Minnesota Department of Natural Resources
Division of Lands and Minerals
William C. Brice, Director



# AGGREGATE RESOURCES
# BENTON COUNTY, MINNESOTA

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**AGGREGATE POTENTIAL:** For the purpose of this study, aggregate potential is defined as an assessment of the relative probability that an aggregate deposit exists within a given area, with almost all emphasis placed upon geologic evidence, parameters, and interpretation at the reconnaissance level, rather than upon economic feasibility evaluation or other parameters. This assessment does not imply that economic aggregate deposits exist everywhere within a given map unit designated as "Potential Aggregate Resources". Rather, that within such a map unit, geologic processes were active that could have created aggregate deposits at specific sites. Geologic measurements of aggregate deposits remain constant, but economic criteria and environmental permitting vary across time and place. Important site-specific factors such as ownership, zoning, protected waters and wetlands, environmental permitting, distance to markets, royalties, and individual site characteristics, such as access, all contribute to the final "potential" of a specific parcel; however, these factors were not included in this study.

**POTENTIAL SAND AND GRAVEL RESOURCES:** Geologic units that are inferred to contain sand and gravel. These units exhibit the geologic characteristics that typically produce sand and gravel deposits. Existing gravel pit and MN/DOT aggregate sources lying within these units indicate identified or known resources. The geologic units having potential for sand and gravel include alluvial features (flood plains, terraces, fans), glacial outwash features (channels, terraces, fans), and ice-contact features (eskers and kames). These units typically contain sorted sand and gravel with little silt or clay.

**HIGHLY DESIRABLE SAND AND GRAVEL DEPOSITS:** Glaciofluvial features, such as terraces and outwash channels; ice-contact features, such as eskers and kames; and Holocene age flood plains. These deposits are moderately large to very large in areal extent[1]. These deposits consist of sand and gravel with thicknesses typically ranging from 20 to 50 feet with less than 5 feet of overburden. The probability[2] that a potential sand and gravel deposit exists within this unit is high to very high. The textural characteristics[3] of these deposits are classified as good. The quality[4] ranges from moderately high to high relative to all deposits within Benton County.

**MODERATELY DESIRABLE SAND AND GRAVEL DEPOSITS:** Glaciofluvial features, such as outwash channels, terraces, and fans; ice-contact features, such as eskers and kames; as well as Holocene age terraces, floodplains, and fans. These deposits are moderate to large in areal extent with sand and gravel thicknesses typically ranging from 10 to 50+ feet with less than 10 feet of overburden. The probability that a potential sand and gravel deposit exists within this unit is moderately high to very high. The textural characteristics of these deposits are moderately good to good with the quality ranging from moderately high to high.

**LESS DESIRABLE SAND AND GRAVEL DEPOSITS:** Glaciofluvial features, such as fans, deltas, channels, and terraces; ice-contact features, such as eskers and kames; and alluvial features such as flood plains, terraces, fans, beaches, and sand bars. These deposits are moderately small to very large in areal extent and consist of sand and fine sand with thicknesses ranging from 0 to 25 feet with overburden thicknesses between 0 to 25 feet. The probability that a potential sand and gravel deposit exists within this unit is moderate to very high. The textural characteristics of these deposits are moderately poor to moderately good with the quality ranging from moderate to high.

**POTENTIAL CRUSHED STONE RESOURCES:** Granitic bedrock formations that are suitable for crushing. These units are inferred to be very thick (50 to several hundred feet), with overburden thicknesses of less than 50 feet. These granitic units contain some of the highest quality crushed stone resources in the state; however, there is limited quality data to verify these potential areas. Quarries located within these units indicate identified or known resources.

**HIGHLY DESIRABLE CRUSHED STONE DEPOSITS:** Granitic bedrock units with large areal extent that contain materials suitable for crushing. These units have thicknesses of greater than 50 feet, with overburden thicknesses of less than 20 feet. These units have a high to very high probability of containing potential crushed stone deposits. The quality of these units is very good.

**MODERATELY DESIRABLE CRUSHED STONE DEPOSITS:** Granitic bedrock units with a large areal extent that contain materials suitable for crushing. These units have thicknesses greater than 50 feet, with overburden thicknesses ranging from 20 to 30 feet. These units have a moderately high to very high probability of containing potential crushed stone deposits. The quality of these units is very good.

**LESS DESIRABLE CRUSHED STONE DEPOSITS:** Granitic bedrock units that are large in areal extent that contain materials suitable for crushing. These units have thicknesses greater than 50 feet with overburden thicknesses ranging from 30 to 50 feet. These units have a moderately high probability of containing potential crushed stone deposits. The quality of these units is good to very good.

**LIMITED POTENTIAL FOR AGGREGATE RESOURCES:** Units that generally have little or no potential for significant aggregate resources. These units exhibit geologic characteristics that are typically not consistent with significant aggregate deposits. The geologic units having limited potential include glacial lake plains, moraines, small alluvial deposits, or bedrock with overburden thicknesses greater than 50 feet. These units typically contain clay, silt, fine sand, unsorted sediments (till), or very thin layers of sand and gravel. These units may include aggregate deposits that are too small to map.

**LIMITED POTENTIAL FOR AGGREGATE DEPOSITS:** Units that include glacial features such as collapsed glaciofluvial channels, till plains, moraines, glacial lake beds, and small alluvial features such as flood plains and streams. The probability that a potential aggregate deposit exists within this unit is very low to moderate. The aggregate deposits occurring in this unit are moderate to very small in areal extent and typically consist of finer material (sand with some gravel). The thickness of these aggregate deposits are typically less than 25 feet, with overburden thicknesses sometimes reaching over 100 feet. The textural characteristics are poor to moderate with the quality ranging from low to moderate. These units also contain bedrock units with an overburden thickness of greater than 50 feet.

**IDENTIFIED AGGREGATE RESOURCES:** Areas where aggregate resources (sand, gravel, and/or crushed stone) have been or are currently being mined. Pit and quarry locations have been gathered from several different sources, including topographic maps, aerial photographs, county records, county highway department maps, soil surveys, MN/DOT files, fieldwork, gravel operators, and other miscellaneous sources. The pits and quarries range in size from less than 1 acre to greater than 50 acres and may be active, inactive, depleted, or reclaimed. The aggregate quality of the pits varies.

**Gravel Pits:** Locations were gathered from several different reference sources. Any given pit may be active, inactive, depleted, or reclaimed. The color indicates the relative size of the pit.

Large - larger than 10 acres. Medium - larger than a few acres. Small - less than an acre.

**Gravel Pits - MN/DOT files:** Locations gathered from ASIS, the Minnesota Department of Transportation's Aggregate Source Information System listing of aggregate sources. Test hole logs, sieve, and quality test data are available. The color indicates the relative size of the pit.

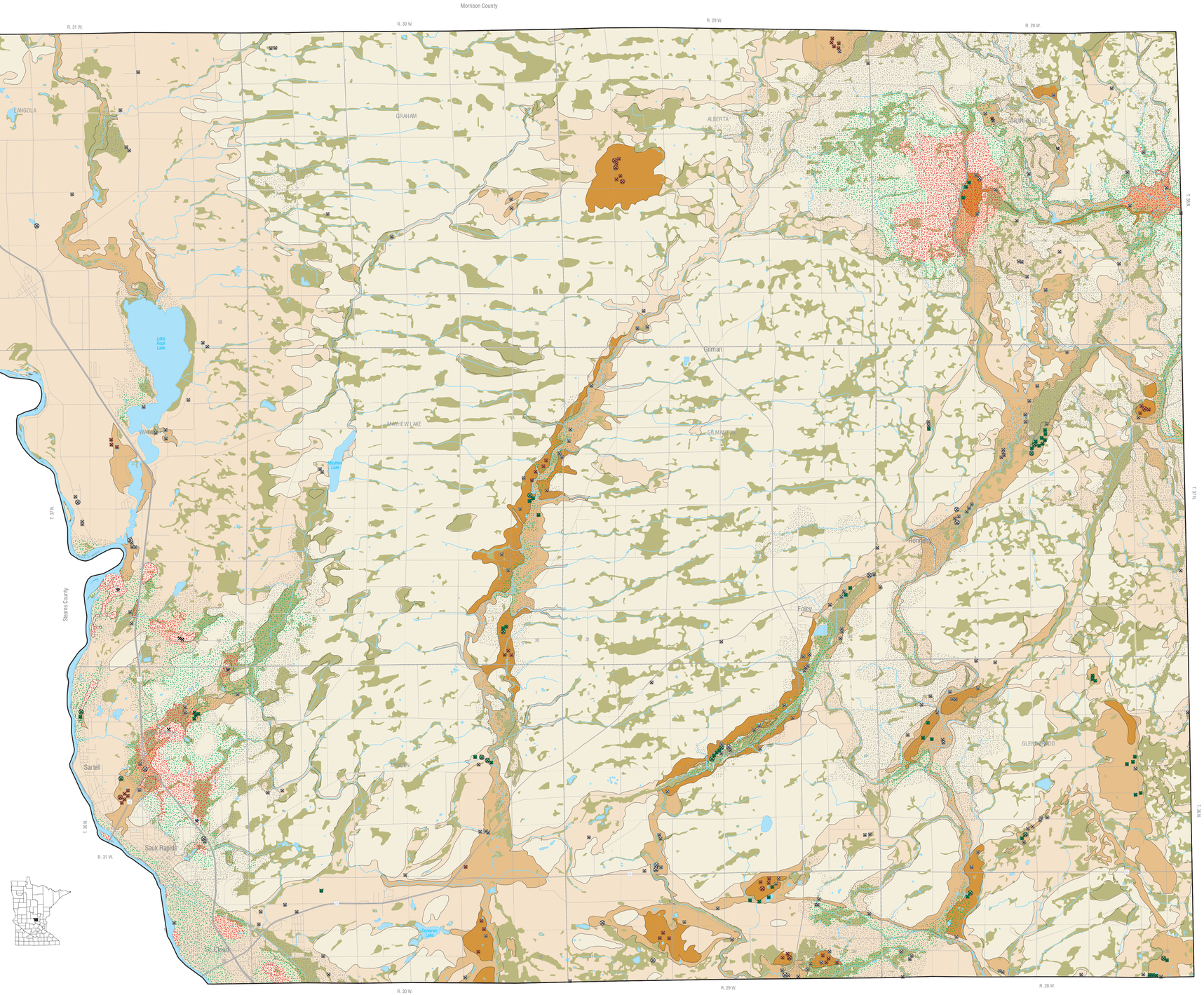
Large - larger than 10 acres. Medium - larger than a few acres. Small - less than an acre.

**Quarries:** Precambrian granite quarries. Any given unit may be active, inactive, depleted, or reclaimed.

**OTHER FEATURES:**

**WETLANDS:** Wetland area. **WATER:** Lakes or rivers.

[1] Areal Extent - the size, horizontal extent, or distribution of a unit (e.g., area in acres).
[2] Probability - the degree of certainty that aggregate exists within a mapping unit.
[3] Textural Characteristics - particle size distribution - the percent of gravel or sand vs. silt or clay (e.g., sieve analysis).
[4] Quality - the characteristics of the material - soundness (e.g., magnesium sulfate test), durability (Los Angeles rattler test), and mineral makeup (percent deleterious material such as shale, iron oxide, and unsound chert).




**Scale 1:50,000**

0 1 2 Miles
0 1 2 3 Kilometers

(Surficial aggregate resource mapping units were delineated at 1:50,000)
(Buried aggregate resource mapping units were delineated at 1:100,000)

Aggregate Resources:
Aerial photograph interpretation, field work, and delineation of mapping units by Jonathan B. Ellingson, 2001-2002, County Aggregate Mapping Program, Division of Lands and Minerals, Minnesota Department of Natural Resources. Source information included aerial photographs from NAPP (National Aerial Photography Program), 1991-1992, 9"x 9" color infrared photos at 1:40,000; DOQs (Digital Orthophoto Quadrangles) at 1:12,000 from USGS (United States Geological Survey); DRGs (Digital Raster Graphics) at 1:24,000 from USGS; 7.5-minute USGS topographic quadrangles at 1:24,000 (dating from 1965-1993); and a digital version of the Soil Survey of Benton County, 1977, from the USDA-NRCS (United States Department of Agriculture - Natural Resources Conservation Service), captured into the Soil Survey Information System (SSIS) format by the University of Minnesota, Department of Soil, Water, and Climate.

Base map data sources:
Lakes, wetlands, and rivers from National Wetland Inventory, U.S. Fish and Wildlife Service, compiled at 1:24,000 from aerial photography (1979-1988) and spot field checked.
Public Land Survey - PLS Project, 2001, Minnesota Department of Natural Resources, Division of Lands and Minerals.
Roads from State of MN/DOT Basemap 2001 - Roads, Minnesota Department of Transportation, BaseMap Development Group, Surveying and Mapping Section.
Civil Townships and Municipal Boundaries from MN/DOT Basemap 2001 - Civilhwy and Muni, Minnesota Department of Transportation, BaseMap Development Group, Surveying and Mapping Section.

GIS database design and cartography by Renee Johnson. Database assistance by Erika Rowe. Field and drilling assistance by Ricco Rihilluoma.



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Projects are determined by a committee composed of Governor-appointed members from the public and private sectors.

This project includes a CD-ROM of maps, data, and metadata in a digital format and the following plates:
Plate I, Report 356, Significant Aggregate Resource Deposits.
**Plate II, Report 356, Aggregate Resources.**
Plate III, Report 356, Surficial Geology.
Plate IV, Report 356, Data Sources and Mapping Methodology.