are characteristic of a glacial region and the topography varies from level to rolling and hilly.

In the area covered by this survey 28 different types of soils were found and mapped. These range in texture from sands of low agricultural value to loams of excellent agricultural value.

Whitson, A.R. (and others). 1916. SGL
Reconnaissance soil survey of northeastern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 47 (soil ser. 12) 87 p., illus., map.

The area covered in this survey includes Forest, Florence, Marinette, Oconto, Langlade, and Shawano Counties.

The surface features are characteristic of a glaciated region and the topography varies from level to rolling and hilly. Ridges in the form of terminal and recessional moraines frequently alternate with less broken tracts of ground moraine, with basins, extensive outwash plains, and numerous swamps and lakes, all having a general northeast and southwest direction. In some places the glacial drift covering has completely obliterated the topographic features of the underlying rock formation, while in other places it only modifies the older topography. White there is some broken land in the area, and numerous hills with steep slopes, the proportion of land which is too rough to be developed agriculturally is comparatively small.

Ten soil series and twenty-five types, excluding peat and muck have been mapped.

Whitson, A.R. (and others). 1919. SGL
Soil survey of Door Co., Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 52D (soil ser. 19) 72 p., illus., map.

Door County lies within the glaciated limestone region of Wisconsin and its surface varies from undulating to gently rolling. Over much of its area the soils are shallow and quite stony. Its total area, including Washington and Chambers Islands, is 469 square miles. Excluding rough stony land, peat, muck, and beach sand, 6 soil series are recognized in the county. They include the Miami, Superior, Poygan, Clyde, Fox, and Plainfield series.

Whitson, A.R.; Geib, W.J., Dunnewald, T.J. 1919. SGL
Soil survey of Milwaukee Co., Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 56A (soil ser. 28) 63 p., illus., map.

Milwaukee county comprises a series of broad, elongated ridges parallelling the shore of Lake Michigan. The surface in general is undulating to rolling. It rises toward the west and an elevation of 260 feet above the lake is attained in the western part of the county.

There is very little sandy soil in the county, about 90 per cent of the soil being heavier than loam. Nine soil series, including 16 types, together with 1 miscellaneous type, are mapped in this county. Of these, the most important are the Miami soils which cover over 74 per cent of the county.

Whitson, A.R.; Dunnewald, T.J.; Thompson, C. 1919.
The soils of northern Wisconsin: U.W., Agr. Exp. Station, Bull. 306, 40 p., illus., map.

Whitson, A.R.; Dunnewald, T.J.; Thompson, C. 1921. SGL

Soil survey of northern Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 55 (soil ser. 27) 46 p., illus., map.

This survey covers the soils of the northern one-half of Wisconsin. The soils of the area are grouped into ten classes, each of which is subdivided into two or three phases.

Whitson, A.R. (and others). 1923. SGL

Soil survey of Racine and Kenosha Counties: Wis. Geol. and Nat. Hist. Survey, Bull. 56B (soil ser. 29) 94 p., illus., map.

The topography of these counties ranges from level or undulating, as on the prairie, terraces, and outwash plains, to broken, as in the kame, kettle basin, and terminal moraine country. The eastern part of the area drains into Lake Michigan, and the remainder through the Fox and Desplaines Rivers, into the Illinois River.

The soils of the area are derived from glacial drift, water-laid materials, and cumulose deposits. Ten distinct soil series, twenty-six soil types, and soil phases, including peat, muck, and dune sand, are recognized and mapped in this area.

Whitson, A.R. (and others). 1926. SGL

Soil Survey of Manitowoc County: Wis. Geol. and Nat. Hist. Survey, Bull. 59B (soil ser. 32) illus., map.

The land surface of Manitowoc County ranges from level to rough and hilly. The most conspicuous physiographic feature is the Kettle Range or Kettle Moraine, a belt of irregular hills, ridges, and depressions which cross the county from southwest to northeast. Along Lake Michigan there is a level area, several miles wide, which grades into gently rolling country before the moraine is reached. This level area is chiefly a lake terrace formation, although it merges with river terraces on Manitowoc and the Twin Rivers in the northeastern part of the county. To the west of the moraine the relief ranges from level to gently rolling, with most of the land surface gently rolling.

The soils of the county naturally fall into two major classes, the well-drained, normally developed or mature soils, and the immature soils. The first group includes soils of the well-drained uplands derived from glacial till and soils of the better-drained areas on old glacial lake and alluvial terraces. The immature soils include areas which do not show a consistent soil profile because the soil materials have not been deposited or well drained or have not been stable sufficiently long to allow weathering to produce a mature profile. Thirty-four soil types are recognized in the county.

Whitson, A.R. (and others). 1926. SGL

Soil survey of Washington and Ozaukee Counties: Wis. Geol. and Nat. Hist. Survey, Bull. 59C (soil ser. 33) 93 p., illus., map.

The area included in Washington and Ozaukee Counties is situated in the eastern part of Wisconsin bordering Lake Michigan. It has a total area of 649 square miles.

The soils of this region have been derived from glacial, lacustrine, and alluvial material, and in addition there are large deposits of peat consisting of partly decayed organic matter. The soils have been classified into 11 series, and 44 types and phases, each one of which is fully described in this report.

Whitson, A.R. 1927. SGL
Soils of Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 68 (soil ser. 49), 270 p., illus., map.

The purpose of this report is to give in nontechnical language a general description of the soils of the State, a brief discussion of the crops and systems of farming to which they are adapted, and the treatments required to secure largest returns. Discussion of soil types is presented by geographical areas.

Whitson, A.R. (and others). 1929. SGL
Soil survey of Bayfield Co., Wisconsin: Wis. Geol. and Nat. Hist. Survey, Bull. 72A (soil ser. 50) 44 p., illus., map.

The southern part of the county is a portion of the highlands of the northern part of the state and has an average elevation of over 1,300 feet. From this highland area there is a broad ridge forming the axis of the peninsula between Lake Superior and Chequamegon Bay. This ridge varies from 1,000 to 1,200 feet in elevation. From the ridge the country slopes toward Lake Superior on the northwest and Chequamegon Bay on the southeast, producing a broad plain sloping gradually from the ridge to the lake on the north and to Chequamegon Bay and the broad valley from the latter southeastward.

Soil types include Superior clay loam, Superior loam, Superior fine sandy loam, Poygan fine sandy loam, Mason sand loam, Orienta sandy loam, Sheboygan sandy loam, Kennan loam, Kennan sandy loam, Antigo fine sandy loam, Cable loam, Plainfield sand, Plainfield light sand loam, Dinning sand, Vilas sand, Bibon fine sand, Sugatuck sand, and peat.

Whitson, A.R. (and others). 1929.
Soil survey of Brown County: Wis. Geol. and Nat. Hist. Survey, Bull. 62A (soil ser. 43) 27 p., illus., map.

Whitson, A.R.; Geib, W.J.; Kellogg, C.E. 1929. UW-AL
The soils of Bayfield County in Land economic inventory of northern Wisconsin, Bayfield County: Wis. Dept. Agr. and Markets, Bull. 100, p. 1-44, illus.

The southern part of Bayfield County is a portion of the highlands of the northern part of the state and has an average elevation of over 1,300 feet. From this highland area there is a broad ridge forming the axis of the peninsula between Lake Superior and Chequamegon Bay. This ridge varies from 1,000 to 1,200 feet in elevation. From the ridge the country slopes toward Lake Superior

on the northwest and Chequamegon Bay on the southeast, producing a broad plain sloping gradually from the ridge to the lake on the north and to Chequamegon Bay and the broad valley extending from the latter southeastward.

Twenty soil types are described and mapped in Bayfield County.

Whitson, A.R. (and others). 1931. SGL

Soil survey of Sheboygan County: Wis. Geol. and Nat. Hist. Survey, Bull. 59A (soil ser. 31) 77 p., illus., map.

The surface relief of Sheboygan County varies from level to rolling to hilly and irregular. The area consists of a gently rolling plain crossed by a range of hills known as the Kettle Range. This range crosses the county from northeast to southwest. It varies in width from $1\frac{1}{2}$ to 3 or 4 miles. A second range of hills is south of the main range and nearly parallel to it. Within these ranges the surface is very irregular, kames, eskers, and potholes are numerous. Between the hills and Lake Michigan the land is level or gently rolling. West of the Kettle Range the surface is gently rolling. The general elevation of the county ranges from about 600 feet to about 970 feet.

The soils of the county may be differentiated, on the basis of their most obvious characteristics, into light-colored, and dark-colored soils. The areas of dark-colored soils, with one exception, are coextensive with the areas of poorly drained land. The exception is the Warsaw soils. In the group of light-colored soils are the Bellefontaine, Miami, Conover, Coloma, Superior, Kewaunee, Rodman, Fox, Lucas, Plainfield, Genessee, and Ewen soil series. In the dark-colored soils are the Warsaw, Clyde, Poygan, Maumee, Wabash, and Saugatuck, which are poorly drained mineral soils, and the organic soils, carlisle muck and Rifle peat.

CLIMATOLOGIC REFERENCES

Ayers, J.C. 1965. WRC

The climatology of Lake Michigan: Univ. Mich., Ann Arbor, Great Lakes Research Div., Pub. no. 12, 73 p.

This report presents a summary of the climatology of Lake Michigan. The author concludes that climatological changes cannot be causing the deteriorative changes that have taken place in Lake Michigan; the climatologically induced changes are too small and in the wrong direction to have stimulated the development of the eutrophic plankton species that are appearing in the lake.

Blust, F.A.; DeCooke, B.J. 1960. UW-GL

Comparison of precipitation on islands of Lake Michigan with precipitation on the perimeter of the lake: Jour. Geophys. Res., v. 65, p. 1565-1572, illus.

A program of precipitation measurement on islands in northeastern Lake Michigan and the lake's perimeter is described. The precipitation on the islands is compared to that on the perimeter of the lake. The results indicate that lake surface precipitation computed from the perimeter stations may be greater than the actual amount in summer and less in winter.

Bolsenga, S.J. 1967. WRC

Total atmospheric water vapor aloft over the Great Lakes basin: U.S. Dept. of the Army, Corps of Engineers, Lake Survey District, research rpt. no. 5-3, 7 p., illus.

Values of atmospheric water vapor aloft were estimated from surface moisture values for 29 stations in the Great Lakes basin using empirical equations as indicated by values of the product-moment correlation coefficient is excellent for all three stations.

Chandik, J.F.; Lyons, W.A. WRC

Radar investigation of summertime land/lake rainfall variations over Lake Michigan: U.W., Madison, Water Resources Center, Tech. Report WIS-WRC-73-10, 53 p., illus.

A detailed analysis of gain-stepped WSR-57 radar data shows that warm season precipitation patterns over the southern basin of Lake Michigan are on the whole unaffected by the presence of a large cold water body. While precipitation echo frequencies associated with air mass shower activity are 13% lower over the lake compared to those over the land portion of the basin, air mass precipitation accounts for less than 10% of all warm season precipitation over the lake portion of the southern Lake Michigan basin. However, when radar echoes for all warm season precipitation types, e.g., cold fronts, squall line, and overrunning are investigated, overlake echo counts are slightly greater than land echo counts for comparative land and lake test areas. Regions of maximum echo occurrence within 100 mi. of Chicago show a persistent orientation similar to climatologically estimated isohyetal patterns for a non-lake affected situation. A hint of increased echo frequencies northeast of the Chicago-Gary industrial complex suggests further studies to ascertain the possibility of inadvertent weather modification.

Changnon, S.A., Jr. 1966. UW-Geog
Effect of Lake Michigan on severe weather: Internat. Assoc. Great Lakes Res., Pub. no. 15, p. 220-234.

Lake influences were found to effect thunderstorm activity in all four seasons with the greatest changes occurring in the summer and fall seasons. In the summer the lake reduces thunderstorms over the southern portion of the lake more than 20 percent but enhances thunderstorm activity in the northern lake area by 20 percent. During the summer in the southern lake area the lake influences actually increase nocturnal thunderstorm activity but the 30 to 50 percent reductions in thunderstorms in the daylight hours cause a net reduction. In the fall, the lake causes a 40 percent increase in thunderstorm activity in parts of lower Michigan and although this increase occurs during the day, it is most pronounced during the nocturnal hours. The lake also affects the areal distribution of hail storms in the spring, summer and fall seasons. In the summer the lake effects reduce hail frequency throughout lower Michigan with the largest reduction being 60 percent along the eastern lake shore. In the fall the lake influences produce a striking increase in hail in lower Michigan.

Changnon, S.A., Jr.; Huff, F.A. 1966. UW-Geog
Measurements of precipitation over Lake Michigan: Internat. Assoc. Great Lakes Res., Pub. no. 15, p. 235-248.

Investigations of various radar and climatological methods of determining precipitation over the lake are reported.

Changnon, S.A., Jr. 1968.
Precipitation climatology of Lake Michigan basin: Ill. State Water Survey, Urbana, Bull. 52, 46 p.

Changnon, S.A., Jr. 1968. UW-GL
Precipitation from thunderstorms and the snowfall around southern Lake Michigan: Internat. Assoc. Great Lakes Res., 11th conference Prof., p. 285-297, illus.

A meaningful measure of the effect of Lake Michigan on thunderstorms and snowfall is provided by precipitation values. Daily data from 41 stations located around the Lake's southern end were analyzed to provide seasonal and annual statistics on the average amount of precipitation on days with thunderstorms on only the west side of the lower lake, days with measurable snowfall on only the west side,

days with thunderstorms only on the east side, days with measurable snowfall on only the east side, days with thunderstorms on both sides, and days with measurable snowfall on both sides. On days when thunderstorms occurred on both sides rainfall on the east averaged 12 percent less than on the west. On days when snowfall occurred on both sides the average precipitation on the east side was 20 percent greater than on the west. On summer days when thunderstorms occurred on the west side and dissipated over the lake the average daily point rainfall on the west was 0.12 in. as compared with 0.03 in. on the east. Conversely when thunderstorms developed over the lake in summer the average point rainfall on the east side was 0.25 in. as compared to 0.15 in. on the west.

Crosman, C. 1888.
Chart showing graphically the fluctuations of the water surface and natural rainfall from 1859-1888, of the Great Lakes: Milwaukee, unpublished, 4 p.

Great Lakes Research Division. 1959. WRC
Sources of hydrographic and meteorological data on the Great Lakes: Inst. of Science and Technology, Univ. Mich., Ann Arbor, Spec. Rpt. no. 8, 183 p., tables.

This report lists sources of hydrographic and meteorological data within and adjacent to the Great Lakes drainage basin.

Harris, D.L. 1968. UW-Geog
Preliminary climatology for the Great Lakes: Mariners Weather Log, v. 12, no. 1, p. 82-84, tables.

Wave observations included in this report were compiled from reports of merchant ships on the Great Lakes. The tables given in this report are based on the 54 percent of the weather reports in which specific information was provided about wave height, wave perior, or both.

Lemire, F. 1961.
Winds on the Great Lakes: Canada Rpt. Transport, Meteorological Branch, CIR. 3560, TEC. 380.

Phillips, D.W.; MacCulloch, J.A.W. 1972. St. Climat
The climate of the Great Lakes Basin: Atmospheric Environment Service of Canada, Lakes and Marine Applications Unit, Climatological Studies no. 20, 40 p., illus., charts.

This report describes in detail the climate of the Great Lakes Basin. Topics of discussion include climatic controls, weather records, temperature, precipitation, humidity, evaporation, radiation, sunshine, sky cover, fog, ice, and wind. Charts of the basin depict: (1) monthly mean and extreme temperature records from the period 1931-1960, (2) mean daily range of temperature for the months of January, April, July, and October, (3) mean daily temperature and its standard deviation for the months of January, April, July, and October, (4) mean daily maximum temperature and its standard deviation for January, April, July and October, (5) mean daily minimum temperature and its standard deviation for the months of January, April, July, and October, (6) mean annual frost free period, (7) mean annual growing season, (8) mean annual precipitation, (9) winter precipitation as a percentage of summer precipitation, (10) means and extremes of monthly precipitation for the period 1931-1960, (11) mean precipitation for January, April, July, and October, (12) mean snowfall for November, January, and March, (13) mean annual snowfall, (14) mean duration of snow cover, (15) dates of 50 percent probability of first snow cover of one inch or more, (16) dates of 50 percent probability of last snow cover of one inch or more, (17) mean vapor pressure for January, April, July, and October, (18) mean annual potential evapotranspiration, (19) mean annual actual evapotranspiration, (2) mean monthly pan evaporation, (21) mean monthly lake evaporation, (22) mean daily incoming solar radiation, (23) mean daily net radiation, (24) mean number of hours of sunshine for January, April, July, and October, (25) mean sky cover from sunrise to sunset for January, April, July, and October, (26) maximum mean ice cover, and (27) wind roses for January, April, July, and October.

Powers, C.F.; Ayers, J.C. 1959. WRC
Sources of hydrographic and meteorological data on the Great Lakes: Internat. Assoc. Great Lakes Res., Special Rpt. no. 8, 183 p.

This report presents the result of a study designed to locate and determine the extent of records in the Great Lakes Region that would aid in the understanding of Great Lakes hydrography. The questionnaire on meteorological and hydrographic records that was employed in this study is included. Sources and type of data available are emphasized.

Richards, T.L.; Irbe, J.R. 1969. UW-GL
Estimates of monthly evaporation losses from the Great Lakes 1950 to 1968, based on the mass-transfer technique: Internat. Assoc. Great Lakes Res., 12th Conference Proc., p. 469-487, illus., tables.

The meteorological service of Canada is currently making estimates at the end of each month of the monthly evaporation losses from each of the Great Lakes bordering Canada. These estimates are based on mass-transfer techniques using modified wind and vapor pressure data from shore line geological and climatological stations and surface water temperature data from regular airborne radiation thermometer flight and ship surveys. This paper presents a brief review of the technique and provides an estimate of monthly evaporation losses from Lakes Superior, Huron, Erie, and Ontario.

Smith, N.P. 1967. UW-ML
The effect of thermal stability of the lower atmosphere on surface winds of Lake Superior: M.S. Thesis, U.W., Madison, 62 p., illus.

The purpose of this study was to determine if readily available meteorological and limnological data could be used to shed light on the problem of energy input into a water surface by the winds in the surface layer. It must be said that the results of the simplified approach used here do not appear encouraging.

U.S. Dept. of Agriculture. 1892-1909. St. Climat
Monthly Weather Review: Weather Bureau, tables, charts.

These reports list monthly temperature and precipitation data for Wisconsin's weather stations prior to 1910.

U.S. Dept. of Commerce. 1910-1975. St. Climat
Climatological Data - Wisconsin: National Oceanic and Atmospheric Administration, monthly, tables.

These reports list monthly mean and daily temperature, precipitation, and snowfall data for all weather stations in Wisconsin. Current stations in Wisconsin's coastal counties include: Superior, Brule Ranger Station, Foxboro, Solon Springs, Gordon, Port Wing 5SW, Bayfield 6N, Madeline Island, Ashland Exp. Farm, Drummond 6W, Mellen, Goodman, Spaulding, Stephenson 5W, Wausaukee, Crivitz, High Falls, Marinette, Peshtigo, Oconto, Breed, Lakewood 3NE, Washington Island, Sturgeon Bay Exp. Farm, Green Bay, Kewaunee, Two Rivers, Manitowoc, Sheboygan, Plymouth, Port Washington, Milwaukee N. Side, Milwaukee Mt. Mary Col., West Allis, Milwaukee, Union Grove, Burlington, Racine, and Kenosha.

U.S. Dept. of Commerce. 1935-1975. St. Climat
Local climatological Data - Green Bay: National Oceanic and Atmospheric Administration, monthly, tables.

These reports list detailed climatological data for Green Bay's Austin Straubel Field Data includes daily maximum, minimum, and average temperature, average dew point, degree days, daily weather type and precipitation, daily average barometric pressure, daily wind data, daily sky cover, and hourly precipitation.

U.S. Dept. of Commerce. 1935-1975. St. Climat
Local climatological Data - Milwaukee: National Oceanic and Atmospheric Administration, monthly, tables.

These reports list detailed climatological data for Milwaukee's Mitchell Field. Data includes daily maximum, minimum, and average temperature, dew point, degree days, daily weather type and precipitation, daily average barometric pressure, daily wind data, daily sky cover, and hourly precipitation.

U.S. Weather Bureau. 1957.
Evaporation maps for the United States: U.S. Dept. of Commerce, Tech. Paper 37, 13 p.

Wisconsin-Michigan Power Company. 1945-1972.
Monthly weather bulletin and Menominee River data summary: Appleton, Wis., Wis.-Mich. Power Co., 8 p.

Wisconsin Statistical Reporting Service. 1967. St. Climat
Wisconsin Weather - Causes, Variations, and Effects: 31 p., illus., charts.

This report contains temperature and precipitation data, as well as other material related to Wisconsin's climate. Maps depict mean monthly precipitation and temperature data for the entire state.

Wisconsin Statistical Reporting Service. 1970. St. Climat
Snow and Frost - Wisconsin: 28 p., illus., maps.

This report describes the occurrence, duration, and severity of frost and snow over the entire state. Charts describe the range of precipitation and frost for the winter months.

Yarnell, D.L. 1934.
Rainfall intensity frequency data - Green Bay: U.S. Dept. of Agriculture, misc. pub. no. 204, 66 p.

Ahrnsbrak, W.F.; Ragotzkie, R.A. 1970. UW-GL
Mixing processes in Green Bay: Univ. Wis., Sea Grant Program, Reprint WIS-SG-71-312. p. 880-890, illus.

A one-dimensional diffusion model is applied to Green Bay. Electrical conductivity and light transmssivity are used to observe the distribution of Fox River water in the Bay. Highest concentrations were found in the vicinity of Long Trail Point and along the eastern and southern end of the Bay.

Ahrnsbrak, W.F. 1971. UW-GL
A diffusion model for Green Bay, Lake Michigan: Univ. Wis., Sea Grant Program, Tech. Rpt 7, 78 p., illus.

A one dimensional model based on the principle of conservation of mass is applied to Green Bay. The seiche is shown to be the mechanism primarily responsible for the dispersal of Fox River water during the summer. Electrical conductivity and light transmissivity are used to observe the distribution of Fox River water in the Bay. A numerical model using a finite difference technique shows that approximately 400 days are required for the Bay to respond to changes in pllutant levels in the River. Fox River water is shown to be being transported through Green Bay into Lake Michigan. During the summer highest concentration gradients of Fox River water were found in the vicinity of Long Trail Point and along the eastern shore of the southern end of the Bay. No appreciable transverse gradients were found in the central and northern portions of the Bay. Ice during the winter inhibits the effectiveness of seiche induced mixing and advective effects are more important.

Ayers, J.C., and others. 1958. UW-Geog
Currents and water masses of Lake Michigan: Internat. Assoc. Great Lakes Res., pub. no. 3, University of Mich., Ann Arbor., 169 p., illus., graphs, maps.

The primary aim of this resport is to develop understanding of the currents and water masses of Lake Michigan. Correlative data on the meterological, biological, and chemical characteristics of the lake were taken routinely. From such data current patterns could be deduced, water masses identified, and unsight into the wind-control of circulation obtained.

Ayers, J.: Hough, J. 1964.
Studies of water movements and sediments in southern Lake Michigan: pt. 2, the surficial bottom sediments in 1962-1963: Univ. Mich., Great Lakes Res. Div., Sp. Pub. no. 19, 44 p.

Church, P.E. 1946. UW-GL
The annual temperature cycle in Lake Michigan: Am. Geophys. Union, Trans. v. 27, p. 109-110.

This report summarizes 2,000 bathythermography observations from 110 lake crossings into brief discussions of the temperature changes in the lake through the year.

Csanady, G.T. 1971. UW-GL
Baroclinic boundary currents and long edge-waves in basins with sloping shore: U.W., Sea Grant Program, Reprint WIS-SG-71-314, p 92-104, illus.

Baroclinic coastal jets were found to be set up by an inflow or outflow of water to or from the shore zone. The center of these jets are somewhat displaced from shore under typical Great Lakes conditions by a distance of about 10 KM. Shore bound waves of long wavelenghts were found to be possible only at frequences below the inertial and are associated with guasi-geostraphic flow. The structure of the basic mode is very similar to that in a constant-depth basin, but that of the higher modes becomes progressively more complex, containing bands of opposing currents.

Disturnell, John. 1865.
The Great Lakes, or inland seas of America: New York, Charles Scribner, 192 p., illus.

Downs, W.; Mallonee P.; Napoli J.; Tweed, A; Weimer L. 1973 UW-GL
Our Great Lakes: Univ. Wis., Sea Grant Program, WIS-SG-73-114, p. 48, illus.

A general report on the Great Lakes containing sections on glacial history, shipping, recreation, pollution, erosion, and lake management. Portions of this report pertain specifically to coastal erosion on Lakes Superior and Michigan.

Engineering Research Institute. 1952.
Low cost shore protection for the Great Lakes: Univ. of Mich, Ann Arbor, Lake Hydraulic Laboratory, Research Pub. no. 3 21 p., illus.

Internation Great Lakes Levels Board. 1973. WRC
Regulation of Great Lakes Water Levels: Report to the Int. Joint Comm. by the Int. Great Lakes Levels Board, 10 volumes, illus., tables.

The purposes of this study are: (1) to review the various factors affecting the fluctuations of the water levels of the Great Lakes; (2) to determine the feasibility of regulating further the water levels in the Great Lakes and connecting channels so as to bring about a more beneficial range of stage and other improvements for the purposes enumerated in the Reference; (3) to determine the changes in existing works and other measures within the basin needed to accomplish such regulation that would be practicable and in the public interest; (4) to provide an estimate of the costs of such measures; and (5) to indicate the probable effects, beneficial or adverse, in each country of any regulation plans or measures proposed. The study considers all major interests affected by the water levels of the Great Lakes.

Appendices contain material pertaining to the following subject matter: hydrology and hydraulics, lake regulation, shore property, fish, wildlife and recation, commercial navigation,power, and regulatory works.

Liw, Paul C.; Housley, John G. 1969. UW-GL
Visual wave observation along the Lake Michigan shore: Internat. Assoc. Great Lakes Res., 12th Conf. Great Lakes Res., Proc., p. 608-621, illus.

A program of visula observations of lake waves along the Lake Michigan shore was conducted by the Water Motion Project, Great Lakes Research Center, in cooperation with the U.S. Coast Guard during the autumns of 1966 and 1967. Observers at seven Coast Guard stations participated in this program. Observations were made from shore to each station at 4-hr. intervals during the periods when small craft or storm warnings were displayed and consisted of the wave height, the wave period, and the direction of wave approach. The analysis shows that the majority of wave heights observed along the Lake Michigan shore during the storm conditions were of the order of one meter, and that wave periods were mostly between three and seven seconds.

Michigan Dep. of Natural Resources. 1973. WRC
A plan for Michigan's shorelines: 135 p., illus., maps.

This plan sets forth a broad management program for the use, enjoyment, conservation, appreciation, protection and perpetuation of the shorelands of Michigan.

Chapters contain information on the following areas: general character of Michigan's shorelands; shore erosion and flooding, environmental areas, other shoreland problems, management guidelines, existing regulatory shoreland management techniques, state and federal shoreland programs, and organizing for shoreland management.

Monahan, E.C. 1968.
A report on a continuing drift-bottle study of the surface currents of Lake Superior: Tech Rpt, no. 2, ONR, NR, 083-212, Physics Dept., Northern Mich, Univ., p. 31-40.

Powers, W. E. 1934. UW-ML
Effects of barometric pressure and winds on the level of Lake Michigan: Ill. State Acad, Sci., Trans., V. 27, p. 113-114, graph.

The several factors which collectively control the level of Lake Michigan are precipitation, withdrawal of water through the Chicago Sanitary System drainage channel, evaporation, true-tides, barometric pressure, winds, and seiches. Although these controls differ in their relative values, winds and barometric pressure can produce measurable changes in the level of Lake Michigan.

Ragotzkie, R. A.; Bratnick, M. 1965. U-Minn
Infrared temperature patterns on Lake Superior and inferred vertical motions. Prac. 8th Conf. Great Lakes Res., Great Lakes Res. Div., Univ. of Mich., Pub. 13: p 349-357.

A series of aerial temperature surveys over Lake Superior in late July 1964 shows two areas of cold surface water dominating the surface temperature pattern. Surface water temperatures of 5-6°C in eastern Lake Superior and 8-9°C in the western part of the lake were consistently observed. A survey of the literature has provided evidence that these cold areas are a regular feature of the lake. A model is proposed which explains the persistence of these cold areas as a balance between radiational heating of the surface layers and upwelling of colder water from below. A calculation based upon the model indicates a vertical velocity of 4.5×10^{-3} cm/sec. The relation between the calculated vertical motion and general circulation of the central portion of the eastern basin is suggested.

Ragotzkie, R.A.; Ahrnsbrak, W.F.; Synowiec, A. 1969. UW-GL
Summer thermal structure and circulation of Chequamegon Bay, Lake Superior--A fluctuating system: Internat. Assoc. Great Lakes Res., 12th Conf. Proc., p. 868-704, illus.

An extensive series of measurements of thermal structure, currents, and seiches was made during July and August 1968 on Chequamegon Bay, a semi-enclosed bay of Lake Superior. Analysis of these data shows that the circulation of this bay is a fluctuating system in which water movement associated with wind-induced movements of the thermocline is the primary mechanism for water exchange between the Bay and the Lake. Superimposed on this flushing mechanism is a complex pattern of temporarily and spatially varying currents associated with seiche activity in the Bay. Current measurements also suggest a weak anticlockwise general circulation. It is postulated that the physical behavior of Chequamegon Bay and its interaction with Lake Superior may be characteristic of other semi-enclosed bays of the Great Lakes.

Ragotzkie, R.A. 1974. UW-SG
The Great Lakes Rediscovered: U.W., Sea Grant Program, Reprint WIS-SG-74-351, p. 454-464, illus.

This article examines the general geology, hydrology, ecology, thermal structure, circulation, ascillations, and eutrophication of the Great Lakes.

Ruggles, D. 1843. UW-ML
On the tides of the North American lakes with observations at Green Bay: Am. Jour. Sci., v. 45, p. 18-27, illus., tables.

This report describes the causes and effects of the tides of North American lakes. Tables present tide height values for Green Bay, Wisconsin.

Ruschmeyer, O.R.; Olson, T.A. 1958.
Water movements and temperatures of western Lake Superior: Univ. of Minnesota, School of Public Health, Minneapolis.

Southeastern Wisconsin Regional Planning Commission. 1963. UW-EL
The natural resources of southeastern Wisconsin: SEWRPC Plan. Rpt. no. 5, 162 p., illus., maps.

This report presents a picture of the natural resource base of the southeastern Wisconsin Region and suggests some programs needed in order to conserve, manage, and further develop these resources. Chapters of special interest include discussion on the following topics: soils, surface water, ground water, and flooding.

Southeastern Wisconsin Regional Planning Commission. 1965. UW-EL
A comprehensive plan for the Root River Watershed: SEWRPC, Plan. Rpt. no. 9, 286 p., illus., maps.

This report is a comprehensive plan for the physical development of the Root River watershed designed not only to solve the pressing problems of flooding, pollution, and changing land use which exists within the watershed but to most advantageously develop the land and water resources of the watershed and provide an environment for human life which is attractive, as well as safe and healthful. Chapters of interest include: Description of the Watershed, Hydrology of the Watershed, Hydraulics of the Watershed, Hydrologic Simulation, and Flood Damages.

Striegl, A.R. 1967. SGL
Shoreline and flood plain zoning along the Wisconsin shore of Lake Michigan: Wisconsin Dept. of Nat. Resources, Div. of Resource Dev., 50 p., illus., maps.

This report includes descriptions of Lake Michigan's shorelands in Wisconsin. The counties included are: Kenosha, Racine, Milwaukee, Ozaukee, Sheboygan, Manitowoc, Kewaunee, and Door. In addition the effects of ice, wave action, currents, and lake levels on the shore are discussed.

U.S. Army Corps of Engineers. 1952.
Preliminary examination report on "property damage on the Great Lakes resulting from changes in lake levels": Great Lakes Division, Chicago, Ill.

U.S. Army Corps of Engineers. 1952.
Variations in Great Lakes levels: Great Lakes Division, U.S. Lake Survey, Detroit, Mich., 33 p.

U.S. Army Corps of Engineers. 1953.
Wave and lake level statistics for Lake Michigan: Office of the Chief of Engineers, Beach Erosion Board.

U.S. Army Corps of Engineers. 1971. SHL
Great Lakes Region Inventory Report, National Shoreline Study: Dept. of the Army, Corps of Engineers, North Central Division, August 1971, v. 5, Sect. 4, p. 29-64, illus., maps.

The Great Lakes Mainland Shoreline of Wisconsin is about 619 miles long. A detailed description of the shoreline is contained in the three subsections of this report. Of the 619 miles of mainland shoreline, about 299 miles have a beach zone and 320 miles are without beaches. The present shoreline uses in Wisconsin are as follows: 174 miles residential, 33 miles industrial and commercial, 11 miles public buildings and related land, 59 miles recreational, and 342 miles agricultural, forest, and undeveloped.

Of the 619 miles of shoreline in Wisconsin it is estimated that about 39 miles sustain critical erosion processes, 250 miles are subject to non-critical erosion, 86 miles are subject to flooding, and 244 miles are non-eroding.

U.S. Army Corps of Engineers, Washington D.C. 1971. SHL
Report of the Chief of Engineers on the National Shoreline Study: National Shoreline Study, Dept. of Army, Corps of Engineers, v. I, 180 p., illus.

In the River and Harbor Act of 1968 the Congress gave to the Chief of Engineers special responsibilities for appraising, investigating and studying the condition of the Nation's shorelines and for developing suitable means for protection, restoration, and management so as to minimize erosion induced damages.
This is the report of the study. Volume I introduces the size and problems of the nation's shorelines. In addition, shore protection and management guidelines are described.

U.S. Army Corps of Engineers. 1972. SGL
Great Lakes shoreline damage - causes and protective measures: North Central Division, General Information Pamphlet, 22 p., illus.

This report is organized in three parts. Part I is a history and background discussion of lake levels, causes of fluctuations and, most important, effects of lake level changes on shorelines. Part II discusses the role of Federal and State Governments in various activities and responsibilities on the Great Lakes related to water and shore areas. It includes information on available data and the sources of such data. Part III is a brief discussion of several emergency type remedial measures, estimates of their cost and general statements on their applicability to various typical situations.

U.S. Dept. of Commerce. 1971-74. WRC
Great Lakes levels 1860-1973: National Oceanic and Atmospheric Administration, National Ocean Survey, 4 vol., tables.

These reports list daily and monthly mean water levels of the Great Lakes, as measured at selected sites.

Viebricher, J.A. 1967. WRC
Lake Superior model independent study report: U.W., Water Resources Center, Spec. Study Rpt., 9 p.

A dynamic model of Lake Superior was built to study the effects of winds, shape, stratification, coriolis effects and energy budget on large scale water circulation. The model is built to have Froude and Rasby numbers similar to those of the lake, distorted horizontal and vertical scales, provisions for stratification of fluid content, and provision for wind to induce circulation and flow patterns in the turbulent flow regime.

Whittlesey, C. 1859. UW-ML
The fluctuations of the water level at Green Bay: Am. Jour. Sci., v. 27 (2) no. 81, p. 305-310.

This report describes the causes and effects of the tides in Green Bay. Tables present extreme fluctuations for August and September, 1858.

Wisconsin Dept. of Natural Resources. 1974. DNR
Coastal imagery - an interim report: 46 p., illus., maps.

The purpose of this report is to establish an inventory of coastal photographs and other remote sensing data of Wisconsin's Lake Michigan and Lake Superior shorelines.

Wisconsin Dept. of Resource Development. 1966. DNR
Wolf River Basin region; comprehensive planning program: Wolf River Basin Regional Planning Comm., 329 p., illus., maps.

This report presents the first three phases of the planning program for the Wolf River Basin. Part one includes an analysis of the region's climate, geology, topography, soils, minerals, water resources, population, economy, land development and community facilities. Part two outlines the comprehensive development plan for the region. Part three deals with means of implementing the plan.