UNIVERSITY OF MINNESOTA
MINNESOTA GEOLOGICAL SURVEY
D.L. Southwick, Director

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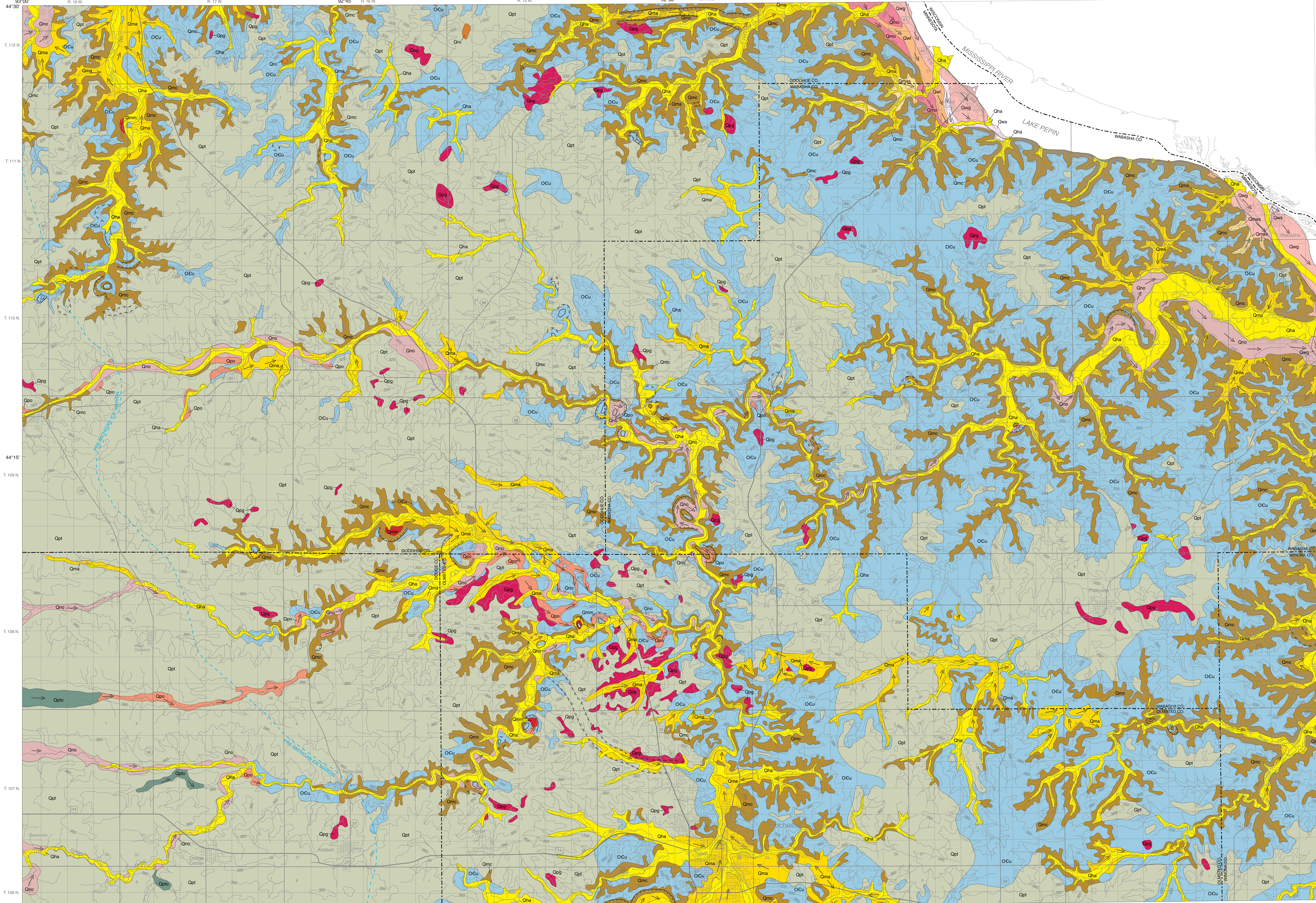
MISCELLANEOUS MAP SERIES
MAP M-107
Surficial Geology, Rochester Quadrangle



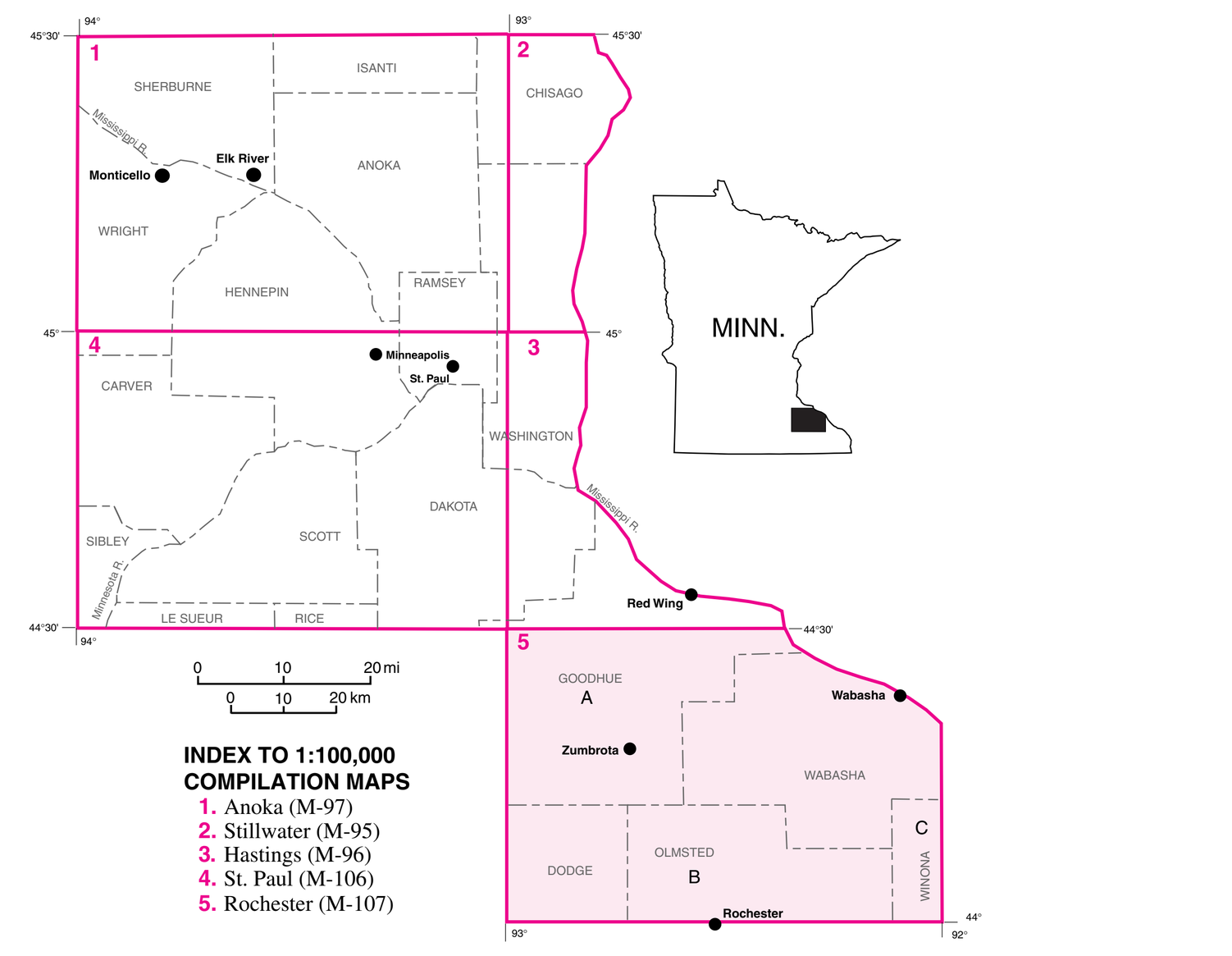
Digital base compiled from the U.S. Geological Survey, Minnesota Department of Transportation, Minnesota Department of Natural Resources, Minnesota Land Management Information Center, and U.S. Bureau of the Census; base annotation by the Minnesota Geological Survey.
Contours derived from the U.S. Geological Survey 30-meter grid cell digital elevation data.
Universal Transverse Mercator Projection, grid zone 15
1983 North American Datum

GIS compilation and cartography by Joyce Meints
digital cartography by Philip Heywood
Edited by Kate Pound

APPROXIMATE MEAN DECLINATION, 2000.

SCALE 1:100 000

CONTOUR INTERVAL 15 METERS



SOURCES OF GEOLOGIC DATA USED TO COMPILE THE MAP

The map above shows the location of the Rochester quadrangle (shaded) relative to the recently completed Stillwater (Meyer, 1999), Hastings (Hobbs, 1999), Anoka (Meyer and Patterson, 1999) and St. Paul (Meyer and Lusardi, 2000) quadrangles. Sources A, B, and C were used to compile the geology of the Rochester quadrangle. The geologic interpretations from sources B and C were revised somewhat for inclusion in this map. New mapping by Howard Hobbs in Wabasha and Dodge Counties was also used in compilation of the Rochester quadrangle.

A. Hobbs, H.C., and Setterholm, D.R., 1998, Surficial geology and thickness of Quaternary sediments, pl. 3 *of* Setterholm, D.R., project manager, Geologic atlas of Goodhue County, Minnesota: Minnesota Geological Survey County Atlas Series C-12, scale 1:100,000, W93°02'29"–92°14'36"/N44°42'53"–44°11'41" [printed single sheet].

B. Hobbs, H.C., 1988, Surficial geology, pl. 3 *of* Balaban, N.H., ed., Geologic atlas of Olmsted County, Minnesota: Minnesota Geological Survey County Atlas Series C-3, scale 1:100,000, W92°40'37"–92°04'75"/N44°11'45"–43°50'05" [printed single sheet].

C. Hobbs, H.C., 1984, Surficial geology, pl. 3 *of* Balaban N.H., ed., Geologic atlas of Winona County, Minnesota: Minnesota Geological Survey County Atlas Series C-2, scale 1:100,000, W92°04'75"–91°16'40"/N44°11'30"–43°50'50" [printed single sheet].

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Hansel, A.K., and Johnson, W.H., 1996, Wedron and Mason groups: Lithostratigraphic reclassification of deposits of the Wisconsin episode, Lake Michigan lobe area: Illinois State Geological Survey Bulletin 104, 116 p.

Harms, G.F., 1959, Soil survey of Wabasha County, Minnesota: U.S. Soil Conservation Service 131 p., 50 maps, scale 1:20,000

Hobbs, H.C., 1984, Surficial geology, pl. 3 *of* Balaban, N.H., ed., Geologic atlas of Winona County, Minnesota: Minnesota Geological Survey County Atlas Series C-2, scale 1:100,000, W92°04'75"–91°16'40"/N44°11'30"–43°50'50" [printed single sheet].

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Hobbs, H.C., and Setterholm, D.R., 1998, Surficial geology and thickness of Quaternary sediments, pl. 3 *of* Setterholm, D.R., project manager, Geologic atlas of Goodhue County, Minnesota: Minnesota Geological Survey County Atlas Series C-12, scale 1:100,000, W93°02'29"–92°14'36"/N44°42'53"–44°11'41" [printed single sheet].

Johnson, W.H., and others, 1997, Late Quaternary temporal and event classifications, Great Lakes Region, North America: Quaternary Research, v. 47, p. 1–12.

Leverett, F. (with contributions by F.W. Sardeson), 1932, Quaternary geology of Minnesota and parts of adjacent states: U.S. Geological Professional Paper 161, 149 p., 5 pls.

Matsch, C.L., 1962, Pleistocene geology of the St. Paul Park and Prescott quadrangles: Minneapolis, University of Minnesota, M.S. thesis, 49 p.

Matsch, C.L., 1972, Quaternary geology of southwestern Minnesota, *in* Sims, P.K., and Morey, G.B., eds., Geology of Minnesota: A centennial volume: Minnesota Geological Survey, p. 548–560.

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Meyer, G.N., and Patterson, C.J., 1999, Surficial geology of the Anoka 30 x 60 minute quadrangle, Minnesota: Minnesota Geological Survey Miscellaneous Map Series M-97, scale 1:100,000, W93°00'–92°00'/N45°30'–45°00' [electronic file].

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Runkel, A.C., 1998, Bedrock geology, pl. 2 *of* Setterholm, D.R., project manager, Geologic atlas of Goodhue County, Minnesota: Minnesota Geological Survey County Atlas Series C-12, scale 1:100,000, W93°02'29"–92°14'36"/N44°42'53"–44°11'41" [printed single sheet].

Stone, J.E., 1966, Surficial geology of the New Brighton quadrangle, Minnesota: Minnesota Geological Survey Geologic Map Series GM-2, 39 p., 3 pls., scale 1:24,000, W93°15'–93°07'30"/N45°07'30"–45°00' [printed single sheet].

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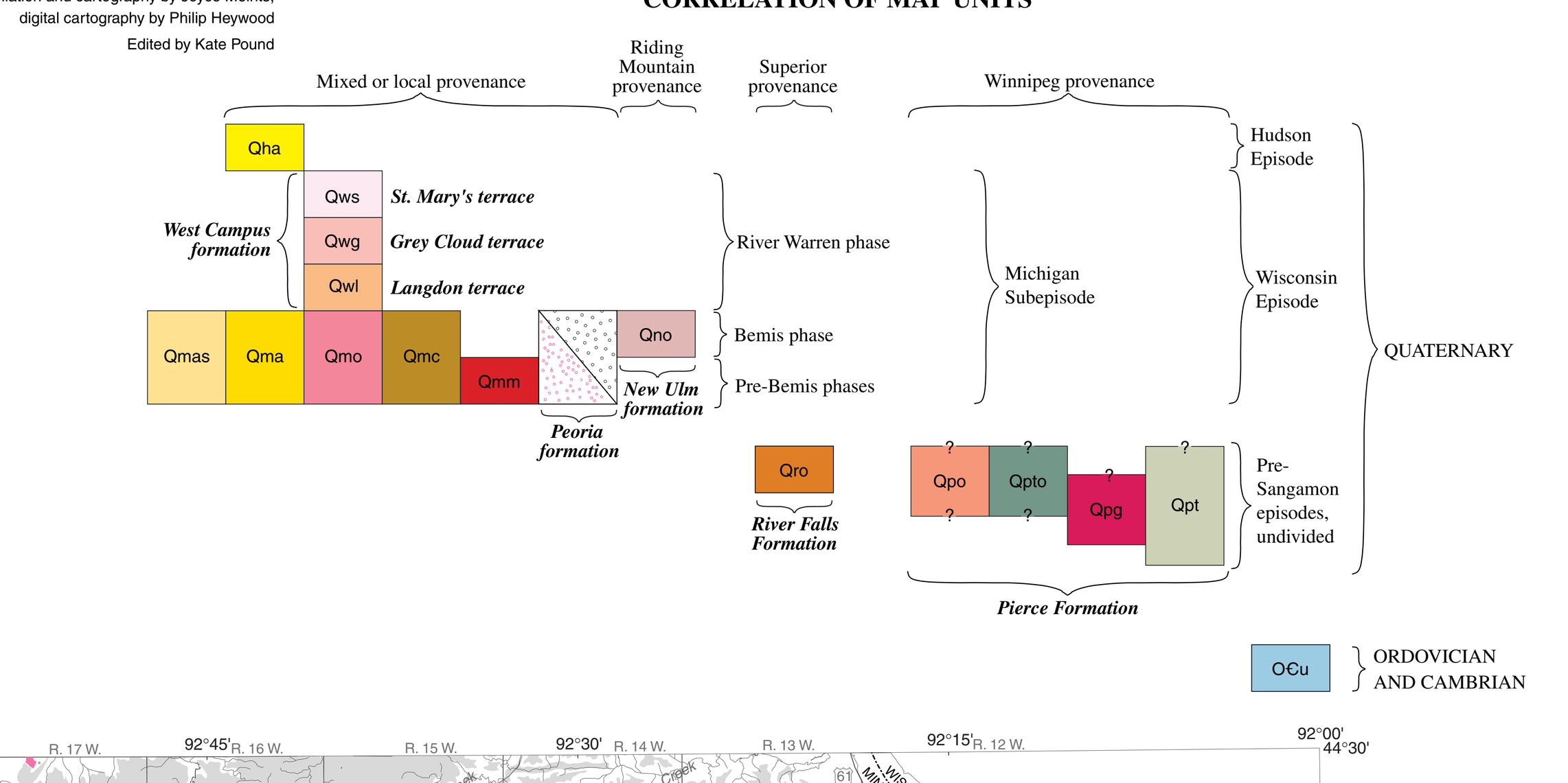
CORRELATION OF MAP UNITS



DESCRIPTION OF MAP UNITS

This map is compiled from maps of Goodhue, Olmsted, and Winona counties, completed from 1984 to 1998 (Hobbs, 1984, 1988; Hobbs and Setterholm, 1998). Unlike some of the maps from which it is derived, most of the Quaternary deposits shown on this map are assigned to informal lithostratigraphic units that have been modified from units previously defined by Matsch (1962 and 1972), Stone (1966), Wright and others (1970), Mickelson and others (1984), and Hansel and Johnson (1996). The Correlation of Map Units incorporates a scheme developed by Johnson and others (1997) for the division of the late Quaternary into episodes that emphasizes the diachronic nature of the map units. The Michigan Subepisode of the Wisconsin Episode replaces the late Wisconsinan glaciation of earlier publications, and the Hudson Episode is the name for the current interglacial or postglacial time—the time since Michigan deglaciation.

QUATERNARY

Qha **Floodplain alluvium**—Chiefly fine sand and silt on floodplains; includes sand and gravel that infills modern river channels. Some depressions have been filled with thick silty to clayey sediment. Includes minor lakeshore sediment as well as deltas built into Lake Pepin. Contacts with other map units are commonly scarps.

West Campus formation (Meyer and Patterson, 1999)—Sand and gravelly sand of mixed Riding Mountain and Superior provenance (Table 1). Coarsens to cobbly gravel in places. Deposited during early, higher stages of the Mississippi River and preserved in terraces above the modern floodplain. The original West Campus Sand of Stone (1966) includes fluvial sediment that underlies the terraces of the Mississippi River valley, but has been expanded (Meyer, 1999; Meyer and Patterson, 1999) to include correlative late-glacial fluvial sediments that underlie terraces in the Minnesota and St. Croix river valleys. The West Campus formation is mapped at three major terrace levels in the Rochester quadrangle.

Qws **St. Mary's terrace** (Meyer, 1999)—The terrace is 10–20 feet (3–6 m) above the present floodplain level. In the riverfront area of downtown Wabasha the contact of this terrace with the higher level Grey Cloud terrace is a smooth slope rather than a scarp. These terrace sediments are also present where a channel separates Grey Cloud terrace from the higher Langdon terrace.

Qwg **Grey Cloud terrace** (Matsch, 1962)—The terrace is about 40–50 feet (12–15 m) above the present floodplain level. The terrace elevation is about 700–710 feet (214–216 m) in Lake City and Wabasha. Most contacts with other map units are scarps.

Qwl **Langdon terrace** (Matsch, 1962)—The terrace is about 70 feet (21 m) above Lake Pepin, and is about 735 feet (224 m) in elevation. Northwest of Lake City the elevation of the terrace surface rises from 735 feet to 750 feet (229 m). A higher level Langdon terrace, with an elevation slightly more than 760 feet (233 m), is present west of a scarp. Most contacts with other map units are scarps.

Qmo **Mississippi valley train**—Sand, gravelly sand, and gravel. Deposited in the Mississippi River valley by glacial meltwater. Preserved in the highest terrace along the Mississippi River at an elevation of 760–780 feet (232–238 m). The only areas where it is mapped at the surface in this quadrangle are west and northwest of Lake City. It underlies the West Campus formation, the floodplain alluvium (Qha), and the sediments of Lake Pepin. Commonly extends down to bedrock, which in many places is 150–250 feet (45–75 m) below the floodplain.

Qma **Sandy alluvium and slopewash**—Sand and gravelly or loamy sand. Forms aprons at the foot of colluvium-mantled bedrock escarpments. Present as terraces above the modern floodplain at elevations above the level of Michigan Subepisode outwash. Also underlies modern alluvium (Qha). May include fine slackwater sediment where it merges downstream with outwash. Pebble assemblage is a mixture of local bedrock fragments derived from valley walls and material derived from glacial sediments on the uplands. Where the modern alluvium (Qha) is too thin or narrow to show on the map, the valley fill is mapped as Qma.

Qmas **Slackwater sediment**—Silty alluvium. Only mapped in tributaries to the Mississippi River in Wabasha County, where the soil survey (Harms, 1959) separates the silty facies from the sandy facies.

Qmc **Colluvium**—Angular unsorted fragments of local bedrock, typically overlain by massive to poorly bedded silt that contains a few angular rock clasts. The rock fragments are derived from mechanical weathering of the bedrock that forms the hillslopes above. The silts are mudflow and slopewash deposits derived from loess on the uplands. The thickness of both units typically diminishes upslope, where bedrock outcrops are common.

Qmm **Mudflow sediment**—Massive gray clay or clayey diamicton; contains pebbles of fossiliferous material derived from the Decorah Shale. The distribution of Decorah Shale in Goodhue County is shown by Runkel (1998). Deposited on footslopes of valley sides, downslope from outcrops of Decorah Shale. This unit typically forms deposits too small to map. Commonly overlain by a few feet of sand or silt (Qha or Qma).

Peoria formation (Hobbs, 1999)—Eolian sediment. Consists of a loess facies and an eolian sand facies. Eroded and transported by wind from outwash plains and older till surfaces. Generally deposited southeast of its source area. Shown on this map only where thicker than 5 feet (1.5 m), although thin Peoria formation extends across much of the map area.

Loess—Shown only on Figure 1. Chiefly silt; includes some very fine sand and clay. The clay was probably deposited as silt-sized aggregates. The overall grain size decreases from northwest to southeast across the map area. Includes interbedded eolian sand in the westernmost areas; it may be underlain by patchy eolian sand.

Eolian sand—Shown only on Figure 1. Clean, fine to medium sand; lacks gravel. Only four small patches are mapped, in the northwestern part of the quadrangle, where it is more than five feet (1.5 m) thick and not covered by loess.

New Ulm formation (Meyer and Patterson, 1999)—Glaciofluvial sediment of Riding Mountain provenance (Table 1) deposited by ice and meltwater associated with the last glacial advance into the region. May include outwash from a pre-Bemis ice advance.

Qno **Outwash**—Sand, gravelly sand, and gravel. Deposited by meltwater issuing from the ice margin at or near its maximum advance during the Michigan Subepisode. Clasts of Superior provenance (Table 1) eroded from older deposits are common, and are generally more abundant in the northern part of the map area. Shale content ranges from absent to fairly common, and is highest in the west of the mapped area. This outwash is underlain in places by older outwash (Qpo), and is probably also underlain in places by sandy alluvium (Qma). Commonly capped by a mantle of windblown silt (loess) less than 4 feet (1.3 m) thick.

River Falls Formation (Mickelson and others, 1984)—Glaciofluvial deposits of Superior provenance (Table 1). Locally includes a truncated paleosol in its upper part, which indicates deposition prior to the Michigan Subepisode.

Qro **Outwash**—Sand, gravelly sand, and gravel. Strongly weathered to a depth of about 10 feet (3 m). Sand and gravel is coated with reddish clay in the upper part of the deposit. Below the leached zone it contains some carbonate clasts. Larger fragments typically break apart easily. This unit has largely been removed by later erosion. Only mapped in two small areas in the northern part of the Rochester quadrangle.

Pierce Formation (Mickelson and others, 1984)—Glacial and glaciofluvial deposits of Winnipeg provenance (Table 1). In the Rochester quadrangle it represents deposits of five or more glacial advances. In its type area the Pierce Formation underlies the River Falls Formation. In the area covered by the Rochester quadrangle, the uppermost till of the Pierce Formation is thin and friable, and may be contemporary with till of the River Falls Formation. The approximate maximum extent of ice during the glacial advance associated with deposition of the uppermost till of the Pierce Formation is shown by a blue line.

Qpo **Outwash**—Chiefly sand and gravel. Contains a truncated paleosol in its upper part. Commonly forms discontinuous terraces above the level of Qma and Qno. Deposited during more than one glacial advance. Shown on the map as a continuous unit where Qma and Qha are present, but are too small to be shown separately. Distinguished from Qpg because it occupies existing valleys.

Qpto **Till-mantled outwash**—Sand and gravel, as for Qpo above, mantled by thin friable till that is a loam to sandy loam diamicton. The sand and gravel is highly weathered, which indicates that there was an interglacial period between it and the overlying friable till.

Qpt **Till**—Chiefly loam-textured diamicton with minor pebbles, cobbles and boulders; dense and firm in most places. Includes lenses of sorted sand and gravel locally. Originally gray and calcareous, although the surface is now highly oxidized and deeply leached in most places. In the western part of the Rochester quadrangle the upper part of this till unit includes a thin layer of friable till similar to that in the upper part of Qpto.

Qpg **Glaciofluvial deposits**—Fine sand to coarse gravel, well sorted. Strongly weathered to a depth of about 10 feet (3 m). Sand and gravel is coated with reddish clay in the upper part of the deposit. Below the leached zone it contains some carbonate clasts. Larger fragments typically break apart easily. This unit represents the eroded remnants of stratified ice-contact deposits and outwash. It is overlain in places by a layer of till less than 5 feet (1.5 m) thick. Distribution of Qpg shows little or no relation to modern stream valleys. Where it is mapped parallel to contours, it probably represents the remains of a tabular body of sand and gravel that has been exposed as a result of stream dissection.

ORDOVICIAN AND CAMBRIAN

O€u **Bedrock, undivided**—Dolostone, limestone, sandstone, and shale of Ordovician age on the uplands; unit also includes Cambrian sandstone and shale along the valley walls of the Mississippi River and associated tributaries. Shown on map in upland areas where covered by less than 5 feet (1.5 m) of Quaternary sediment (other than loess). Locally mantled by less than 10 feet (3 m) of sand and clay interpreted either as Cretaceous sediments, or as deeply weathered bedrock. Hard, unweathered bedrock may thus be more than 5 feet (1.5 m) below the ground surface in some places where O€u is mapped.

MAP SYMBOLS

Geologic contact—Approximately located.

General flow direction of braided streams—Arrow points downstream in the direction that water once flowed.

Scarp within outwash—Singular occurrence mapped in New Ulm formation outwash (Qno) in the extrene northwestern corner of the map area. Records an erosional event that took place during deposition of Qno. Elsewhere, scarps commonly mark the geologic contacts between fluvial deposits.

Glaciofluvial diversion channel—Dashed where eroded and obscure; ticks point downslope. Channels that cut across the current drainage network and may be infilled by younger sediment. May have been cut by meltwater that was diverted by ice that moved across the region. The channel connecting Hay Creek and Wells Creek was formed when ice that deposited the River Falls Formation moved southward across the Mississippi River, and blocked its flow (Hobbs, 1999).

Meander scar—Dashed where older, more obscure, and generally higher above stream level; ticks point downslope; bedrock core shown where present. Symbol represents abandoned meander loop that was formed during an earlier phase of the stream.

Inferred pre-Michigan ice margin—Approximate maximum extent of the ice that deposited the thin friable till of the Pierce Formation. Label is on up-ice side of margin.

TABLE 1. GENERAL CHARACTERISTICS OF MAPPED GLACIAL DEPOSITS

PROVENANCE	RIDING MOUNTAIN	WINNIPEG	SUPERIOR
TILL TEXTURE	Mostly loamy	Loamy to clayey	Loamy to sandy
TILL COLOR			
Oxidized	Yellow to olive-brown	Yellow-brown	Reddish-brown
Unoxidized	Gray	Gray	Grayish-red
ROCK TYPES IN TILL AND OUTWASH			
Precambrian			
Black to gray-green rock	Uncommon	Uncommmon	Common
Red sandstone & felsite	Absent to rare	Rare to uncommon	Uncommon to common
Paleozoic carbonate	Common	Common to abundant	Uncommon to common
Cretaceous			
Gray shale	Uncommon to abundant	Absent to rare	Absent
Limestone & calcareous shale	Rare	Rare to uncommon	Absent

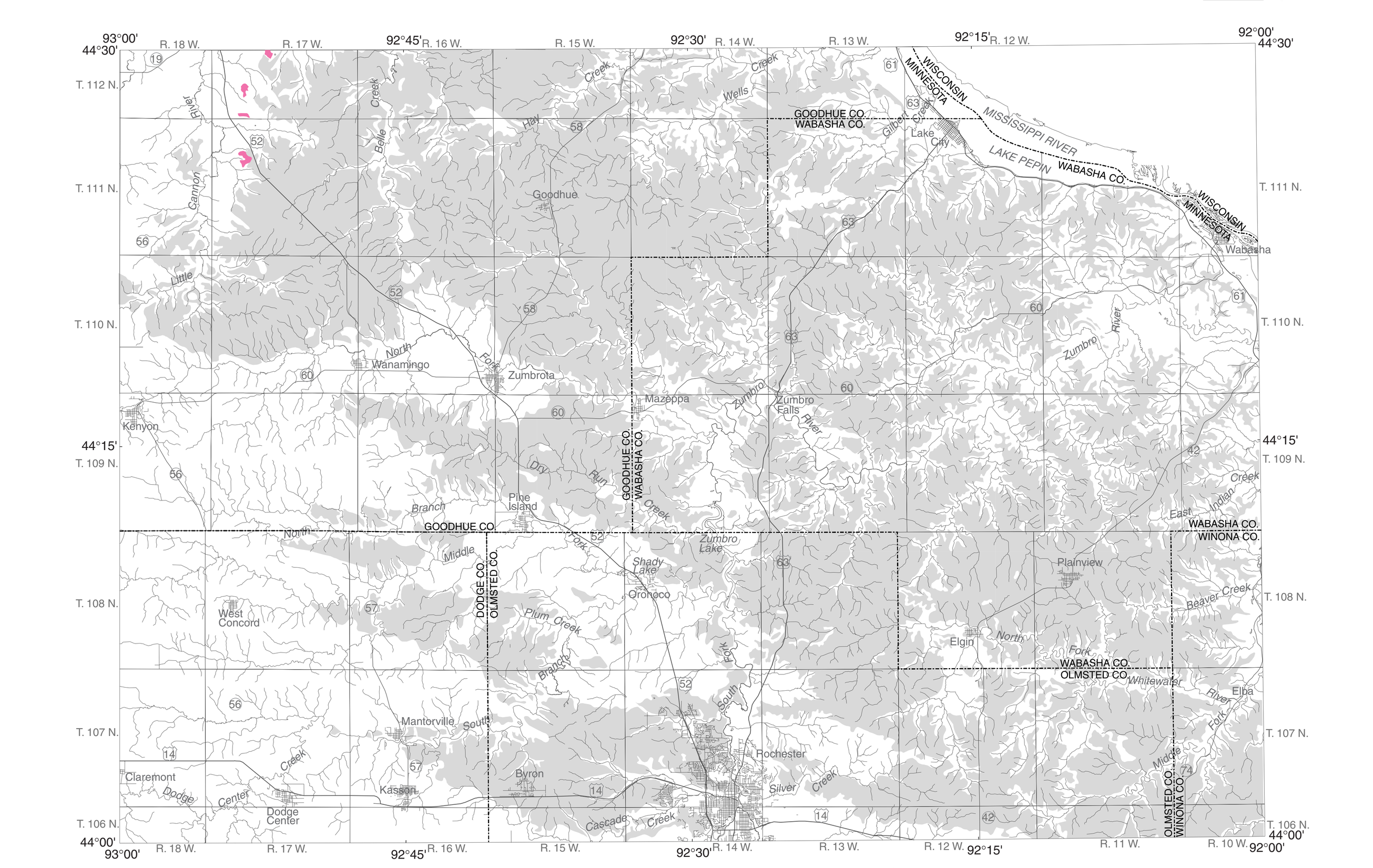


Figure 1. Distribution of Peoria Formation sediments in the Rochester 30 x 60 minute quadrangle. See Description of Map Units for further information.

SURFICIAL GEOLOGY OF THE ROCHESTER 30 x 60 MINUTE QUADRANGLE, MINNESOTA

Compiled by
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2000