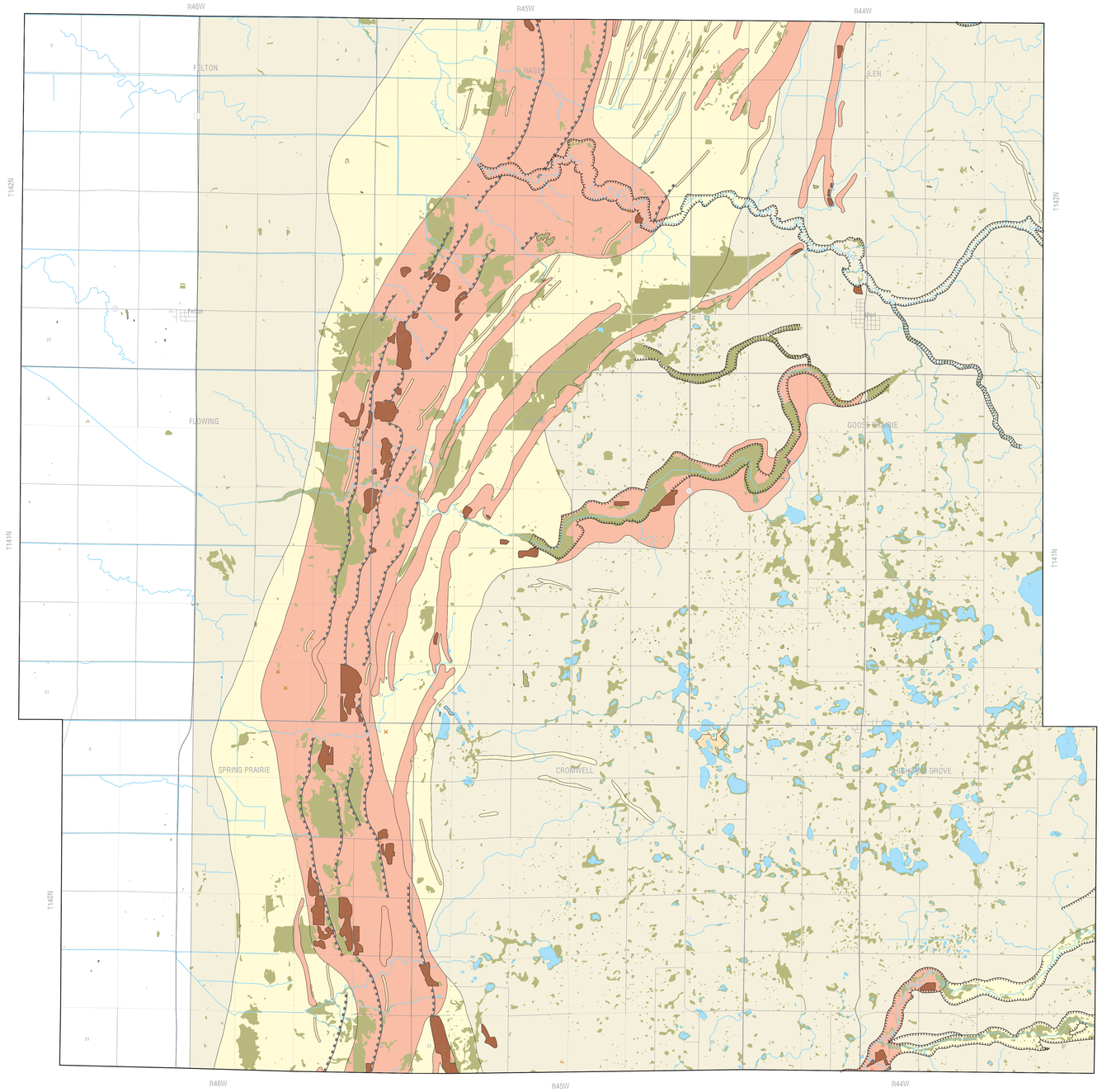
AGGREGATE RESOURCES
EASTERN CLAY COUNTY, MINNESOTA

J.D. LEHR

1997



AGGREGATE POTENTIAL

HIGH AGGREGATE POTENTIAL: the relative probability of an aggregate deposit existing within this area is high. The percentage of shale is low, percentage of gravel is high, deposit size varies, and overburden thickness varies. This map unit includes geologic units B-1, O-1, O-3, O-4, and So.

MODERATE AGGREGATE POTENTIAL: the relative probability of an aggregate deposit existing within this area is moderate. The percentage of shale is low, percenta of gravel varies, deposit size is generally smaller, and overburden thickness is thicker. This map unit includes geologic units B-2 and I-1.

SLIGHT AGGREGATE POTENTIAL: the relative probability of an aggregate deposit existing within this area is slight. The percentage of shale is higher, the percentage of gravel varies, the deposit size is smaller, and overburden is thicker. This map unit includes geologic units B-3, O-2, and I-2.

LIMITED AGGREGATE POTENTIAL: the relative probability of an aggregate deposit existing within this area is limited. This map unit includes areas of silt deposited in Glacial Lake Agassiz and glacial till.

WETLAND: wetland area, not including open water lakes or rivers.

WATER: Lake or river.

UNMAPPED AREA: aggregate potential not mapped in this part of the study area.

GRAVEL PIT: area of pit delineated from interpretation of aerial photographs.

GRAVEL PIT: pit identified by field work. Area of pit not delineated because the pit was not visible on the aerial photographs.

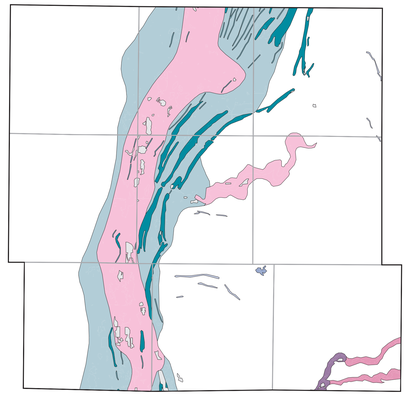
GRAVEL PIT: pit identified on 1:24000 USGS topographic maps and not a part of pits delineated from interpretation of aerial photographs.

FLUVIAL CHANNEL SCARP: an area that is/has been eroded by stream flow, often exposing areas with aggregate potential.

WAVE-CUT SCARP: an area that was affected by wave action of Glacial Lake Agassiz, exposing areas with aggregate potential.

GEOLOGIC CONTACT: delineation of the geologic units.

GEOLOGIC FACTORS



Ice-contact deposits

I-1 Ice-Contact Stratified Deposits: Sand and gravel deposited by glacial meltwater streams, with some resedimentation by gravity processes. This unit occurs as eskers and irregular-shaped hummocks. Aggregate deposits of this type are variable in thickness, but generally of limited lateral extent, with a variable thickness of overburden. Percentage gravel is variable, but locally may be quite high, while in some areas the deposits may be entirely sand. Data on percent deleterious material is lacking, however the quality of these deposits is probably similar to type O deposits.

I-2 Ice-contact Stratified Deposits: Sand and gravel deposited by glacial meltwater streams in contact with glacial ice, with some resedimentation by gravity flow processes. Aggregate deposits of this type are variable in thickness, and lateral extent. This type of deposit was subsequently buried by later glacial advances and therefore has a variable, but generally pervasive thickness of overburden. Percentage of gravel is variable, but locally may be quite high, while in some areas the deposits may be entirely sand. Percent deleterious materials quite variable, but is generally high relative to other aggregate deposits in the county.

Outwash deposits

O-1 Outwash: Sand and gravel deposited by glacial meltwater streams confined to a valley. Aggregate deposits in this unit are moderately thick and have generally thin overburden. Gravel percentage is fairly high, with a mixture of coarse and fine gravel. Percentage of deleterious material, chiefly shale, but including iron oxides, is moderately high relative to other deposits in the region. This unit represents part of the outwash valley train in the Hawley area where gravel mining has occurred and subsurface data indicate potential for further development.

O-2 Outwash: Chiefly sand deposited by glacial meltwater streams confined to a valley. This unit occurs in the glacial drainage channels east and south of Hawley. The aggregate potential of this unit will be limited by low percentages of gravel. Gravel-rich zones may occur beneath sand overburden. The percentage of deleterious material in this type of deposit is probably similar to other type O deposits, in other words, moderate amounts of shale.

O-3 Collapsed Outwash: Sand and gravel deposited by glacial meltwater streams flowing upon stagnant ice. These two units form
O-4 a collapsed outwash plain in the southeastern part of the county. Aggregate deposits have variable thickness, but are locally quite thick. Overburden thickness is also variable, but is generally minimal. Percent gravel is variable, but is locally quite high, with some areas containing appreciable quantities of coarse gravel. Percentage of deleterious material, chiefly shale, is moderately high relative to other deposits in the region. Unit O-3 is differentiated from unit O-4 by a higher density of gravel pits and by subsurface data indicating potential for further development. Aggregate deposits that may occur in unit O-4 will be very simillar to O-3 deposits, but the probability of finding a deposit in these areas is inferred to be lower.

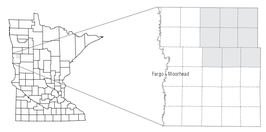
So Subaqueous Outwash of Northeastern Provenance: Sand and gravel deposited by subglacial meltwater streams where they entered a lake that existed in the Red River Valley prior to Lake Agassiz. These deposits are not expressed as depositional landforms, but are exposed at the surface where the younger sediment has been removed by either stream erosion, or by wave action in Lake Agassiz. Aggregate deposits of this type are locally very thick (75 to 100 feet), but may be moderately thick, or absent in places. Overburden thickness is highly variable, ranging from minimal to excessive (greater than 40 feet). Gravel percentage is also highly variable, ranging from high percentage of coarse gravel to entirely sand. Percentage of deleterious material (shale and iron oxides) is generally low, characteristic of northeastern-source deposits. Potential for these types of deposits is inferred to be somewhat higher in proximity to erosional landforms present within this unit. This type of deposit represents the highest quality aggregate resource present in the entire region.

Beach deposits

B-1 Major Beach Ridges: Sand and gravel deposited in near-shore environments of Lake Agassiz. Forms prominent beach ridges. Aggregate deposits are typically thin (10 to 20 feet thick) and narrow, but generally have very little overburden. Gravel percentage is variable, and is generally dominated by fine gravel (#10 mesh to #4 mesh). Percentage of deleterious material is generally low.

B-2 Minor Beach Ridges: Sand and gravel deposited in near-shore environments of Lake Agassiz. This unit represents minor beach ridges, and in some cases, offshore bars composed entirely of sand. Examples of this type of deposit are not common, therefore supporting data are not abundant. Aggregate deposits are inferred to be rather thin, but generally with little overburden. Low percentages of gravel will limit these deposits to certain uses. Percentage of deleterious material is inferred to be low.

B-3 Beach Deposits Not in Ridges: Chiefly sand, with local concentrations of sand and gravel, deposited in near-shore environments of Lake Agassiz. This unit consists of that portion of the shoreline area of Lake Agassiz which is outside the other mapping units (beach ridges, for example). These deposits are generally thin. Deposits within this unit generally have little overburden. Percentage of gravel is quite variable, but is generally low to intermediate. The gravel fraction may be predominantly fine gravel. Percentage of deleterious material is generally low, as in other beach deposits. Occurring within this unit in the vicinity of Muskoda are meltwater stream deposits similar to type O-1 which are buried by till and beach-deposited sand and gravel. This unit has potential for other types of buried deposits, especially in the vicinity of shoreline erosional features.



SCALE 1:50,000

0 1 2 Miles
0 1 2 3 Kilometers

(Aggregate resource mapping units were delineated at 1:50,000)

Aggregate Resources: Aerial photo interpretation of NAPP (National Aerial Photography Program, 1991-1992, 10"x10" color infrared photos at 1:40000), field work, and delineation by J.D. Lehr, 1994-1996, Aggregate Mapping Program, Minnesota Department of Natural Resources, Division of Minerals.

Base map: Roads, lakes, and rivers from State of Minnesota Basemap, CD-ROM produced by Minnesota Department of Transportation Surveying and Mapping BaseMap Development Group.
Public Land Survey - PLS Project, Minnesota Department of Natural Resources, Division of Minerals.
Wetlands from National Wetland Inventory, U.S. Fish and Wildlife Service, compiled at 1:24000 from aerial photography (1979-1988) and spot field checking.

Plate I -- Aggregate Resources, Eastern Clay County, Minnesota, Text and figures describing methodology.
Plate III -- Aggregate Resources, South Half, Eastern Clay County, Minnesota, Map at a scale of 1:50,000.
Plate IV -- Aggregate Resources, Eastern Clay County, Minnesota, Map at a scale of 1:100,000.