

Wisconsin Geological and Natural History Survey
Bulletin 91
Quaternary geology
of Ozaukee and Washington Counties, Wisconsin
Plate 1

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Explanation

Postglacial sand and silt. Commonly a mixture of sand, silt, and clay containing varying amounts of organic matter; found mostly along the edges of modern streams and at the base of extensive slopes. Contacts between this unit and postglacial organic sediment have been drawn arbitrarily in many places.

Postglacial organic sediment. Peat and muck; thickness ranges from less than 1 m to about 5 m; underlain by deposits of streams, glaciers, or lakes; generally found in low parts of the landscape on flat to gently sloping surfaces.

Postglacial wave-cut terraces along the shore of Lake Michigan. Sand and gravel less than 1 m to several meters thick over older diamicton; generally well sorted; in many places contains imbricated pebbles; sand is water-deposited beach and offshore sediment. Unit **spw**: dissected by postglacial streams and higher in elevation than unit **spw**, which represents a mid-Holocene (Nipissing) shoreline at an elevation of about 189 m. The modern beach is included where unit **spw** is shown adjacent to Lake Michigan.

OZAUKEE MEMBER OF THE KEWAUNEE FORMATION

Diamicton and interbedded sand and silt in dissected bluffs. Basal till with lesser amounts of waterlaid diamicton and mudflow deposits; reddish-brown, crudely stratified or unstratified, compact, uniform, clayey silt, interbedded with moderately well sorted, well stratified sand and silt; most silt and sand is lacustrine; includes modern beach sand; may be vegetated or bare and actively eroding; upper 8 m contains fractures.

Diamicton in areas of hummocky topography. Mostly basal till, commonly with a 1- to 3-m thick layer of mudflow deposits; reddish-brown, crudely stratified or unstratified, clayey silt; generally compact and uniform, except in upper few meters, where sand lenses and other discontinuities are found; upper 10 m contains fractures; surface has low relief (less than 5 m), hummocky topography that is stream dissected within 3 km of Lake Michigan. Unit **Zth**: hummocky end moraine.

Diamicton in areas of palimpsest streamlined topography. Generally compact, uniform basal till; reddish-brown, crudely stratified or unstratified, clayey silt; upper 10 m contains fractures; streamlined forms inherited from an earlier ice advance.

Gravel and sand in outwash plains. Moderately well sorted, well stratified gravel and sand deposited by glacial streams. Unit **Zgp**: less than 20 percent of original floodplain interrupted by depressions formed by melting ice blocks. Unit **Zgpp**: more than 20 percent collapsed surface, yet exhibits some of the uncollapsed former stream bed. Both units deposited by braided streams in front of end moraines or in valleys running parallel to glacier margin.

Silt and sand in lacustrine plains. Moderately well sorted silt, sand, and clay underlying flat plains. Unit **Zip**: occupies low places in the landscape where lakes were dammed by retreating ice margin. Unit **Zip**: found higher in the landscape; commonly surrounded by units **Zth** or **Zth**; deposited in ice-walled lakes.

OAK CREEK FORMATION

Diamicton in areas of hummocky topography. Gray to grayish-brown, crudely stratified or unstratified, clayey silt; generally very uniform, compact basal till, except upper few meters, where sand lenses and other discontinuities may be present in mudflow deposits; waterlaid diamicton common in exposures along Lake Michigan; upper 10 m contains fractures; surface has low relief (less than 5 m), hummocky topography. Unit **Oth**: hummocky end moraine.

Gravel and sand underlying hummocky topography. Poorly to moderately well sorted gravel and sand; surface has moderate relief (less than 15 m), hummocky topography; deposited on and beneath glacial ice by meltwater stream near the ice margin; sediment later collapsed to produce hummocky topography as underlying ice melted.

Gravel and sand in outwash plains. Moderately well sorted to well sorted, well stratified gravel and sand. Unit **Ogp**: less than 20 percent of original stream bed interrupted by depressions formed by melting ice blocks. Unit **Ogpp**: more than 20 percent collapsed surface, yet exhibits some of the uncollapsed former floodplain. Both units deposited by braided streams in front of end moraines or in valleys running parallel to glacier margin.

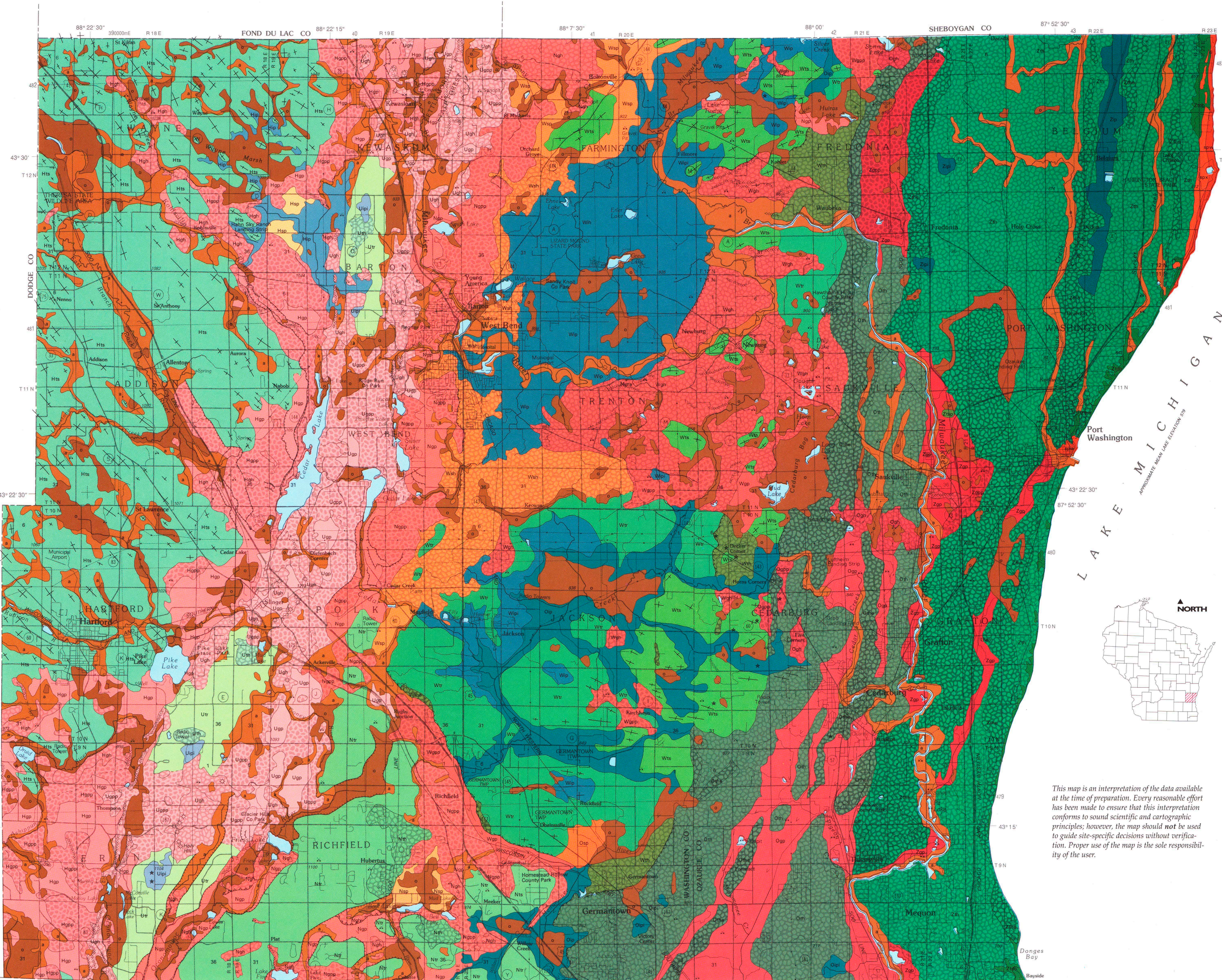
Sand and silt in lacustrine plains. Moderately well sorted to well sorted sand underlying flat or gently rolling low relief (less than 3 m) surface; predominantly beach and nearshore sand deposited in ice-marginal lakes.

Silt and sand in lacustrine plains. Moderately well sorted silt, sand, and clay underlying flat plains. Unit **Oip**: occupies low places in the landscape where lakes were dammed by retreating ice margin. Unit **Oip**: higher in the landscape, commonly surrounded by unit **Oth** or **Oth**; deposited in ice-walled lakes.

WAUBEKA MEMBER OF THE HOLY HILL FORMATION

Diamicton in areas of streamlined topography. Gray to brown, crudely stratified or unstratified, gravelly, clayey, sandy till; generally compact, uniform basal till; upper 8 m contains fractures; streamlined forms were inherited from an earlier ice advance.

Diamicton in areas of rolling topography. Gray to brown, crudely stratified or unstratified, gravelly, clayey, sandy silt; generally compact, uniform basal till; upper 8 m contains fractures; surface is rolling with moderate relief (less than 15 m).



Diamicton in areas of hummocky topography. Gray to brown, crudely stratified or unstratified, gravelly, clayey, sandy silt; generally compact, uniform basal till, except in upper few meters where sand lenses and other discontinuities may be found in mudflow sediments; upper 8 m contains fractures; surface has moderate relief (less than 15 m), hummocky topography. Unit **Wth**: hummocky end moraine.

Gravel and sand in areas of hummocky topography. Poorly to moderately well sorted gravel and sand; surface has moderate to high relief (greater than 10 m), hummocky topography. Deposited on and beneath glacial ice by meltwater stream near the ice margin; sediment later collapsed to produce hummocky topography as underlying ice melted.

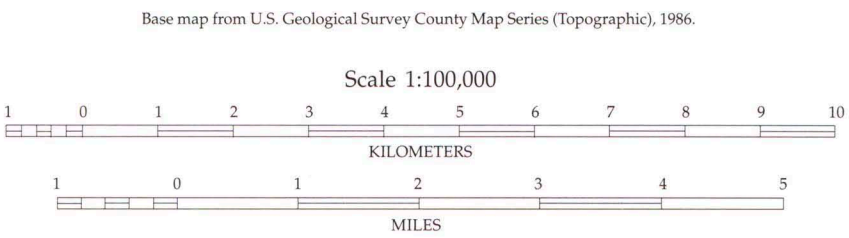
Gravel and sand in outwash plains. Moderately well sorted to well sorted, well stratified gravel and sand. Unit **Wgp**: less than 20 percent of original stream bed interrupted by depressions formed by melting ice blocks. Unit **Wgpp**: more than 20 percent collapsed surface, yet exhibits some of the uncollapsed former stream bed. Both units deposited by braided streams in front of glacier margin.

Sand in lacustrine plains. Moderately well sorted to well sorted sand. Unit **Wsp**: gently rolling low relief (less than 10 m), gently sloping surface. Unit **Wsh**: moderate relief (about 15 m) depressions formed by melting ice blocks and by postglacial dissection. Both units predominantly beach and nearshore sand and fine gravel deposited in ice marginal lakes.

Silt and sand in lacustrine plains. Moderately well sorted silt with some sand and clay. Units **Wip** and **Wipi**: flat or gently rolling surfaces of low relief (less than 3 m). Unit **Wih**: moderate relief (about 15 m) depressions formed by melting ice blocks. **Wip** and **Wih** deposited in regional low areas that contained ice-dammed lakes; both deposited offshore of units **Wsp** and **Wsh**, but unit **Wipi** is higher in the landscape and was deposited in ice-walled lakes.

NEW BERLIN MEMBER OF THE HOLY HILL FORMATION

Diamicton underlying rolling and streamlined topography. Brown to light yellowish-brown, crudely stratified or unstratified, gravelly, clayey, silty sand; generally compact, uniform basal till. Unit **Ntr**: rolling topography with moderate relief (less than 15 m). Unit **Nts**: contains streamlined forms produced by sliding at the glacier bed; surface has high relief (greater than 15 m).



Diamicton in areas of hummocky topography. Brown to light yellowish-brown, crudely stratified or unstratified gravelly, clayey, silty sand; generally compact, uniform basal till, except in upper 5 m, where sand lenses and other discontinuities may be found in mudflow sediments; surface has moderate relief (less than 15 m), hummocky topography.

Gravel and sand in areas of hummocky topography. Poorly to moderately well sorted, poorly to well stratified gravel and sand; surface has high relief (greater than 15 m), hummocky topography; deposited on and beneath glacial ice by meltwater stream near the ice margin; sediment later collapsed to produce hummocky topography as underlying ice melted.

Gravel and sand in outwash plains. Moderately well sorted, well stratified gravel and sand. Unit **Ngp**: less than 20 percent of original stream bed interrupted by depressions formed by melting ice blocks. Unit **Ngpp**: more than 20 percent collapsed surface, yet exhibits some of the uncollapsed former stream bed. Both units deposited by braided streams in front of glacial margin.

Sand and silt in lacustrine plains. Moderately well sorted sand and silt underlying flat plains; occupies low places in the landscape where lakes were dammed by retreating ice margin.

HORICON MEMBER OF THE HOLY HILL FORMATION

Diamicton in areas of streamlined topography. Light yellowish-brown, crudely stratified or unstratified, gravelly, clayey, silty sand; generally compact, uniform basal till. Unit **Htr**: rolling topography with moderate relief. Unit **Hts**: streamlined forms produced by sliding at the glacier bed; surface has high relief (generally greater than 15 m).

Gravel and sand in areas of hummocky topography. Poorly to moderately well sorted sand and gravel; surface has moderate to high relief (greater than 10 m), hummocky topography; deposited on and beneath glacial ice by meltwater stream near ice margin; sediment later collapsed to produce hummocky topography as underlying ice melted.

Gravel and sand in outwash plains. Moderately well sorted, well stratified gravel and sand. Unit **Hgp**: less than 20 percent of the original stream bed interrupted by depressions formed by melting ice blocks. Unit **Hgpp**: more than 20 percent collapsed surface, yet exhibits some of the uncollapsed former stream bed. Both units deposited by braided streams in front of glacier margin.

Sand in lacustrine plains. Moderately well sorted sand and silt underlying flat plains; occupies a low position in the landscape where lakes were dammed by retreating ice margin.

Silt and sand in lacustrine plain. Moderately well sorted silt, sand, and clay underlying flat plains; occupies low places in the landscape where lakes were dammed by retreating ice margin.

UNDIFFERENTIATED DEPOSITS OF THE HOLY HILL FORMATION IN THE KETTLE MORaine AREA

Note: Because the Kettle Moraine formed at the junction between two glacial lobes, sediment from both lobes (Horicon and New Berlin Members) is intimately mixed.

Diamicton in areas of rolling topography. Brown to light yellowish-brown, crudely stratified or unstratified, gravelly, clayey, silty sand; generally compact, uniform basal till; surface has moderate relief (less than 15 m).

Diamicton in areas of hummocky topography. Brown to light yellowish-brown, crudely stratified or unstratified gravelly, clayey, silty sand; generally compact, uniform basal till, except in upper 5 m, where sand lenses and other discontinuities are found in mudflow sediment; surface has moderate relief (less than 15 m), hummocky topography; occupies high places in landscape.

Gravel in areas of hummocky topography. Poorly to moderately well sorted, stratified gravel and sandy gravel; surface has high relief (greater than 15 m), hummocky topography; less than 20 percent of the original stream bed is preserved; occupies highest position in the Kettle Moraine landscape; deposited on, in, or beneath glacial ice by meltwater in the interlobate corridor; sediment later collapsed to produce hummocky topography as underlying or adjacent ice melted.

Gravel and sand in outwash plains. Moderately well sorted, well stratified gravel and sand. Unit **Ugp**: less than 20 percent of original stream bed interrupted by depressions formed by melting ice blocks. Unit **Ugpp**: more than 20 percent collapsed surface, yet exhibits some of the uncollapsed former stream bed. Both units occupy higher positions in the landscape than otherwise similar units on either side of the Kettle Moraine; both deposited by braided streams flowing southwestward through the interlobate corridor.

Silt and sand in lacustrine plains. Moderately well sorted silt, sand, and clay underlying flat plains; occupies high places in the landscape; surrounded by **Ugh** or **Uth**; deposited in ice-walled lakes.

Symbols

- Ice-contact face. Indicates ice-margin position where sand and gravel was deposited against ice, then collapsed as ice melted.
- Ice-margin position. Interpreted position of maximum extent of readvance of ice or position of ice-margin stability where ice-contact face or end moraine is missing.
- Path and direction of meltwater stream.
- Stream cutbank. Hachures point toward stream channel center line.
- Esker. V points in direction of meltwater flow.
- Drumlin. Length of lines on symbol proportional to length of drumlin axes.
- Ice-wedge polygons
- Moulin kame
- Geologic contact. Dashed where uncertain; solid where position shown on map is judged to be generally within 0.1 km of actual position; dashed where the position shown may be more than 0.1 km from actual position.

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Plate 1. Quaternary geologic map of Ozaukee and Washington Counties, Wisconsin.