



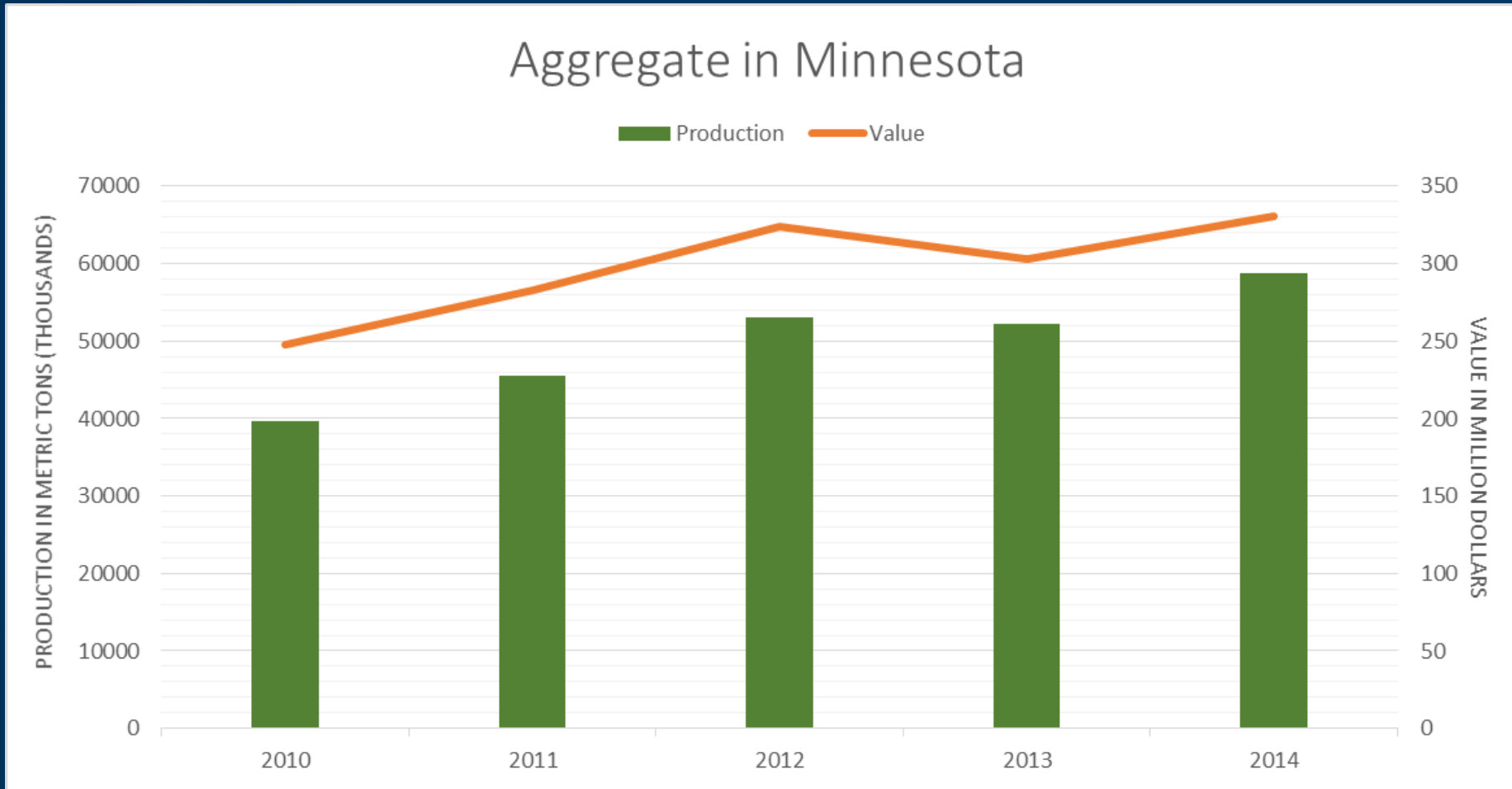
Aggregate Resource Distribution, Scarcity, and Land Use

Heather Arends – Mineral Potential Section Manager

Presentation Overview

- Growth of the Minnesota aggregate production
- Causes of scarcity
- Regions of natural scarcity
- Distribution of aggregates across the state
 - MNDOT classification of aggregate
 - Distribution of quality aggregates
- Regional significance of resource management

Aggregate Production and Value in Minnesota



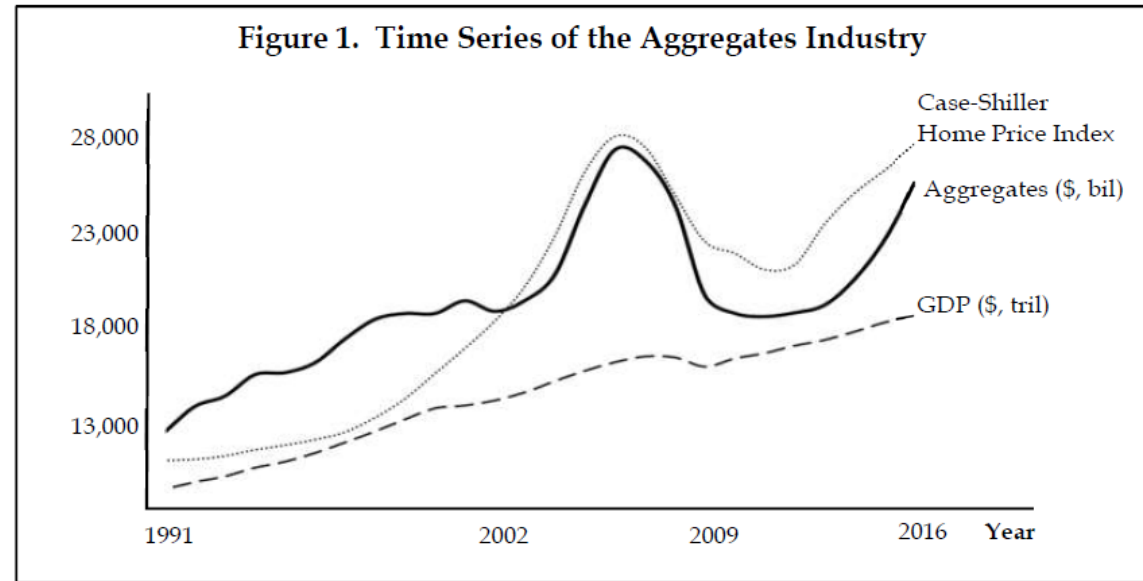
Value ~ \$330M

The

Data Source: USGS Data Sets, Aggregates by State and End Use
<https://minerals.usgs.gov/minerals/pubs/commodity/aggregates/>

National Aggregate Resource Numbers

- Nationally, industry output has grown 5.3% annually
- From 2015 to 2016: USGS also reported a national increase in demand of aggregates ~10%
- Growth of aggregate is closely tied to housing market than to GDP



In Figure 2, a radar scatter diagram shows more clearly that the value of the output of the aggregates industry is more closely related to the housing market than to GDP. This figure plots the percentage annual change in the three illustrated series. Wide swings in the housing and aggregates industry are temporally proximate, though unsurprisingly coincident with the milder movements in GDP.

Data Source: Phoenix Center for Advanced Legal & Economic Public Policy Studies, The Economic Impact of the Natural Aggregate Industry (2017). <http://www.phoenix-center.org/scorecards/AggregatesIndustry2017ScorecardFinal.pdf>

Scarcity Overview - Sterilization

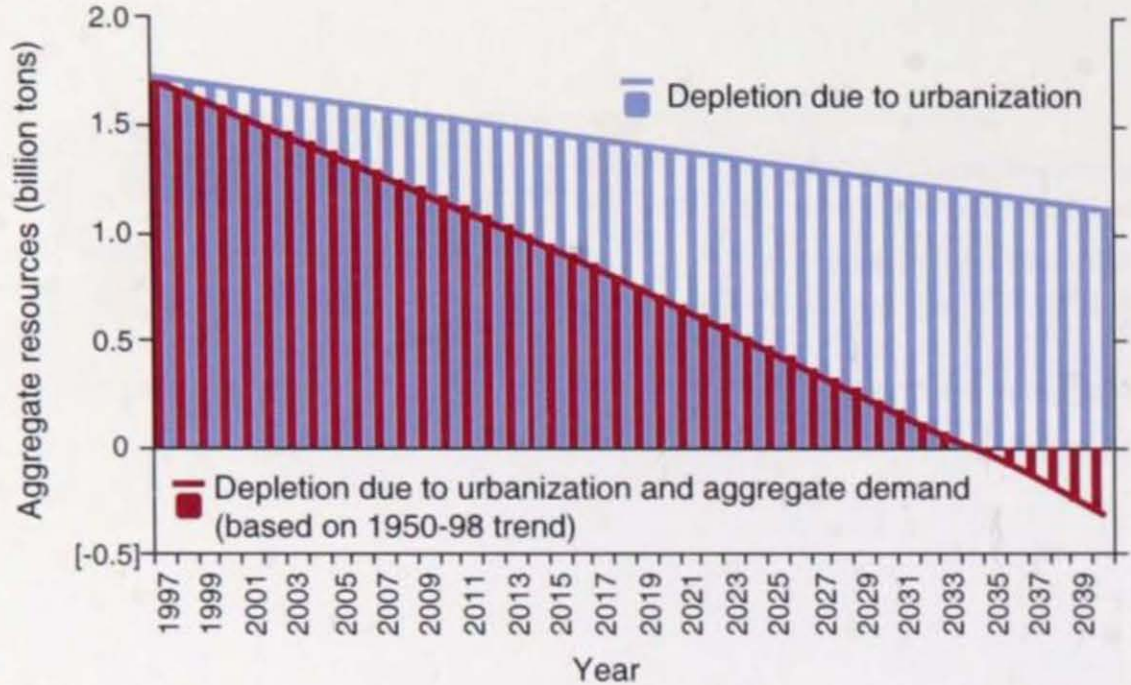


Figure 17. Depletion of the aggregate resource base for period 1997–2040. The blue curve shows depletion that will occur through loss of aggregate-bearing lands to urbanization; the red curve shows the total depletion stemming from land loss plus consumption of the resource as projected from the 1950–1998 use-rate scenario. This consumption model predicts the exhaustion of resources in 2034 (Appendix Table E-1).

Data Source: Southwick, D.L., Jouseau, M., Meyer, G.N., Mossler, J.H., and Wahl, T.E., 2000, Aggregate resources inventory of the seven-county metropolitan area, Minnesota: Minnesota Geological Survey Information Circular 46, 91 p.)



Scarcity Overview - Sterilization

494 and France: 1947

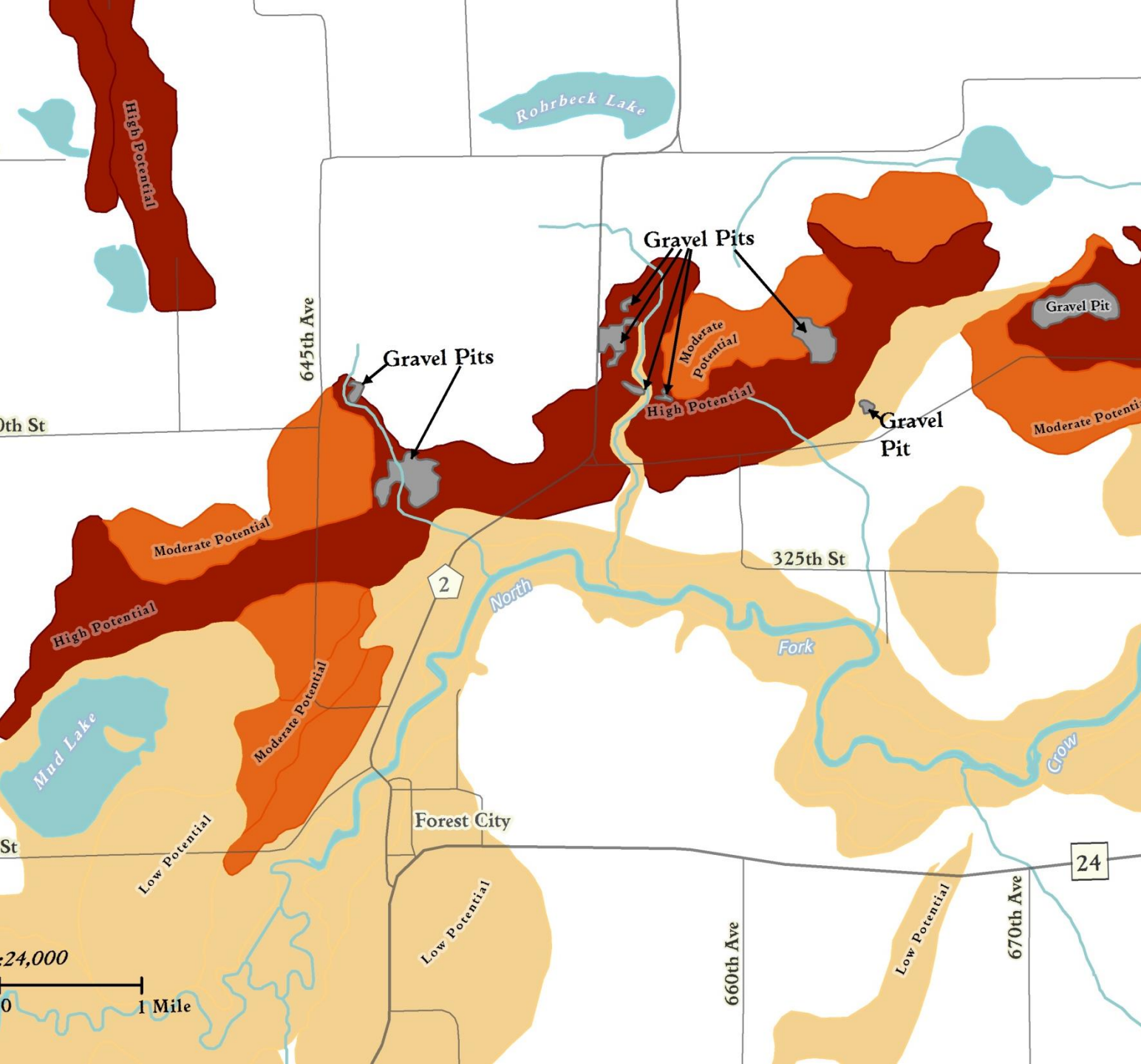
Scarcity Overview - Sterilization

494 and France: 2015

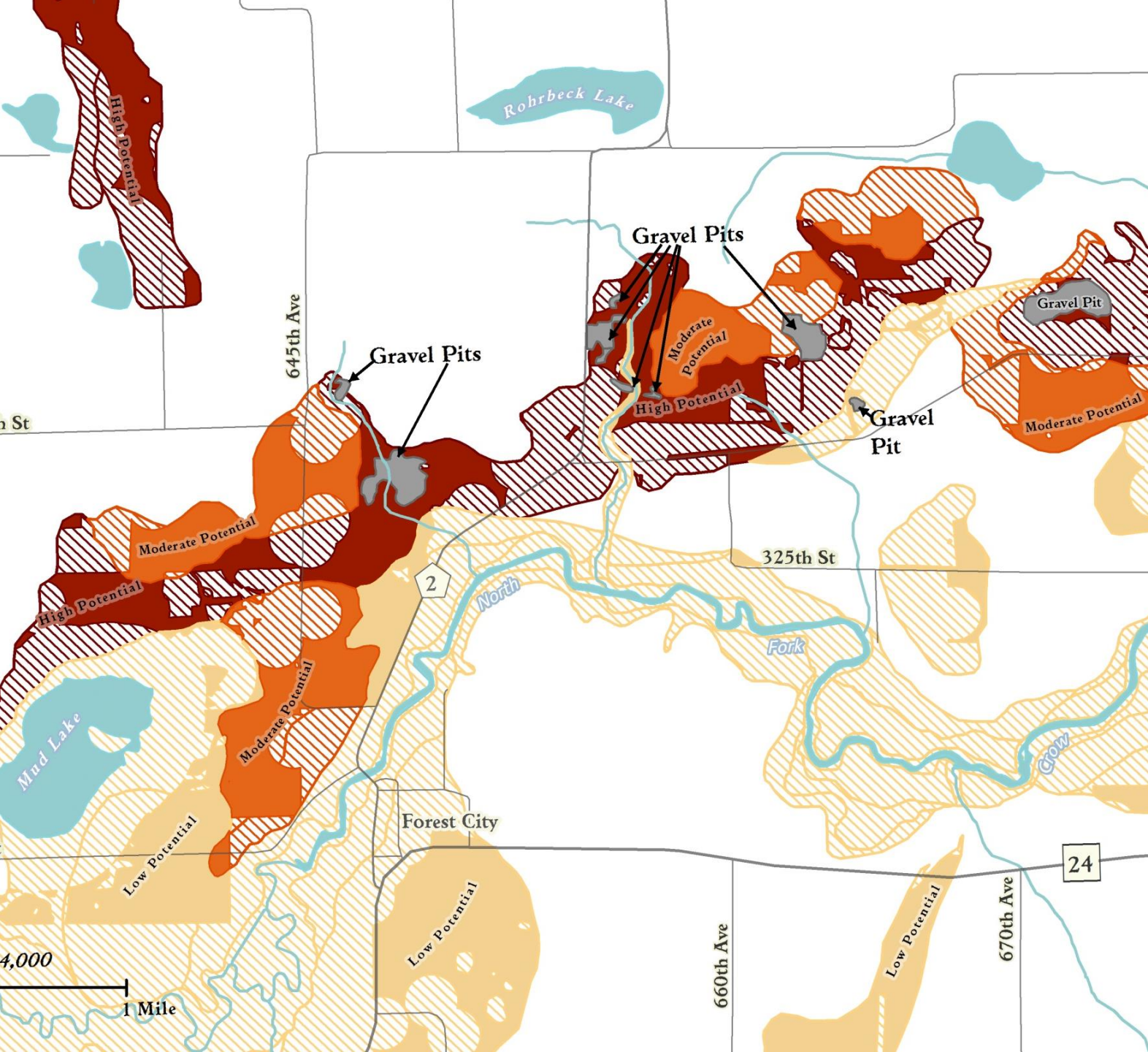


Scarcity Overview Land Use Restrictions

Meeker County



Scarcity Overview Land Use Restrictions



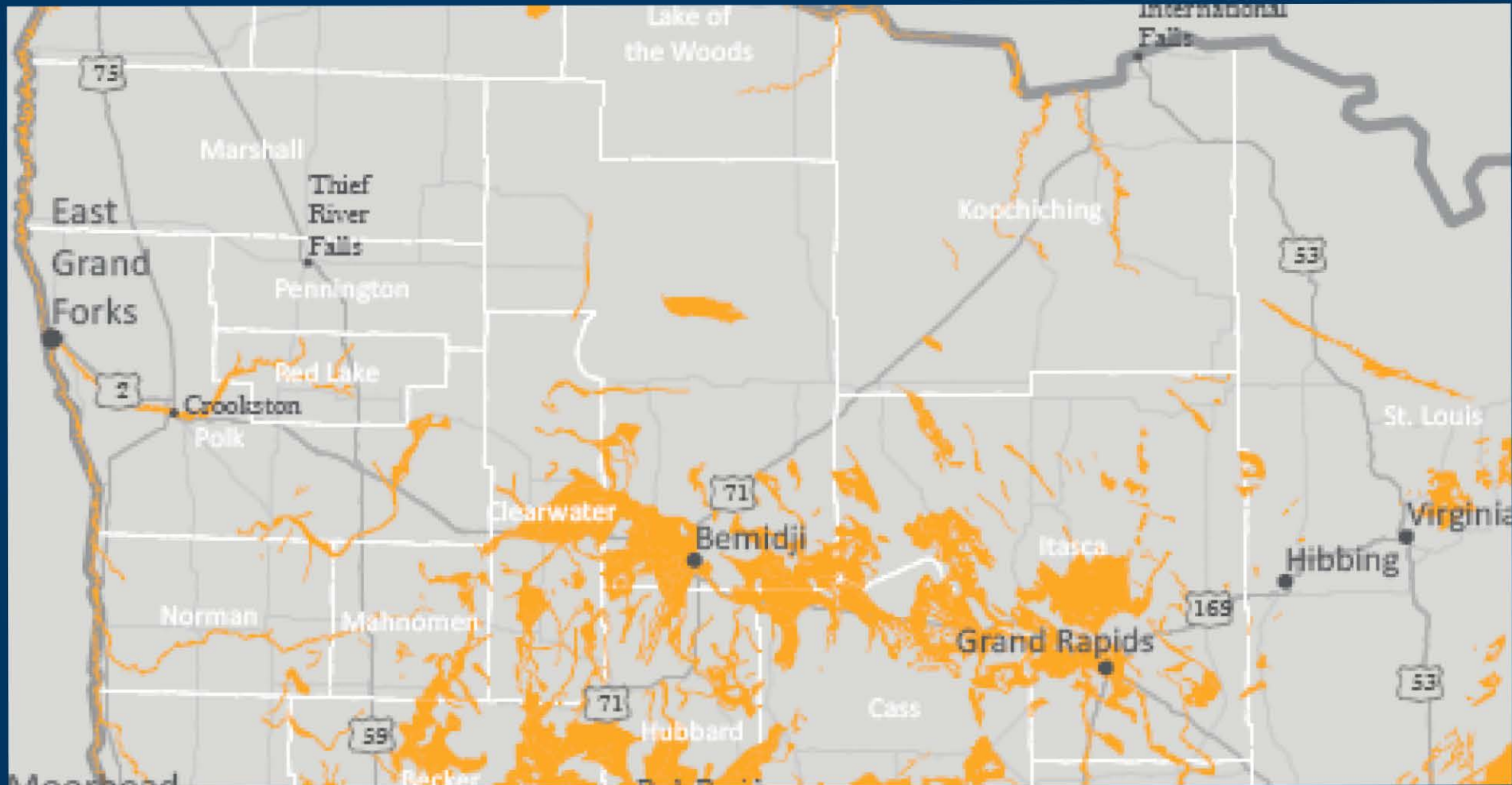
Meeker County



Scarcity

- Aggregate resources are a finite natural resources.
- Once plentiful supplies of aggregate resources are diminishing around the state.
- Scarcity is caused by both depletion as well as land use that prohibits mining.

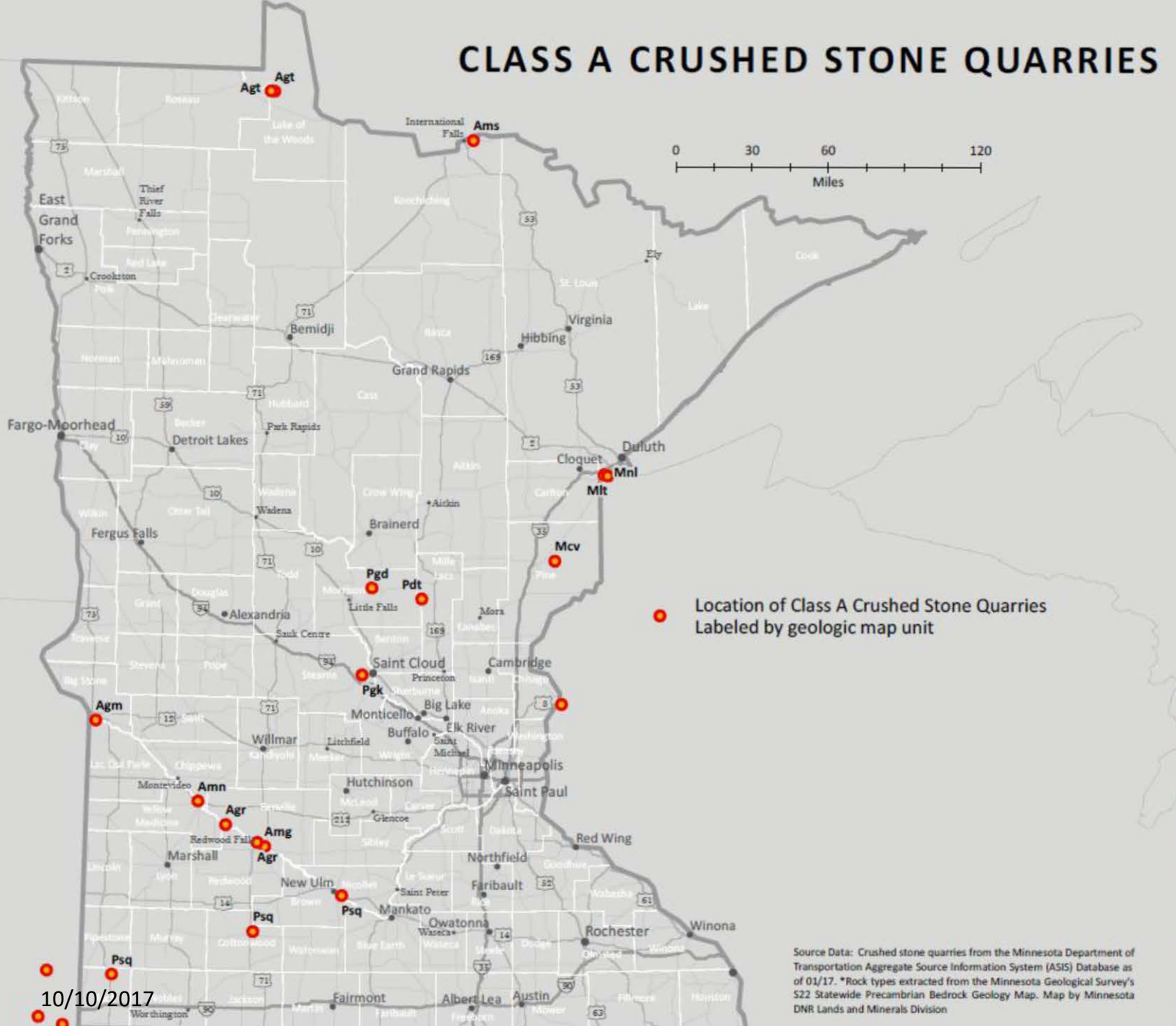
Natural Scarcity



MNDOT CLASSIFICATION OF AGGREGATES: Standard Specification for Construction (2016)

Class	Description
Class A	Crushed rock: quartzite, gneiss, granite, basalt, diabase, gabbro, and other igneous rock types
Class B	Crushed rock carbonates, rhyolite, and schist
Class C	Natural or partly crushed gravel from a natural gravel deposit
Class D	Mixture of classes
Class R	Recycled

CLASS A CRUSHED STONE QUARRIES



Location of Class A Crushed Stone Quarries Labeled by geologic map unit

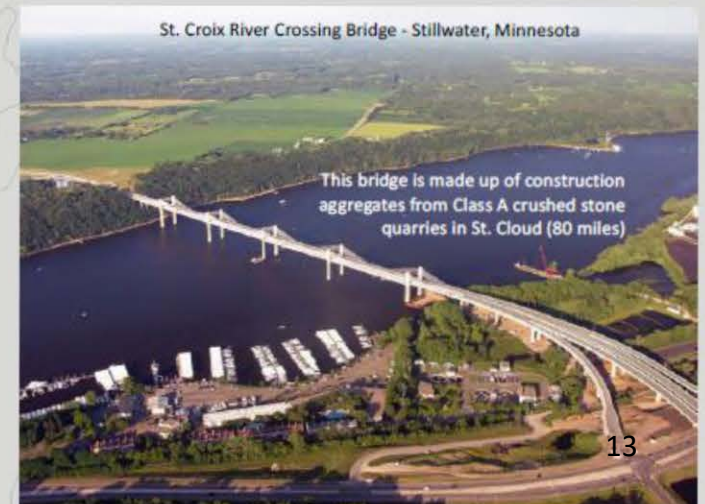
MnDOT Graded Aggregate for Bituminous Mixtures Requirements 3139.2
 A2a. CLASS A - The aggregate shall consist of crushed igneous bedrock (specifically basalt, gabbro, granite, rhyolite, diorite, andesite, or rock from the Sioux quartzite formation)

Table - MGS Rock Type Label and Description

MGS Map Label	Description
Agm	Granite to granodiorite, variably magnetic
Agr	Granitic intrusion
Agt	Tonalite, diorite and granodiorite
Amg	Granitic orthogneiss and migmatite
Amn	Amphibolitic to dioritic gneiss
Ams	Schist of sedimentary protolith
Mcv	Chengwatana volcanics, primarily mafic flows
Mlt	Troctolite
Mnl	Primarily basaltic lava flows
Pdt	Tonalite
Pgd	Gray granodioritic to dioritic intrusion
Ppk	Rockville porphyritic granite
Pgr	Granite, red to pink, variably porphyritic, massive
Psq	Sioux quartzite

10/10/2017

Source Data: Crushed stone quarries from the Minnesota Department of Transportation Aggregate Source Information System (ASIS) Database as of 01/17. *Rock types extracted from the Minnesota Geological Survey's S22 Statewide Precambrian Bedrock Geology Map. Map by Minnesota DNR Lands and Minerals Division



St. Croix River Crossing Bridge - Stillwater, Minnesota

This bridge is made up of construction aggregates from Class A crushed stone quarries in St. Cloud (80 miles)

Glacial Drift Covering Bedrock

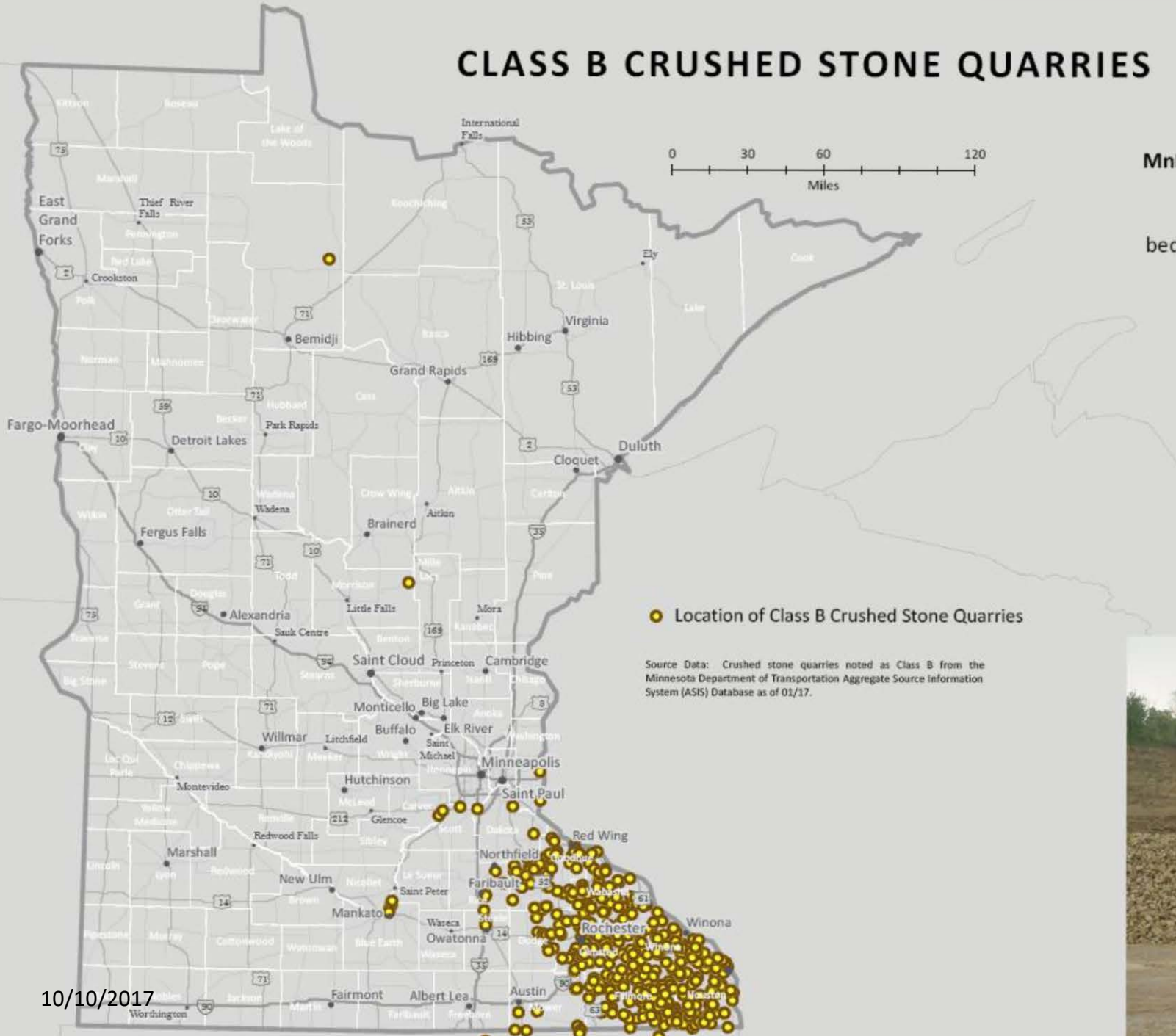


Overburden

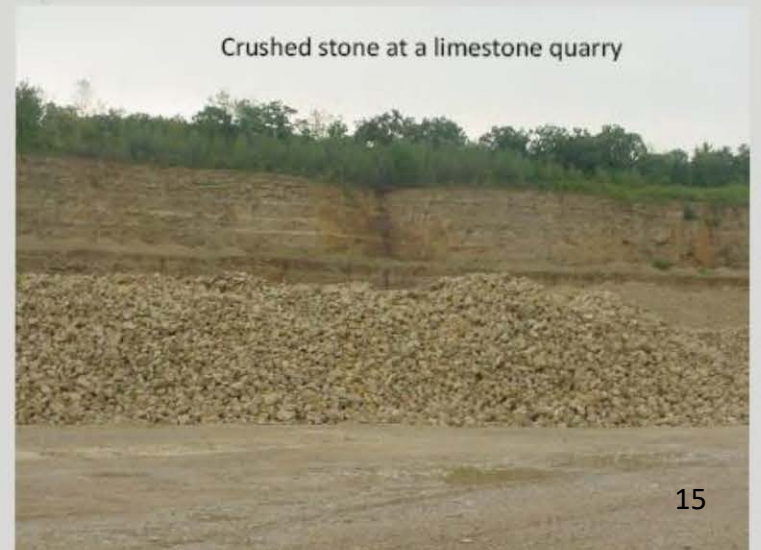
Bedrock

06/05/2005

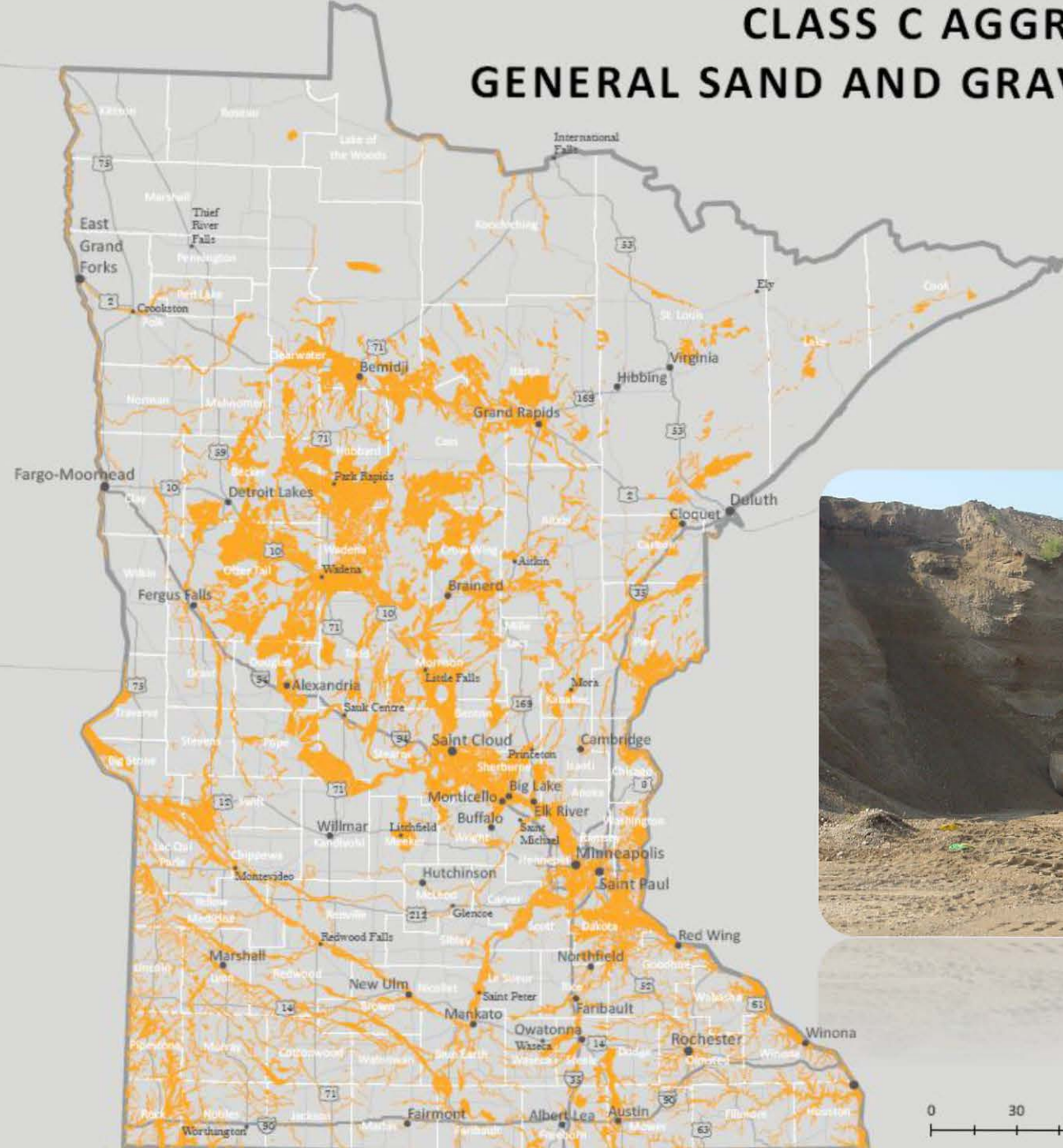
CLASS B CRUSHED STONE QUARRIES



MnDOT Graded Aggregate for Bituminous Mixtures
 Requirements 3139.2
 A2a. CLASS B - Crushed rock from other bedrock sources such as carbonate (limestone) and metamorphic rocks (schist)



CLASS C AGGREGATE GENERAL SAND AND GRAVEL DISTRIBUTION



CONSTRUCTION AGGREGATE QUALITY ISSUES

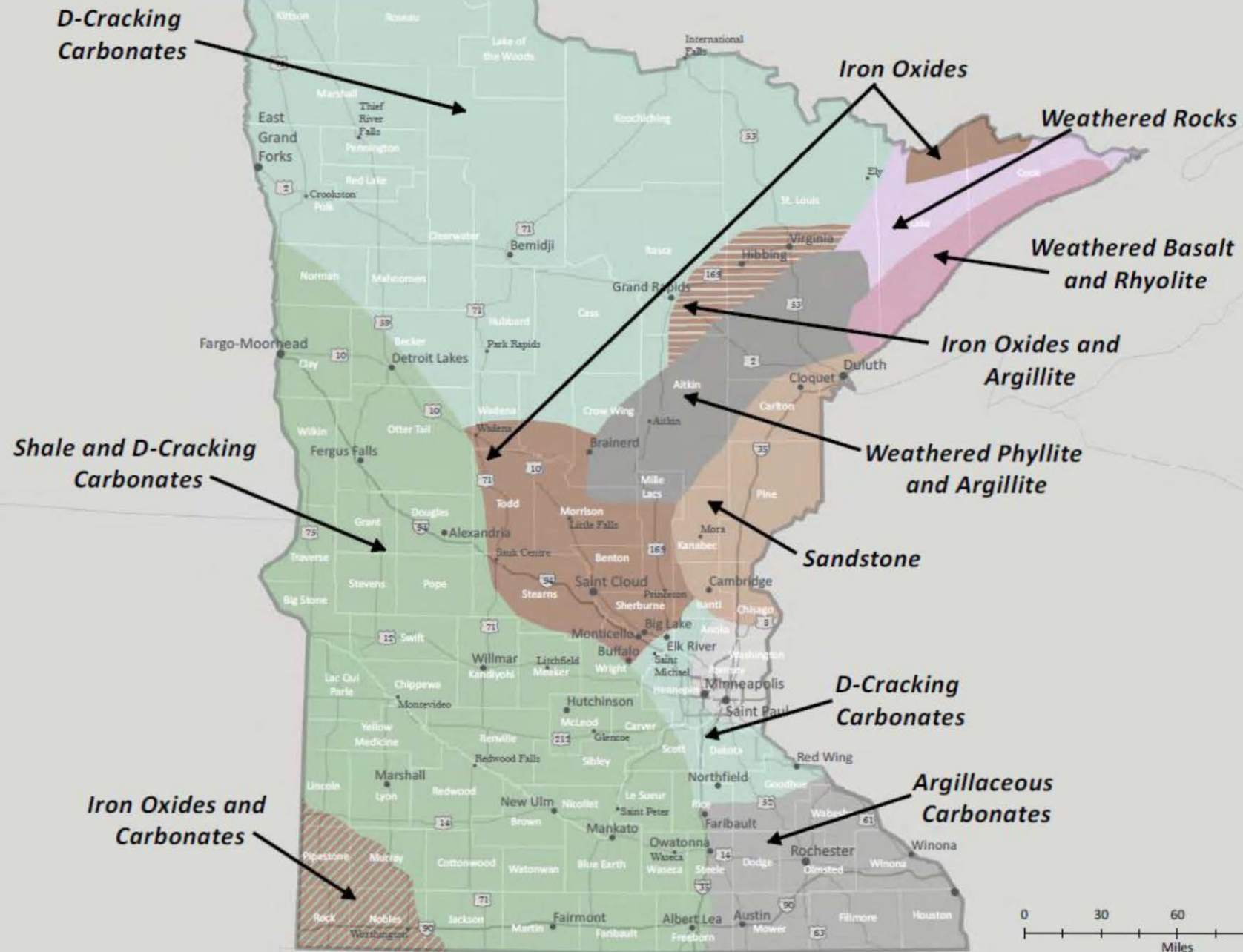




Figure 20. Alligator Cracking

Quality



SHALE



IRON OXIDES



CHERTS

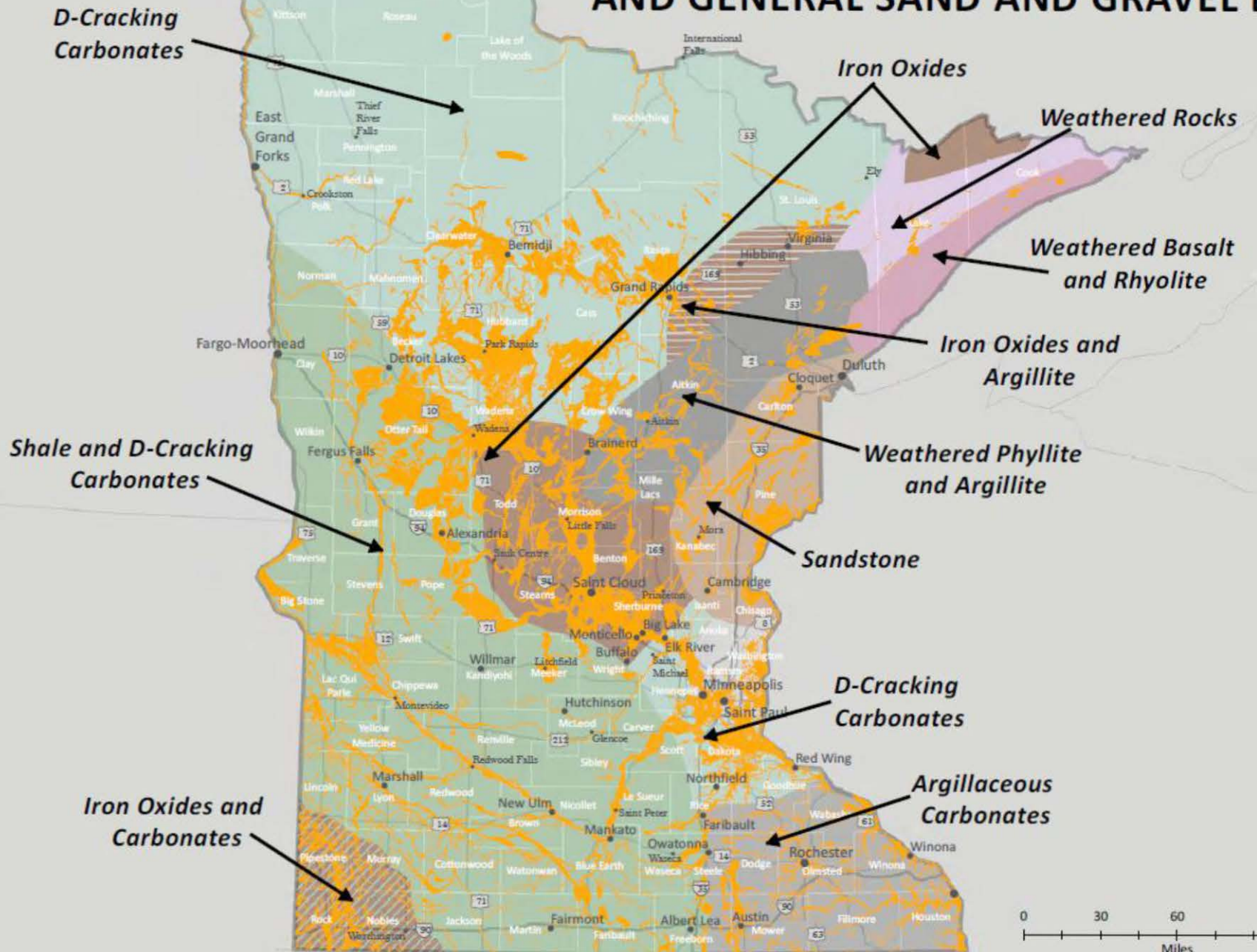


SANDSTONE



ARGILLITE

CONSTRUCTION AGGREGATE QUALITY ISSUES AND GENERAL SAND AND GRAVEL DISTRIBUTION



Factors that determine statewide sand and gravel distribution

Glacial depositional environment

- Presence of aggregate-bearing landforms



Quality Issues

- Texture
- Source of Glacier (Deleterious components)
- Sorting

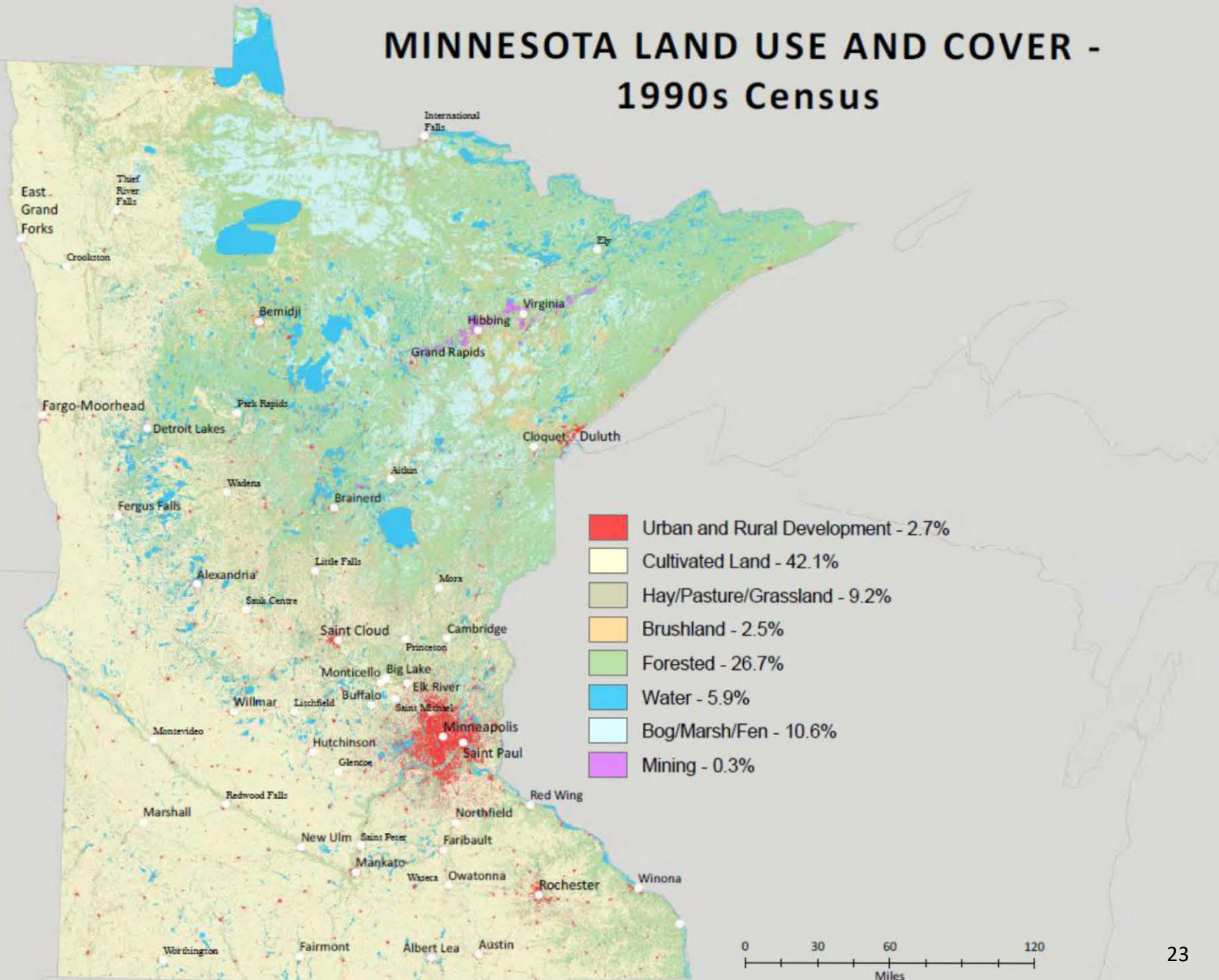


UNEVEN DISTRIBUTION

Mining as Land Use

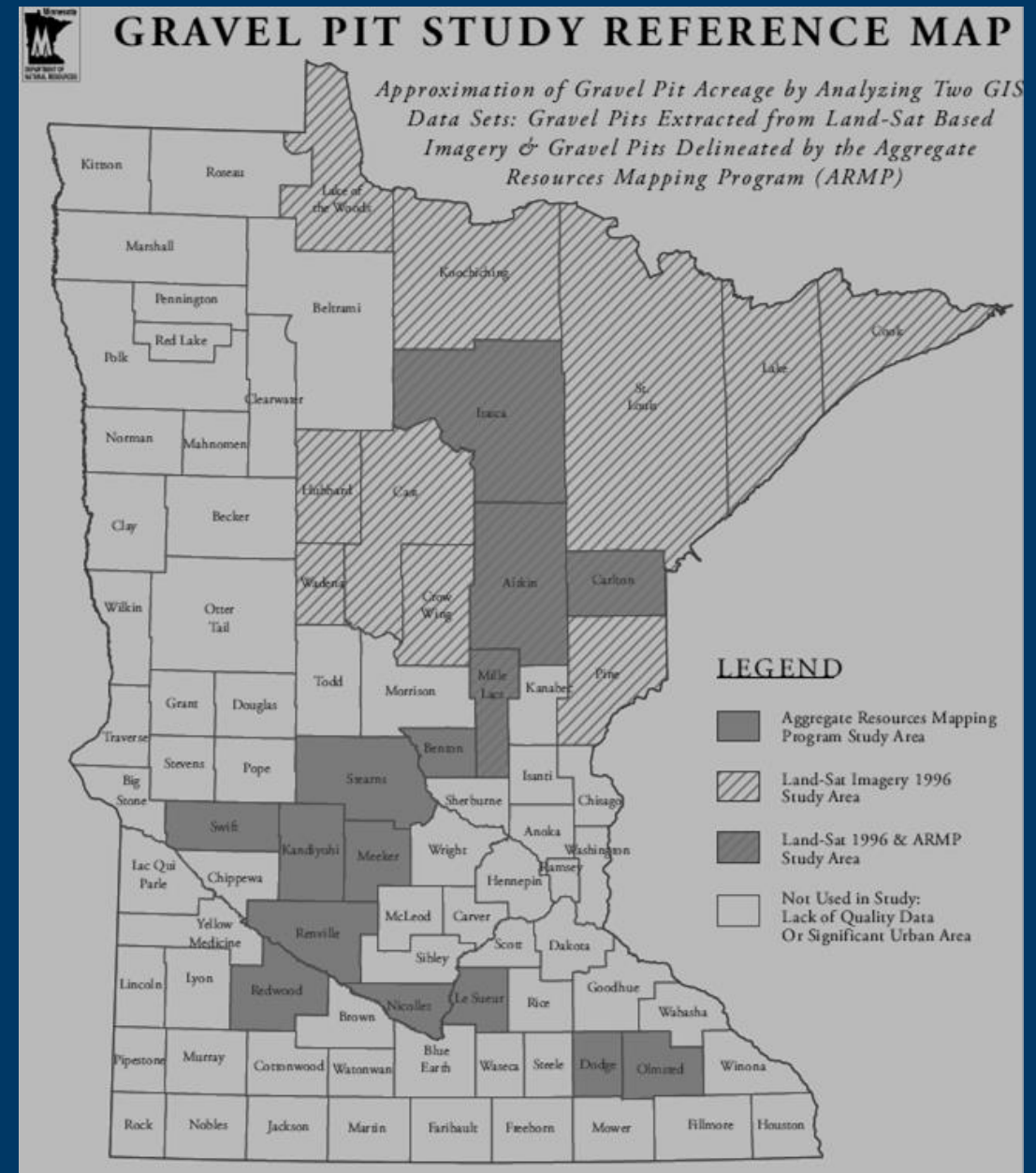


MINNESOTA LAND USE AND COVER - 1990s Census

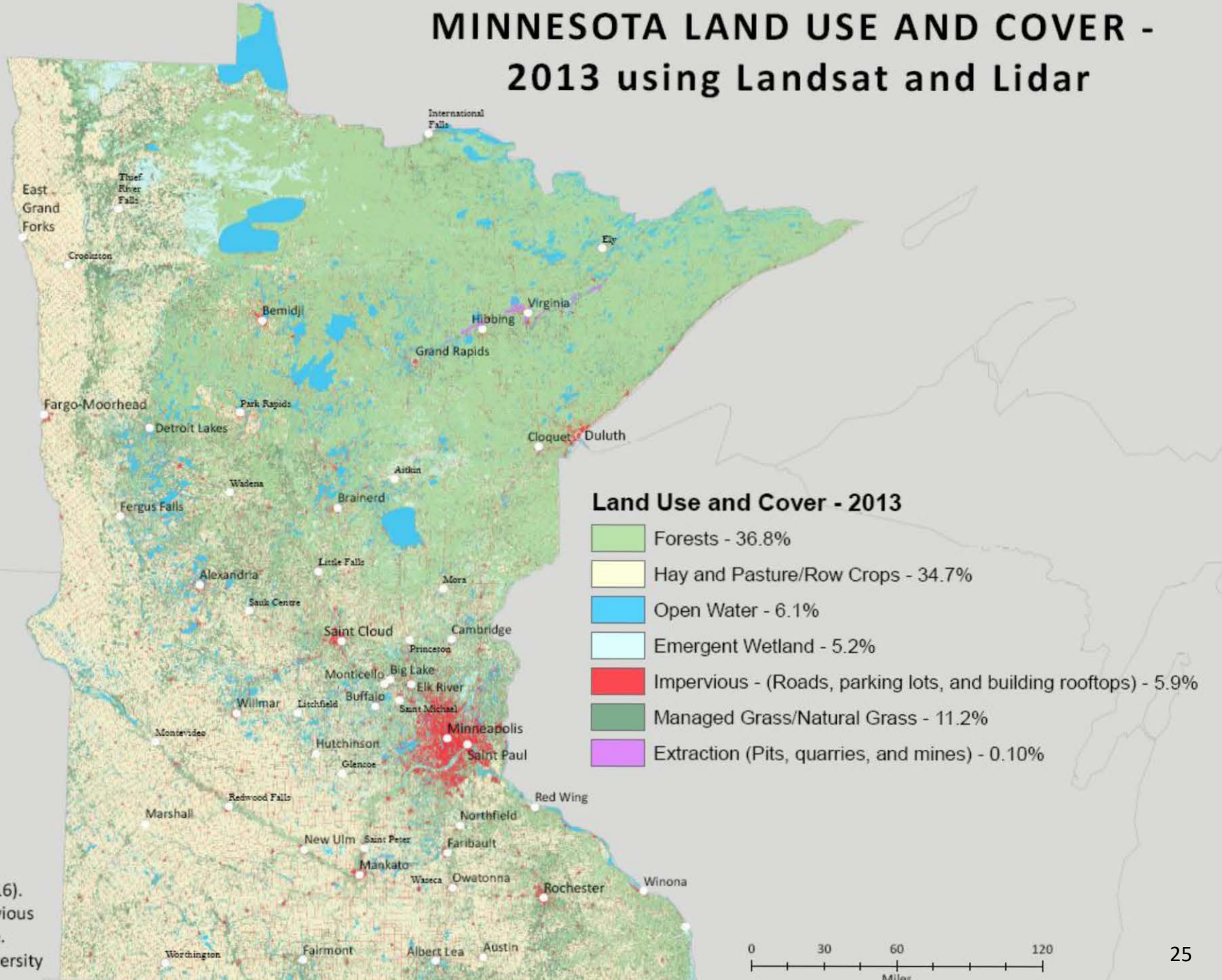


Approximation of Gravel Pit Acreages in Minnesota by DNR Land and Minerals Division in 2008

	DNR AGGREGATE RESOURCE MAPPING DATA	LANDSAT IMAGERY DATA
Number of counties surveyed	15 Counties	14 Counties
Total number of gravel pits > 5 acres	1,272	792
Total Acres	Approx. 17,600 acres	Approx. 14,400 acres
Percent of Land Used for Current or Historical Gravel Mining	0.19%	0.075%



MINNESOTA LAND USE AND COVER - 2013 using Landsat and Lidar



Data Citation:

Rampi, Lian P; Knight, Joe F; Bauer, Marvin. (2016). Minnesota Land Cover Classification and Impervious Surface Area by Landsat and Lidar: 2013 Update. Retrieved from the Data Repository for the University of Minnesota, <http://doi.org/10.13020/D6JP4S>.

10/10/2017



Mining as Land Use

- In four different land use surveys, mining only uses $\sim 0.1\%$ of the land
- With a range 0.1 to 0.3%
- In terms of a land use, mining is insignificant in comparison to agriculture and urbanization

Summary

- Aggregate resources are not evenly distributed within the state
- Not all aggregates are the same – the quality of aggregates are unevenly distributed within the state
- Large regions in Minnesota facing scarcity issues:
 - Natural scarcity
 - Land use restrictions
 - Urban/suburban development
- Aggregate mining is a small percent of Minnesota's land use, access to local aggregates is needed to keep “building” costs down

The State's role

- Natural resource issues extend beyond jurisdictional boundaries
- Some aggregate resource deposits have regional significance
- The value of the Aggregate Resource Task Force and the Aggregate Mapping Program is:
 - It is the only state support/involvement in aggregate resource management
 - Have the perspective to identify statewide trends/issues that impact local governments
 - Have the mechanisms to provide technical expertise/information/data that impacts





Thank you – Questions?

Heather Arends

Mineral Potential Section Manager