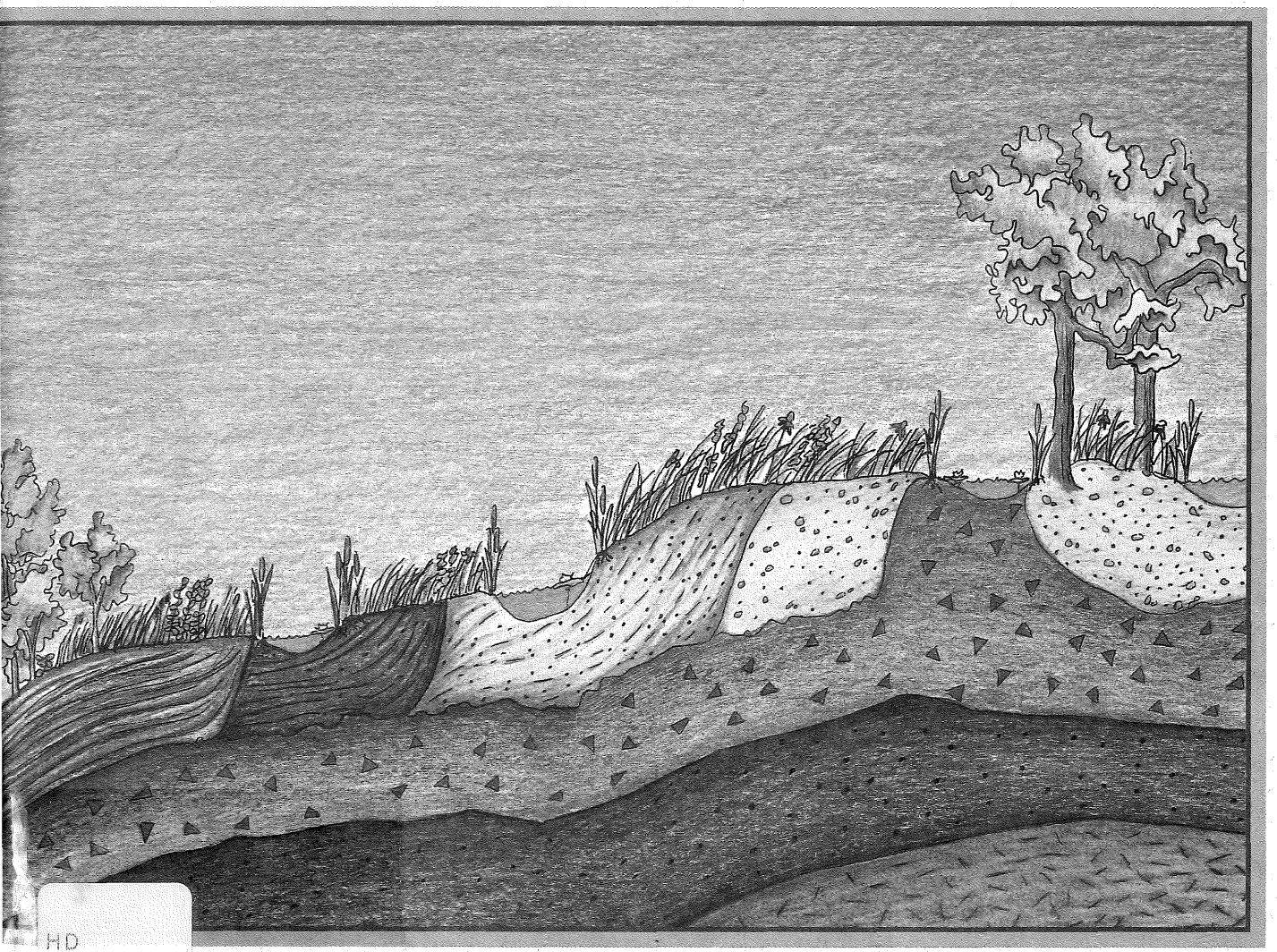
ML95 Chap. 220 Sec. 19 Subd. 5(e)

CLAY COUNTY BEACH RIDGES FORUM

for gravel mining and prairie protection

FINAL REPORT



About the Clay County Beach Ridges Forum

At the close of the last ice age nine thousand years ago, a series of ancient beach ridges developed at the margin of a huge lake formed by glacial meltwaters. The lake, known as Glacial Lake Agassiz, eventually drained and the lake plain became the modern day Red River Valley. Today, those beach ridges are an important source of sand and gravel materials for the Red River Valley. These same beach ridges also support some of the largest and best remnants of native prairie remaining in Minnesota and the entire Midwest.

Throughout the Red River Valley, gravel mining has expanded on the beach ridges to meet increasing market demands. In Clay County, Minnesota, the steady growth of the Fargo/Moorhead metropolitan area is driving an expansion of the gravel mining industry in the eastern half of the county. At the same time, native prairie is declining due to pressure from a variety of land uses. Because the beach ridges in Clay County support both gravel and prairie resources, questions have been raised about how continued expansion of the gravel mining industry may affect the remaining prairie. Concerns have also been expressed about how prairie protection efforts could affect future availability of aggregate materials.

In 1995, a local forum convened to discuss gravel mining and prairie protection on the beach ridges in Clay County.* The Forum was an opportunity for landowners, gravel producers, supporters of native prairie, interested members of the public and governmental agencies to learn about the prairie and gravel resources in the county and to discuss the future of those resources in a proactive setting. This volume is the final report of the Clay County Beach Ridges Forum. It contains a summary of the resource information collected by the Forum as well as final recommendations. The Forum concluded its work in June 1997.

At the outset, the Forum was committed to learn about the prairie and gravel resources in Clay County through a systematic review of the resource information. After more than a year of discussion, debate and deliberation, the issues remain complex. Throughout the process, the Forum tried to consider the needs of the future in terms of gravel and prairie resources. The Forum believes that the recommendations that follow are balanced and built on a foundation that represents many different viewpoints. The Forum further acknowledges that these recommendations will serve only as a beginning toward resolution of the ongoing land use questions. Many of the recommendations brought forward by the Forum depend on future consideration by other entities with authority to make change. The work of the Forum is clearly a strong starting point upon which others can build.

Clay County Beach Ridges Forum
June 1997

* The project for establishing the Forum was funded by the Minnesota Legislature based on the recommendation of the Legislative Commission on Minnesota Resources. The project was staffed by the Minnesota Department of Natural Resources who carried out work as directed by the Forum. For more information about the Clay County Beach Ridges Forum, contact the Clay County Courthouse or the Minnesota Department of Natural Resources at the addresses listed on the inside of the back cover.

CONTENTS

Part I. The Forum ..... page 1

- What are the Lake Agassiz Beach Ridges?
- Why are the beach ridges important?
- Why study the beach ridges in Clay County?
- What is the Clay County Beach Ridges Forum?
- Who was involved?
- Public participation.
- What were the Forum goals?

Part II. Resource Information ..... page 6

- What are the prairie resources in Clay County?
- Prairie conservation.
- Special prairie plants and animals.
- Prairie restoration.
- Economic impact of prairie visitors.
- Importance of the aggregate industry.
- Aggregate potential in Clay County.
- Aggregate drilling.
- Gravel mining in Clay County.
- Uses for gravel.
- Population growth and aggregate demand.
- Aggregate recycling.
- Regulations that apply to gravel mining.
- Aggregate Material Tax.

Part III. Analysis ..... page 22

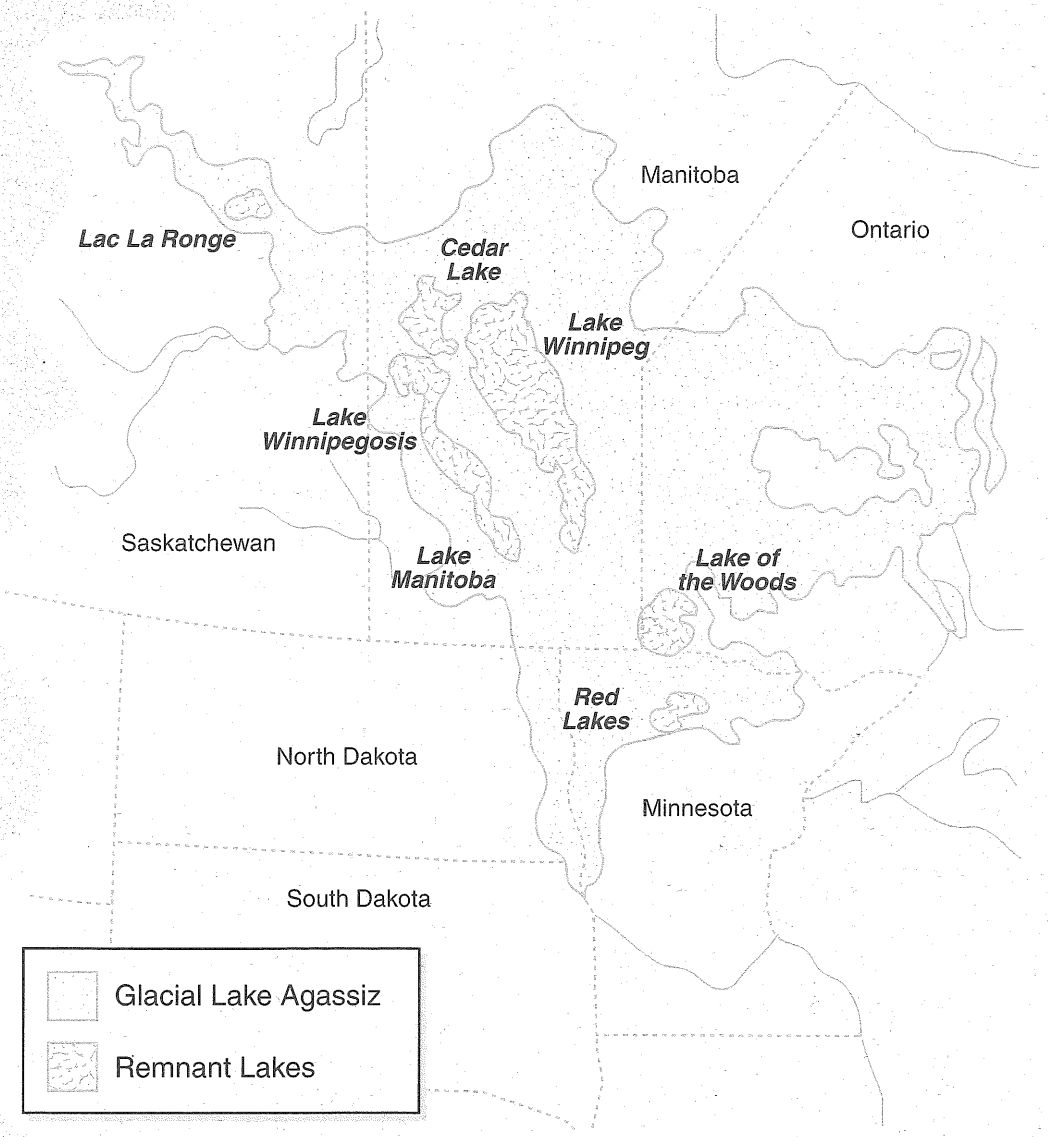
- What was the study area?
- Information used in the analysis.
- Methods used.
- Future analysis.
- Other observations.

Part IV. Recommendations ..... page 40

- General recommendations.
- Specific actions.
- Possible future project proposals.
- Other areas of concern.

Appendix A: Where to obtain more information.

Glacial Lake Aggassiz



What are the Lake Agassiz Beach Ridges?

Thousands of years ago, the Red River Valley was a very different place. Then, glaciers covered much of the upper Midwest. When the glaciers finally melted, huge lakes were formed. One of those lakes was Glacial Lake Agassiz. Today, the modern day Red River Valley is found on the former lake bed of Glacial Lake Agassiz. The shorelines of the ancient lake are now seen as a series of linear ridges composed of sand and gravel materials that are slightly higher in elevation than the surrounding lands.

Why are the beach ridges important?

The Lake Agassiz beach ridges throughout the Red River Valley support a wide variety of important land uses including agriculture. This report focuses specifically on the relationship between gravel and prairie resources as they occur on the beach ridges and does not consider other land uses.

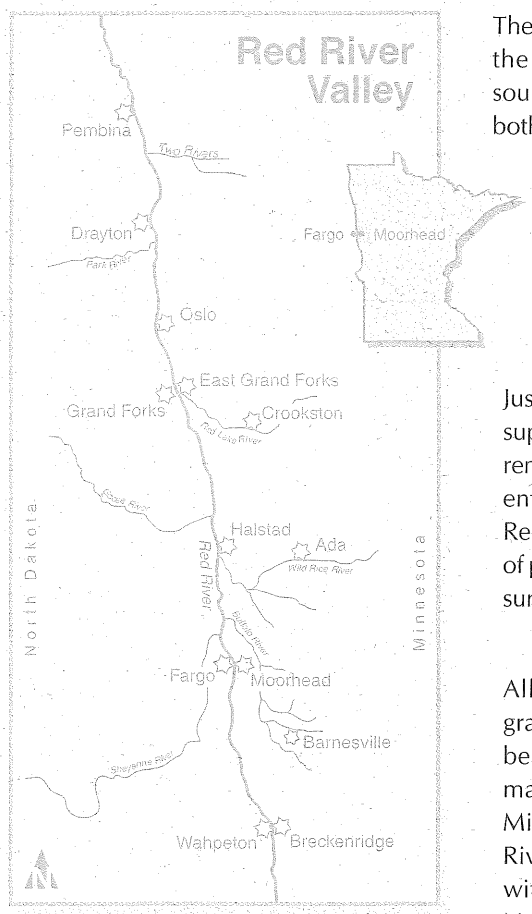


Figure 1. Red River Valley.

The gravel resource that underlies the beach ridges is the primary source of construction aggregate for both rural communities and urban centers in the Red River Valley. The gravel mining industry supplies essential building materials, provides good jobs, and contributes significantly to the local economy.

Just as important, the beach ridges support some of the largest and best remnants of native prairie left in the entire Midwest. Throughout the Red River Valley, the last remnants of prairie are in decline due to pressure from a wide range of land uses.

Why study the beach ridges in Clay County?

All across the Red River Valley, gravel mining has expanded on the beach ridges to meet increasing market demands. Clay County, Minnesota is located in the Red River Valley and shares a border with neighboring Cass County in North Dakota (Figure 1). In Clay County, the steady growth of the

Fargo/Moorhead area is driving an expansion of the gravel mining industry in the eastern half of the county where the beach ridges are found. As the population of this area continues to increase, the demand for aggregate products will also grow.

This report focuses on the relationship between gravel and prairie in the eastern half of Clay County, an area of 18 townships that includes most of the gravel mining activity in the county as well as the remaining tracts of prairie. Because the beach ridges in Clay County support both gravel and prairie resources, questions have been raised about how continued expansion of the gravel mining industry may affect the remaining prairie. Concerns have also been expressed about how prairie protection efforts could affect future availability of aggregate materials. The relationship between prairie and gravel is important because both are non-renewable resources that are uniquely located. Gravel deposits must be mined where they are found and cannot be relocated. Similarly, native prairie cannot be transplanted elsewhere. The same relationship between gravel and prairie resources observed in Clay County can be seen throughout the Red River Valley.

What is the Clay County Beach Ridges Forum?

In 1995, a local Forum was convened to discuss gravel mining and prairie protection on the beach ridges in Clay County, Minnesota. The Forum has been an opportunity for landowners, gravel producers, supporters of native prairie, interested members of the public and governmental agencies to learn about the prairie and gravel resources found in Clay County and to discuss the future of those resources in a neutral and proactive setting.

The project for establishing the Forum was funded by the Minnesota Legislature based on the recommendation of the Legislative Commission on Minnesota Resources. The project was staffed by the Minnesota Department of Natural Resources (DNR) who carried out work as directed by the Forum.

The Forum provided a setting for building relationships among people who did not often have the chance to meet informally. It created an organizational frame work for people to first discuss and then make recommendations about the beach ridges. The resource discussions that took place in the Forum centered on information generated by a customized geographic information system (GIS) that was compiled for the project. As such, it is one of the first projects in Minnesota to use GIS technology in a public setting.

The Forum concluded its work in June 1997. This volume is the final report from the Clay County Beach Ridges Forum. Part I is an explanation of the Forum and its activities. Part II contains information collected by the Forum about the resources occurring on the beach ridges. Part III is a discussion of the analysis conducted by the Forum based on the resource information. Part IV contains the Forum's final recommendations.

Who was involved?

Initially, a local Steering Committee representing a range of interests on the beach ridges stepped forward to chart a mission and set goals for the project. All members of the Steering Committee volunteered to serve because of their interest in the project and the possible outcomes. The committee met monthly or sometimes more often from January 1996 to June 1997.

As interest in the project grew, so did the size of the Steering Committee. Over time, the Steering Committee became a Forum where issues could be freely discussed. At the end of the project, the Forum was a group of about 34 people with a core of 15 to 20 who regularly attended meetings. The people listed below are those who requested to be on the Steering Committee mailing list. A Project Coordinator from the Department of Natural Resources administered the project and facilitated meetings.

Steering Committee

Bruce Squires, CAMAS-MinnDak, Inc.
Brian Winter, The Nature Conservancy
Evelyn Leach, Elkton Township Clerk
Dan Ames, Ames Sand & Gravel
Ron Ekre, landowner
Chuck Egge, Egge Construction
Jon Evert, Clay County Commissioner
Gene Fitzgerald, Fitzgerald Construction
Roger Minch, landowner
Tim Magnusson, Clay County Planning
Ann and Orvis Gytri, landowners
Glenn Bjerk, Border States
Ken Fox, landowner
Jim Dahl, landowner
Ruth Landfield, landowner
Cliff McLain, Moorhead Public Services
Ron Morken, landowner
Jerry VanAmburg, Buffalo River Watershed District
Mary Grabaskas, U.S. Fish & Wildlife Service
Jack Cousins, Clay County Engineer
Dave Asplin, Asplin Sand & Gravel
Otto Schmid, MN Dept. of Transportation
Walt Johnson, Dept. of Natural Resources
Dean Schmidt, Natural Resources Cons. Service
Roy Mattson, Keene Township
Doug Wells, MN Department of Natural Resources
Bob Wright, Wild Rice River Watershed District
Peter Buesseler, MN Dept. of Natural Resources
Donald Schwert, North Dakota State University
Bob Gee, Clay County Planning Commission
Paul Krabbenhoft, Clay County Planning Comm.
John Gunderson, U.S. Fish & Wildlife Service
Paul Munsterteiger, MN Dept. of Transportation

Project staff from the Minerals Division of the Minnesota DNR included:
Cindy Buttleman, Project Coordinator; Renee Johnson; Paul Purman

Public participation.

Public participation was critical to the success of the Forum. All meetings were open to the public with visitors encouraged to attend (and visitors often attended). The Forum created several opportunities for public involvement. Four public meetings were held, a field trip to view prairie and gravel resources in the county was conducted, a technical session about the computerized resource information generated by this project was organized, several presentations to the Clay County Board and Planning Commission were made, and a quarterly newsletter was distributed to 450 interested parties. All of these activities were well received by the public.

What were the Forum goals?

The first task for the Forum was to define a mission and goals for the project. The following mission statement was eventually adopted.

> *The mission of the Clay County Beach Ridges Forum is to identify and recommend ways to achieve a balance between the protection of our natural prairie heritage and environmentally yet economically sound gravel mining opportunities through appropriate land use management.*

The Forum later adopted three goals for the project.

Goal 1. Provide key information about the beach ridges to landowners, gravel operators, land managers and the public. During the first six months of the project, the Forum gathered information about the beach ridges and heard from several speakers on pertinent topics. The Forum sought to be a source of accurate and balanced information about the gravel and prairie resources found in Clay County. They believed it was important for the public to understand both the economic and the natural heritage value of the beach ridges.

The Forum wanted the information gathered through this project to be summarized in different ways for future use by a full range of the public. The informational products devised by the Forum range from a computerized resource information system to a children's coloring book about the beach ridges. The following list describes the informational products developed by the Forum for use by the public. The Forum provided the leadership and oversight on the development of these products while project staff from the DNR were responsible for their completion. Appendix A contains information on where these products can be found.

Computerized resource information system. A computerized resource information system was compiled for use by the Forum in

this project and for future use by the public. It integrates existing and relevant digital resource datasets for the eastern half of Clay County. The system allows users to study prairie and gravel resources in combination and to create custom maps and applications. The information is available to the public on CD-ROM at the Lake Agassiz Regional Library and to visitors at the Moorhead State University Regional Science Center. The information is also housed in the Clay County Courthouse for use by county staff.

Map displays. Maps displaying gravel and prairie resources were distributed to all townships and community centers in the county. Several large maps were prepared for display in public settings throughout Clay County.

Lake Agassiz Beach Ridges: A Coloring Book for Children. This coloring book for children depicts the value of both the prairie and gravel resources. It was distributed on Earth Day 1997 to all third grade classrooms in the county.

The Beach Ridge Landscape in Clay County: An Information Handbook. This handbook is a series of one page fact sheets that provide information on key topics relating to gravel and prairie resources.

Final Report. The final report of the Forum documents all aspects of the project and includes a summary of the process, resource information, analysis and recommendations.

Goal 2. Protect natural resources and avoid future conflicts with special emphasis on prairie and gravel. The Forum's second goal was to study the information that had been compiled - especially the computerized resource information - and then make recommendations with respect to prairie and gravel resources in the county. The results of that effort are summarized in Part IV of this report.

Goal 3. Recommend ways to improve reclamation. Throughout the duration of the Forum, much was learned about the value of the gravel mining industry to Clay County and the economics of this business. Given the long history of gravel mining in the county as well as the number of existing gravel mining areas, the Forum strived to first become informed on reclamation and then make thoughtful recommendations. Several of the recommendations in Part IV of this report address reclamation.

Part II. RESOURCE INFORMATION

The first goal of the Forum was to be a source of accurate and balanced information about the prairie and gravel resources found in Clay County. What follows is a summary of the resource information compiled by the Forum.

What are the prairie resources in Clay County?

There are many different types of prairie found in the Midwest and the type depends on local topography, precipitation and soil. The tallgrass prairie was typically found in western Minnesota where prairie grasses sometimes grew six feet high. Prior to European settlement, almost the entire Red River Valley was covered by tallgrass prairie. The original vegetation map of Minnesota shows that only the river and stream bottoms were wooded in Clay County (Figure 2). The rest of the county was tallgrass prairie.

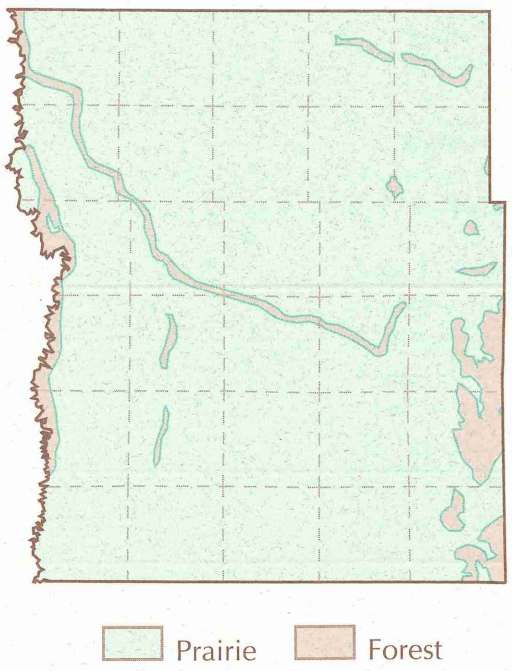
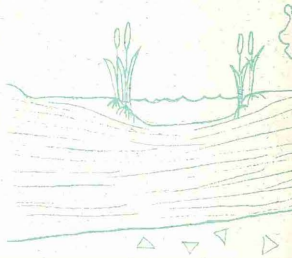


Figure 2. Original vegetation in Clay County (Adapted from Marschner, F. J. 1974. The original vegetation of Minnesota (map, scale 1:500,000). USDA Forest Service, North Central Forest Experiment Station. Redraft of the original 1930 edition).

The prairie landscape was shaped by large grazing animal herds such as bison, drought, fire, and extreme temperatures. Plants and animals living on the prairie are specially adapted to the unique climate and conditions found in western Minnesota. Prairie plants evolved to conserve water and survive fire. More than 200 different plants and animals can be found on a single acre of prairie ground. Most of the plant growth is underground where long roots reach deeply for water and food.

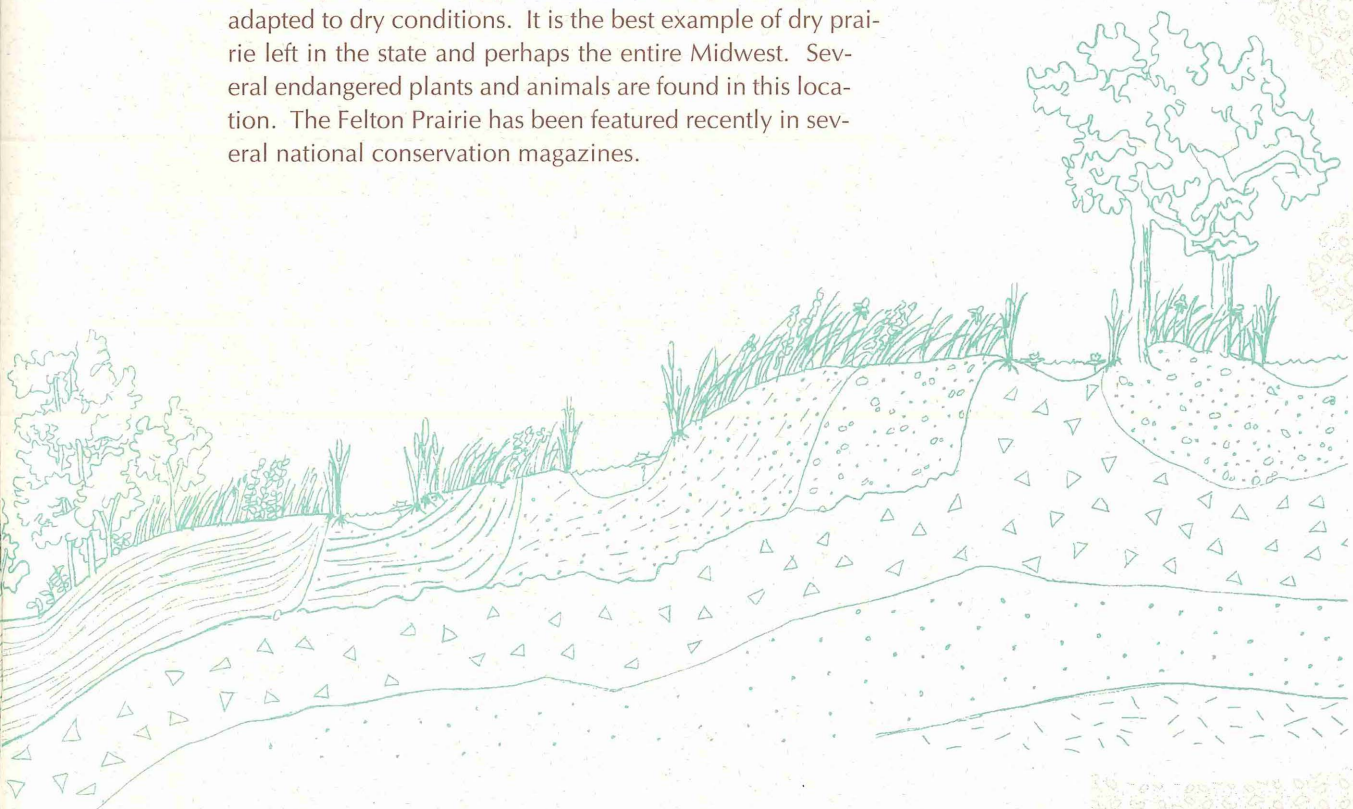
With settlement underway in the 1860's, many immigrants found the rich prairie soils of the Red River Valley to be valuable for farming. Almost all of the original tallgrass prairie was eventually cleared except for some land on the beach ridges. This land was probably not plowed because the soil was sandy compared to the rich heavy soils on the lake plain of Glacial Lake Agassiz to the west. Prairie land that has never been plowed is generally called native prairie. Today, less than 1% of the original 18 million acres of prairie in Minnesota remains. Most of these prairie remnants are found on the beach ridges in the Red River Valley (Figure 3).



The remaining prairie in Clay County was recently mapped by the DNR (Minnesota County Biological Survey Staff. 1997. Natural Communities and Rare Species of Clay County, Minnesota Map, scale 1:75,000. MN Department of Natural Resources). About 21,310 acres in the county were identified as having some prairie characteristics. Prairie resources in the county vary in quality. Included in this figure are areas containing prairie of low significance, prairie of modest significance, prairie of medium significance and prairie with high significance.

The prairie with medium or high significance represents the best and least disturbed prairie in the county. About 14,290 acres of prairie with high or medium significance are found in Clay County. This figure includes some of the best prairie in Minnesota and represents approximately 10% of all the prairie remaining in the state. For the purposes of this report, prairie lands with high or medium significance will be referred to as "high/medium" prairie.

There are two main concentrations of prairie found in Clay County - Felton Prairie and Bluestem Prairie. Felton Prairie is a special kind of prairie that supports animals and plants specially adapted to dry conditions. It is the best example of dry prairie left in the state and perhaps the entire Midwest. Several endangered plants and animals are found in this location. The Felton Prairie has been featured recently in several national conservation magazines.



Bluestem Prairie is located south of Trunk Highway 10 near Buffalo River State Park. It is an excellent example of a mesic tallgrass prairie landscape. Much of Bluestem Prairie is contiguous and offers uninterrupted views of the tallgrass prairie.

A third area of shrub swamp and marsh with scattered prairie remnants is found in the southeastern corner of the county and is known as the Barnesville Slough. Also found in this general location is a concentration of prairie/savanna/woodland remnants.

These three areas combined account for the bulk of what remains of the county's original prairie vegetation. Other smaller and isolated parcels of prairie are scattered throughout the eastern half of the county.

Prairie conservation.

Some of the best prairie in Clay County is protected by designation as state Scientific and Natural Areas (SNAs) or through conservation efforts by private landowners or conservation organizations like The Nature Conservancy. Several state and federal conservation programs are available to interested private landowners to protect prairie remnants on their lands and a substantial amount of prairie has been enrolled in these programs by willing private landowners. Because the majority of prairie that remains in Clay County is in private ownership, landowners are an important factor in future prairie conservation efforts.

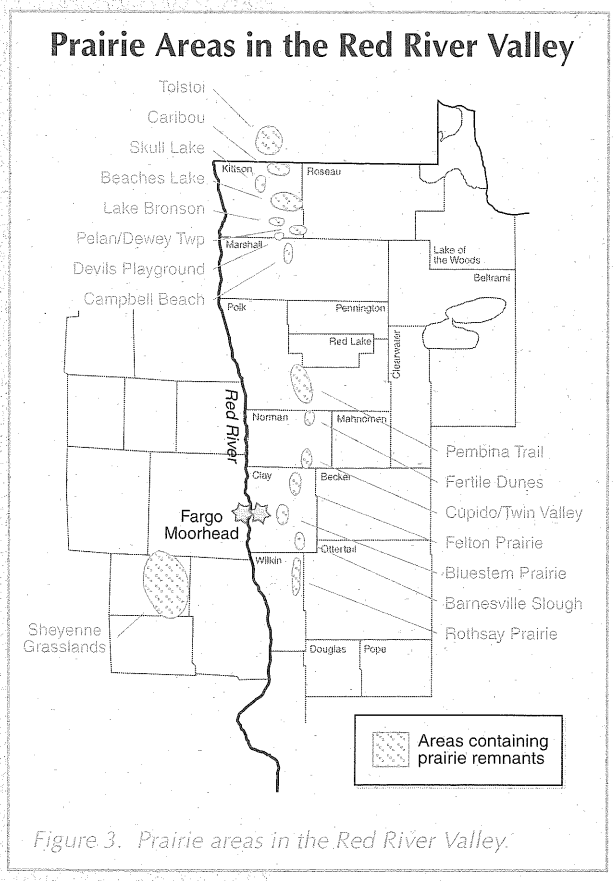


Figure 3. Prairie areas in the Red River Valley.

In addition, prairie that occurs on public land in a designated management unit is likely to remain as prairie (such as a wildlife management area, a waterfowl production area or a park). However, not all public land is in a management unit. Some high/medium prairie on public land is managed for gravel. It should also be noted that a significant amount of low quality and disturbed prairie occurs on public land that would benefit from prairie restoration efforts.

The prairie landscape is neither explicitly recognized nor protected by law in Min-

nesota. However, other existing laws can apply to prairie landscapes. For example, prairie wetlands are regulated like other wetlands under the jurisdiction of the Wetlands Conservation Act of 1991 (Laws of

A family on the prairie in Clay County (date unknown).

Minnesota for 1991, Chapter 354). In general, proposed development that would impact prairie wetlands requires mitigation. Calcareous fens, a unique type of wetland often found down slope from beach ridges in the Red River Valley, are protected through the Wetlands Conservation Act. Ten calcareous fens are located in Clay County from a total of 103 listed statewide. Certain federal farm programs may also apply to agricultural use of prairie lands. Finally, some animals and plants that live on prairie remnants in Clay County have legal status as threatened or endangered species. Proposed development that would potentially impact these species may require careful review.

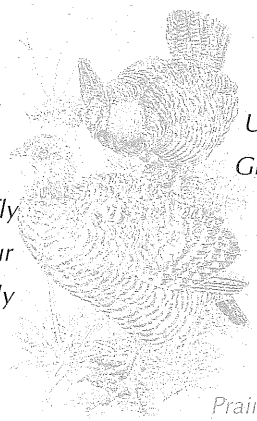
Special prairie plants and animals.

Because of the loss in prairie habitat since European settlement began, many plants and animals that live on the prairie are considered endangered or threatened. In Clay County, 17 animal species and 19 plant species have been identified by the state as threatened, endangered, or

special concern species. Of these, the western prairie fringed orchid is the only federally-listed species known to occur in the county, the rest are state-listed. Most but not all of these species are found on the beach ridges (an exception is lake sturgeon). There are also as many as 40 prairie chicken booming grounds located in Clay County on an annual basis. The DNR and the U.S. Fish and Wildlife Service can provide additional information about these plants and animals.

Special Animals in Clay County

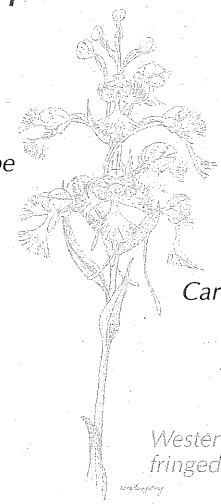
Baird's sparrow
Henslow's sparrow
Sprague's pipit
Prairie vole
Poweshiek skipper butterfly
Chestnut-collared longspur
Assiniboia skipper butterfly
Dakota skipper butterfly
Western hognose snake
Loggerhead shrike
Marbled godwit
Uhler's arctic butterfly
Greater prairie chicken
Burrowing owl
Lake sturgeon
Plains pocket mouse
Yellow rail



Prairie chicken

Special Plants in Clay County

Blanket flower
Red threeawn
Prairie moonwort
Louisiana broom-rape
Hall's sedge
Blunt sedge
Northern gentian
Sterile sedge
Dry sedge
Felwort
Nuttall's sunflower
Clustered broom-rape
Hair-like beak-rush
Whorled nut-rush
Hill's thistle
Small white lady's slipper
Carex scirpiformis (type of sedge)
Few-flowered spike rush
Western prairie fringed orchid



Western prairie fringed orchid

Prairie restoration.

There are several excellent examples in Clay County where lands that once were covered by tallgrass prairie have been restored to prairie vegetation. With time, effort, and patience, it is possible and in some cases desirable, to restore an assemblage of the original prairie vegetation. Once established, native prairie grasses can provide a long-term vegetative cover that is self-sustaining and requires little maintenance. Another advantage is that prairie grasses do not usually require fertilizer

amendment for establishment. They also have a high value to wildlife. Although a restored prairie offers many benefits, it can never fully substitute for a native prairie. Restoring more than a fraction of the species found in a native prairie is beyond present capabilities.

Prairie restoration can be a challenging endeavor. Most warm-season prairie grass seed will not germinate until prolonged moisture is available at warm temperatures. As a result, it may be the spring after initial seeding before seedlings are observed. After germination, warm-season prairie grasses establish an extensive root system during the first year. The top growth during this time amounts to small leaves that can be difficult to identify. It is usually not until the second year when success becomes apparent.

Prairie grass seed can be relatively expensive to purchase and sometimes difficult to find. A specially-adapted seed drill is sometimes needed for seeding large areas. Adequate site preparation and regular weed control are essential for establishment. Due to the increasing popularity of native prairie plantings, these difficulties are quickly being overcome. Several government agencies and private vendors in the area can provide advice and technical assistance to private landowners on how to restore prairie.

Economic impact of prairie visitors.

Every year, an unknown number of visitors come to Clay County to view the prairie vegetation or the animals that live there. These visitors have a positive economic impact on the local economy that is difficult to quantify.

Claim shack on the prairie in Clay County (date unknown).

On Bluestem Prairie, the number of visitors are recorded by The Nature Conservancy, Buffalo River State Park, and the Moorhead State University Regional Science Center. The Nature Conservancy office located on Bluestem Prairie offers opportunities to observe the spring courtship dance of prairie chickens from a special viewing blind. More than 90 people each spring use the blind. Reservations are necessary and the schedule fills early with visitors that come from as far away as the east coast. A waiting list is maintained.

In 1996, about 78,965 people visited Buffalo River State Park. Some of these visitors come to see the prairie while others visit to pursue recreational opportunities available at the park. Also in 1996, the Moorhead State University Regional Science Center hosted about 16,581 visitors to the center including almost 9,000 kindergarten to 12th grade students, many from outside Clay County. Prairie landscapes are a major focus of the educational activities at the science center.

Only anecdotal information is available for the Felton Prairie area. Some people who live and work in the Felton area have observed an increase in the number of visitors to the Felton Prairie. This may be related in part to the attention that Felton Prairie has gained recently in the state and even on the national level.

Hunting is another recreational activity that has a positive but unknown impact on the local economy. Prairie lands support an abundance of wildlife which is important in providing a good experience for hunters.

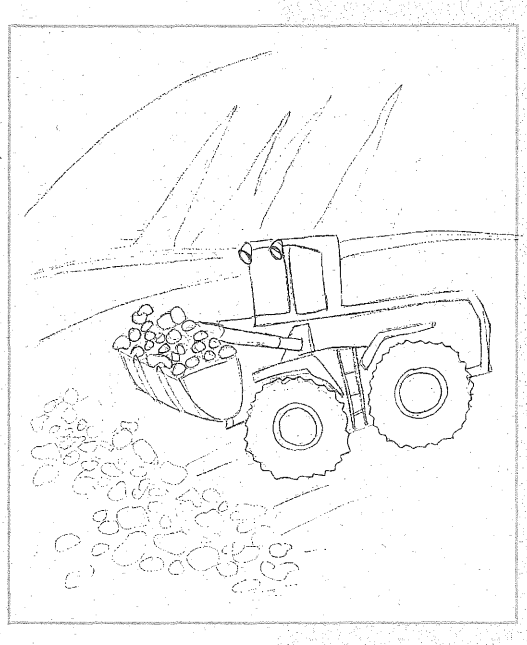
Importance of the aggregate industry.

Gravel deposits occur throughout Minnesota and are a legacy of the state's glacial history. Sand and gravel are most often found as a surficial deposit of unconsolidated material that is mined using shovels, draglines, loaders, trucks and other similar equipment. Crushed stone, in contrast, is made by crushing large blocks of rock that are usually extracted from the earth using hard rock mining methods.

Gravel, rock and crushed stone can be further crushed, washed, and blended to meet size and quality specifications. Together, sand, gravel, rock, crushed stone and their various size fractions are referred to as aggregate materials. Aggregate materials are the building blocks from which a variety of construction products can be made. Aggregate materials are used in concrete products, asphalt, road base, fill, snow and ice control and other miscellaneous uses.

Sand and gravel mining contributes significantly to the federal, state and local economy. Every year, people living in the United States consume

on average about 10.0 tons of aggregate materials per person. On a national level, the 1996 total annual production for both crushed stone and construction sand and gravel was the highest production ever recorded. According to mineral industry surveys prepared by the U. S. Geological Survey, the estimated annual production of crushed stone consumed in 1996 was 1.3 billion tons (a 5.6% increase over 1995) while the estimated output of construction sand and gravel produced in 1996 was 963 million tons (a 5.8% increase over 1995). In Minnesota, an estimated 31.9 million tons of construction sand and gravel were sold or used by producers in 1996 for an estimated value of $99.4 million. Sand and gravel consumption is so important to the economy that it is considered to be a reliable measure of economic activity. Aggregate production is commonly reported by weight (as in tons) and by volume (as in cubic yards).



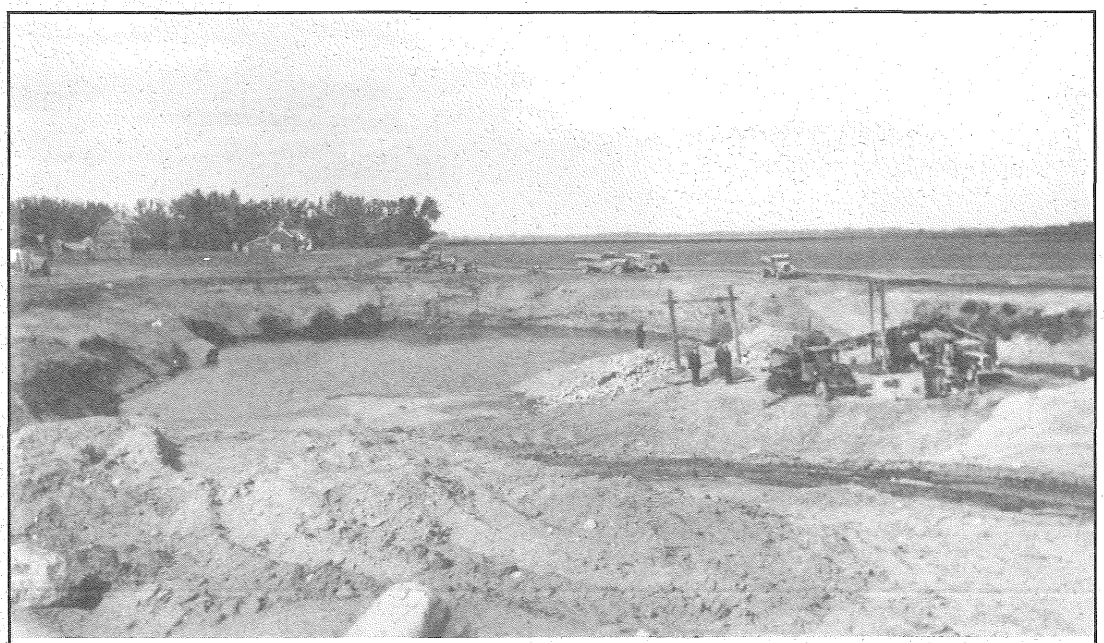
Sand and gravel deposits vary considerably in quality. To most people, all gravel looks the same. In reality, the characteristics of the deposit are an important consideration in how the material will be used. For example, the manufacture of concrete requires an aggregate that is free of deleterious materials such as shale and iron oxides. If a gravel deposit meets the specifications for concrete manufacture, it is considered more valuable than a deposit that could be used for fill material. Strength and durability of the aggregate is another important consideration in meeting specifications for road building. Sometimes, material from two or more sources must be blended to meet the specifications for a particular project.

A range of construction products can often be made at one location. Frequently, one source can supply several different size fractions as well as materials of different quality. The variously-sized products are placed in stockpiles on the mining site for future use. Often, there may be a surplus of an undersize or oversize fraction that has no immediate market value and it is stockpiled until a market develops for the material.

Sand and gravel mining is the most common form of mining in the state. Because sand and gravel are relatively inexpensive to mine but expensive to transport, most operations are located close to where the resource will be used. As a result, gravel pits are found in every county in Minnesota. There are an estimated 4,000 gravel pits statewide (according to a 1991 informal survey conducted by the DNR).

Aggregate potential in Clay County.

An aggregate potential map for Clay County recently completed by the DNR indicates where there is potential within the eastern half of the county to find future gravel deposits (Lehr, J.D. In press. Aggregate Resource Potential of eastern Clay County, Minnesota Map, scale 1:50,000. MN Department of Natural Resources). The map shows that there is not a uniform blanket of good gravel found in the eastern half of the county. Instead, the gravel resource is variable throughout the area and the potential to discover future deposits of good gravel reserves is limited to certain locations. Because it is expensive to haul gravel, aggregate potential is realistically modified by proximity to market and location of current construction projects. The haul distance from mining site to market is a critical factor.



Gravel mining in the Sabin area (circa 1940).

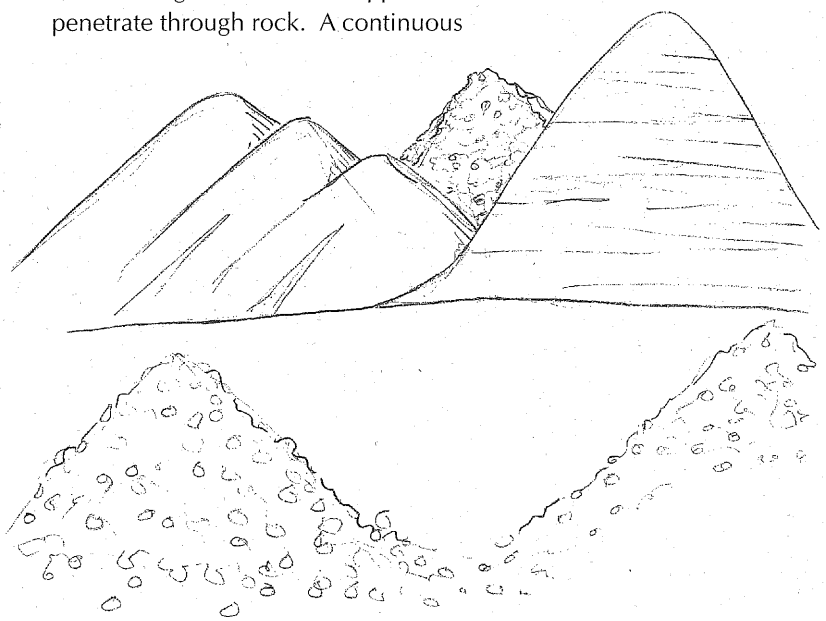
Gravel resources in Clay County differ in quality and characteristics. The physical properties of the aggregate combined with the haul distance determine the price and what the material will be used for. Some companies are now blending materials from different locations in the county to meet contract specifications. A rare deposit of high quality aggregate needed for the manufacture of concrete is found near Felton. This is one of the best and largest sources of concrete aggregate in the Red River Valley.

The aggregate potential map indicates graphically that aggregate resources are finite. Clay County contains some exceptionally high quality aggregate deposits not commonly found elsewhere and the potential to discover future deposits is limited. In the Red River Valley and across the state, good aggregate deposits are not being mined because other land uses preclude their development. As gravel resources become more scarce, aggregate deposits will undoubtedly become more valuable.

The aggregate potential map for the county can be used for broad planning purposes. However, to accurately determine the presence of an economic gravel deposit on a specific parcel may require further testing. Backhoe trenching is commonly used in Clay County as an economical means of testing for aggregate. Another type of testing is aggregate drilling. Drilling into the ground to obtain samples of the underlying material is used to evaluate aggregate deposits. In general, there are two types of drilling methods. The first is conventional rotary auger drilling. This type of drill rig can reach about 50 to 60 feet below ground. If rock is encountered in the drill hole, the drill cannot penetrate and the hole is abandoned. The information obtained from rotary drilling can be less accurate than through other types of drilling methods but the costs are less. Estimated costs in 1996 were about $750 per day. The greatest limitation for this type of drilling is encountering rock in the drill hole and poor sample recovery.

Aggregate drilling.

Another drilling method is rotosonic drilling. The rotosonic rig has a diamond tipped drill which can penetrate through rock. A continuous



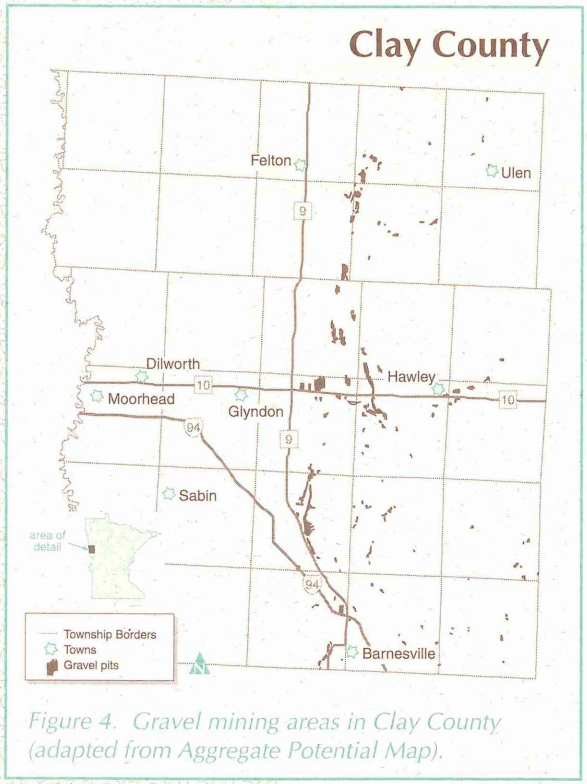


Figure 4. Gravel mining areas in Clay County (adapted from Aggregate Potential Map).

drill core can be extracted from the drill hole. The primary advantages with this drilling method are that the drill can penetrate rock, very accurate information can be obtained, and the area of disturbance on the surface is small. Estimated costs in 1996 were about $1,000 for a 50 foot hole but costs can be highly variable. With rotosonic drilling, fewer drill holes may be needed because of the greater accuracy.

The depth of overburden material covering a gravel deposit in part determines if the material is economically feasible to mine. Drilling can provide information on the thickness of the overburden. For example, if aggregate drilling reveals 30 or 40 feet of overburden material lying on top of gravel, the deposit may be beyond economic consideration for mining in today's economy. It is important to note that deeply buried deposits could become economic to mine in the future with advances in processing technology and changes in the market.

Gravel mining in Clay County.

Gravel mining areas are a common sight throughout Clay County. Gravel mining is concentrated in the eastern 18 townships of the county where the gravel is located. Within these townships, there are approximately 236 gravel mining sites (Figure 4). This estimate is highly variable and includes inactive, reclaimed, and active sites. Roughly 3,700 acres have been affected by gravel mining in the eastern half of the county (this data is from the aggregate potential map for eastern Clay County). Of the 236 mining sites, about 75 have been recently active. The number of active sites is quite variable and changes every year, if not more often. These figures do not include mining that occurs in the western half of the county.

There are about 8 to 12 companies mining gravel in Clay County, the exact number depends on current road construction projects and other contracts. This estimate does not include an unknown number of mobile operators who work for short periods of time in the county on various construction projects. In total, the aggregate industry contributes significantly to the local economy not only by supplying gravel to build infrastructure but also by providing good jobs. It is estimated that approximately 500 people are directly employed by the industry during peak construction season.

Uses for gravel.

The gravel mined in Clay County is used for a variety of purposes ranging from fill material to concrete aggregate. A significant (but unknown) amount of gravel mined in Clay County is used for projects in the Fargo/Moorhead area and in Cass County, North Dakota. Uses for gravel include the manufacture of concrete, blocks, fill, road materials, road sand, pea gravel, sewer rock, asphalt, riprap and landscaping among others.

Fargo/Moorhead is a high growth market that requires large volumes of aggregate to build, maintain and improve infrastructure. Consider that an average new home contains about 250,000 pounds of mineral materials. With the surge in population over the last decade, large amounts of aggregate have been needed to build new homes in the Fargo/Moorhead area. In addition, construction in Fargo/Moorhead requires more aggregate than most other areas because of the heavy clay soils found in the Red River Valley.

A large amount of gravel is also used within Clay County for road maintenance and construction. For example, Clay County maintains 475 miles of gravel road. Township roads account for an additional 860 miles of gravel road. Approximately 175,000 cubic yards of aggregate material are used by the county or townships in road maintenance in a given year. Use of gravel materials for the maintenance of roads is a very important local concern.

To accommodate the increase in traffic and the need to upgrade and repair roads, the Minnesota Department of Transportation (MnDOT) is planning for several major road upgrades and bridge repairs in the state trunk highway system over a ten year planning horizon. The Clay County Highway Department also has an ongoing need for aggregate materials to improve the county highway network.

Population growth and aggregate demand.

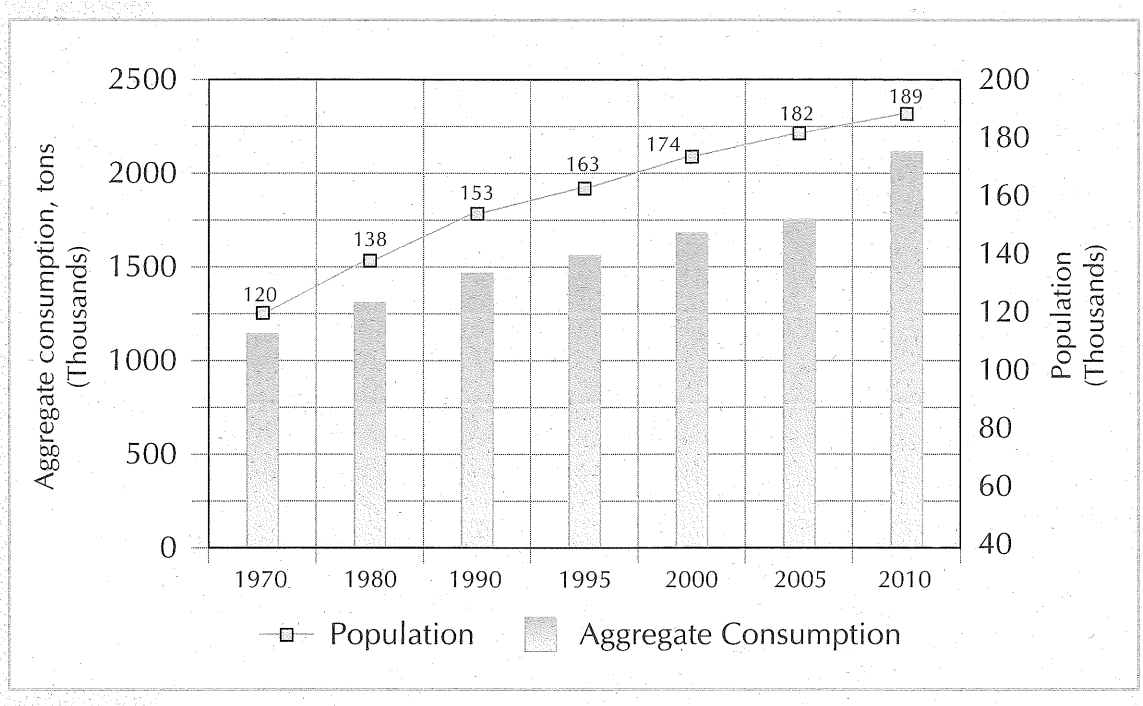
One way to look at aggregate demand is by per capita consumption. On average, people in the rural areas of Cass/Clay counties consume about 8 tons of aggregate/person/year - without even realizing it - through road building and infrastructure development. Within the Fargo/Moorhead area, the consumption is higher at 10 tons/person/year due to the special needs of that market and the growth rate.

Population projections can be used to roughly forecast aggregate demand. In 1995, the rural population of Cass and Clay Counties was projected to be 33,152 while the urban population was projected to be 129,896. Multiplying the rural population by the per capita consumption rate of 8 tons/person/year and the urban population by the rate of 10 tons/person/year yields a total estimated gravel consumption for 1995

of 1,564,176 tons. Similar calculations can be made for past and future population projections. Figure 5 shows the increase in population and estimated aggregate consumption over time. A steady increase in aggregate consumption can be seen and the trend is projected to continue to the year 2010 and beyond.

Figure 5. PROJECTED POPULATION GROWTH AND AGGREGATE CONSUMPTION for the Fargo/Moorhead area.

Year	Population Cass + Clay	Estimated Aggregate Consumption tons/year
1970	120,261	1,143,156
1980	137,574	1,308,722
1990	153,296	1,468,878
1995	163,048	1,564,176
2000	173,695	1,667,722
2005	182,287	1,752,268
2010	189,323	2,108,300

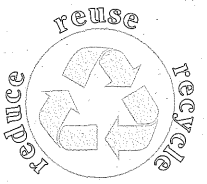


Sources: Population figures provided by Fargo-Moorhead Metropolitan Council of Governments; aggregate consumption based on per capita consumption estimates provided by sand and gravel industry.

Although these are only estimates, the projections clearly show that the growth in the Fargo/Moorhead area is expected to continue at a steady rate. Aggregate materials contribute significantly to the area's quality of life and it is assumed that the demand for gravel will continue to increase parallel to population growth.

Aggregate recycling.

Most of the gravel used in the Fargo/Moorhead market is "fresh" aggregate (also known as "virgin" aggregate) mined from a deposit most likely in Clay County. An increasing amount of aggregate material enters the Fargo/Moorhead market from Becker County, Minnesota located just east of Clay County. Although the majority of construction products require a fresh aggregate (concrete, for example), there is a growing demand for recycled aggregate product in both national and local markets.



Recycled aggregate is made from demolition material that is crushed, cleaned of impurities and then sold for a variety of uses, mostly as fill or base. In 1996, about 100,000 tons of recycled aggregate went back into the Fargo/Moorhead area. Recycled aggregate accounts for approximately 10% of all aggregate consumed in this market. The demand for recycled aggregate was not met because the supply of clean demolition material was limited. With demand for recycled material so great, almost all available demolition is recycled by the aggregate industry. Even though there is an expanding market for recycled aggregate, there will always be a need for fresh material.

Regulations that apply to gravel mining.

The primary authority for regulating extractive uses like gravel mining is at the county or township level. In Clay County, gravel mining is a conditional land use that requires a Conditional Land Use Permit from the Clay County Planning Commission. Depending on location, a township permit may also be required for new gravel mining operations. Operations that were active before a Conditional Land Use Permit was required do not have to obtain a permit. About 25 permits have been issued by the Planning Commission since the late 1980's. Guidelines have been developed for gravel mining but they are offered only as guidelines and do not address reclamation.

State permits from the DNR may be required for some gravel mining operations if there is a need to appropriate water. Permits from the Minnesota Pollution Control Agency (MPCA) may be required for storm water discharge, water quality concerns, air emissions, and above ground storage tanks. Wetland mitigation may also be necessary if wetlands are impacted by the operation.

Environmental review in the form of an Environmental Assessment Worksheet (EAW) is required when a gravel mining operation is expected to exceed 40 acres in size to a mean depth of 10 feet. Environmental Impact Statements (EIS) are mandatory for operations exceeding 160 acres. EAWs can be conducted on a discretionary basis if a proposed project is below the mandatory threshold. In 1996, Clay County completed three EAWs relating to gravel mining. No EISs have been conducted. The expansion of the gravel mining industry in the eastern half of the county is reflected in the number of new permits and EAWs.

Aggregate Material Tax.

The Aggregate Material Tax is a state statute (Minnesota Statute 298.75) that is imposed in 25 counties. It is commonly known as "the gravel tax". Most of the counties on the Minnesota side of the Red River Valley have authority to collect the tax as well as counties in the St. Cloud and Twin Cities areas. Recent amendments provide for two counties in southwestern Minnesota to collect the tax (Figure 6). The Aggregate Material Tax originated in Clay County in the 1960's and later was amended to include other interested counties.

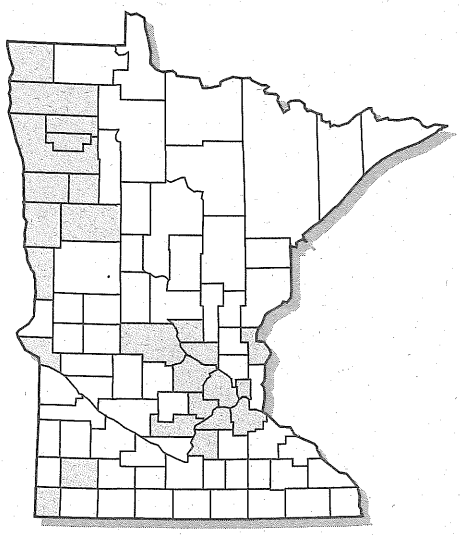
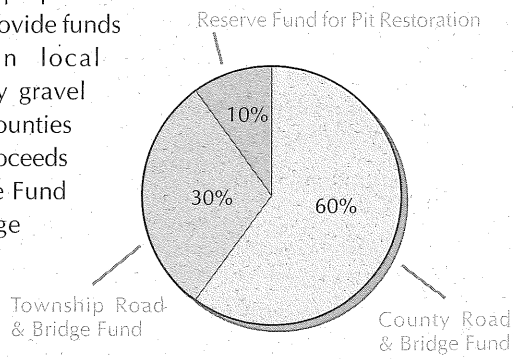


Figure 6. Counties that collect the Aggregate Material Tax.

The Aggregate Material Tax is a production tax on the removal of gravel material. The tax is calculated on a per cubic yard or per ton basis. According to the statute, an operator is any person engaged in removing aggregate material from the surface or subsurface for the purpose of sale.

The Aggregate Material Tax is imposed upon operators at the rate of ten cents per cubic yard of gravel produced in any county imposing this tax. The original purpose of the tax was to provide funds to maintain local roads and bridges used heavily by gravel haulers. The statute requires all counties that collect the tax to distribute the proceeds as follows: County Road and Bridge Fund (60%); Township Road and Bridge Fund (30%), and a special reserve fund for the restoration of abandoned or depleted pits on public lands (10%).



Gravel Tax Distribution

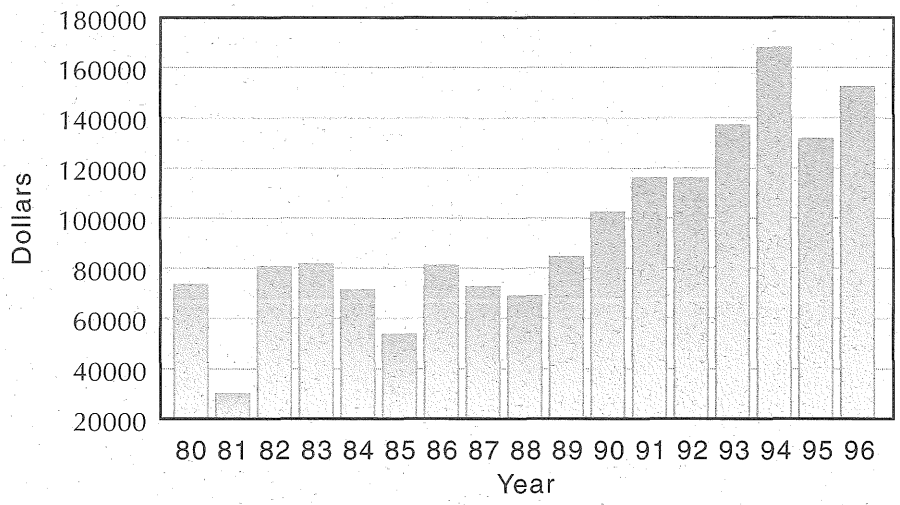
All operators must file a quarterly report and payment with the county auditor in the county in which the gravel material is removed. If a governmental unit or other individual or entity owns a pit, quarry or deposit and removes gravel for their own use, then no aggregate tax would be imposed. In 1995, approximately $2,114,823 in revenue was collected by all counties imposing the tax. Figure 7 summarizes the amount of gravel tax revenue collected by Clay County from 1980 to 1996.

Figure 7. GRAVEL TAX REVENUE FOR CLAY COUNTY

1980 to 1996

1980 - $ 73,434	**1986** - $ 80,993	**1992** - $115,753
1981 - $ 29,865	**1987** - $ 72,484	**1993** - $136,927
1982 - $ 80,503	**1988** - $ 68,806	**1994** - $167,805
1983 - $ 81,533	**1989** - $ 84,574	**1995** - $131,526
1984 - $ 71,279	**1990** - $102,214	**1996** - $152,236
1985 - $ 53,566	**1991** - $115,849	

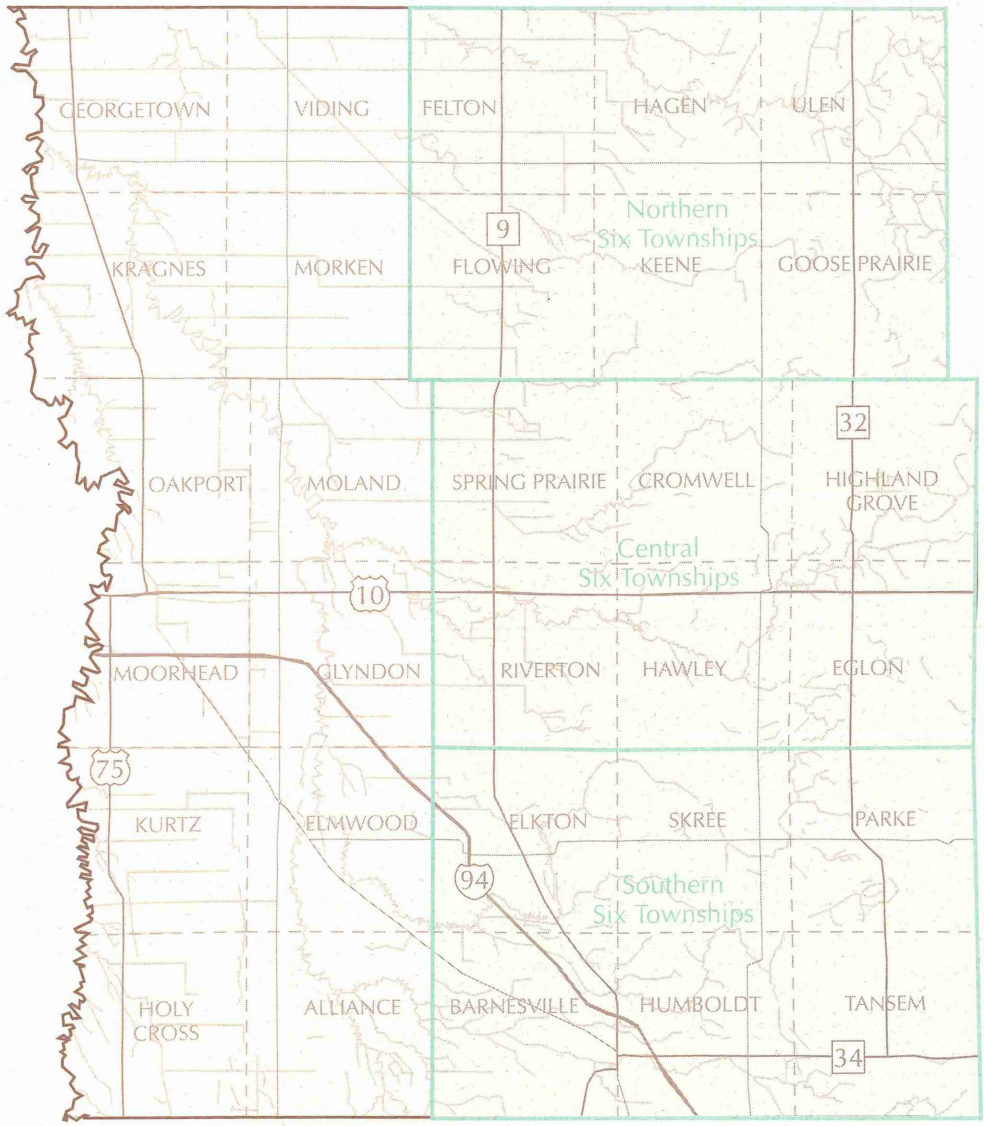
Total for all Years = $ 1,619,348



Source: Clay County Planning Office.

CLAY COUNTY

Townships, Roads, and Hydrography



Eastern eighteen townships study area

Six township study area

Part III. ANALYSIS

An important accomplishment of the Forum was to combine existing datasets into a computerized resource information system for the eastern 18 townships of Clay County. The Forum agreed to conduct an analysis by querying the computerized resource information with a set of specific questions relating to prairie and gravel resources. This portion of the report describes the analysis that was performed by the Forum.

What was the study area?

The Forum agreed to define the study area for the project as the eastern half of the county comprising 18 townships. This area includes most of the gravel mining activity in the county as well as the remaining tracts of prairie. The study focused specifically on the relationship between gravel and prairie as they occur in the eastern half of the county and did not consider other land uses. The reason for focusing only on this relationship is that both prairie and gravel are nonrenewable resources that are uniquely located. Gravel deposits must be mined where they are found and cannot be relocated. Likewise, native prairie cannot be transplanted elsewhere.

Within the group of 18 townships, there are distinct differences in the gravel and prairie resources. The northern six townships contain a unique deposit of high quality aggregate needed for the manufacture of concrete and is the site of the Felton Prairie. The central six townships supply fill and lower quality materials and are closer to market. Bluestem Prairie is found in this location. The southern six townships have experienced an expansion of gravel mining and represents a new source that, with processing or blending, can meet higher specifications. The Barnesville Slough is located there.

Further dividing the study area into three blocks of six townships was helpful in looking at the data. The three subdivisions were referred to as the northern six townships (Felton, Hagen, Ulen, Flowing, Keene, Goose Prairie), the central six townships (Spring Prairie, Cromwell, Highland Grove, Riverton, Hawley, Eglon), and the southern six townships (Elkton, Skree, Parke, Barnesville, Humboldt, and Tansem).

Information used in the analysis.

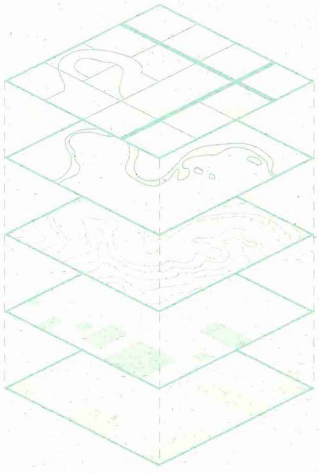
A substantial amount of resource information already existed before this project was initiated but it had never been combined or integrated. Two datasets were of particular interest. One was a digital map showing the remaining prairie resources in Clay County as shown in Figure 8. The other was a recently completed digital map showing the aggregate potential in the eastern half of the county and the location of existing gravel

mining areas (Figure 9). Combining these two maps and looking at the areas of significant prairie in relation to the aggregate potential was of great interest to the Forum. Having both the prairie and gravel resources available as maps in digital format provided a unique opportunity to study these two datasets in combination.

An important accomplishment of the project was to combine existing datasets into a computerized resource information system for the eastern 18 townships of Clay County. The system was created by technical staff at the DNR in close coordination with the Forum. The computerized resource information allowed the Forum to view datasets in combination. That means that a single map generated from one dataset can be overlaid with other maps to create customized map products (Figure 10). More importantly, the computerized resource information can be queried according to questions specified by users.

After combining the digital datasets into a computerized resource information system, a series of maps was prepared for the 18 townships as a whole and for each block of six townships. The following information was portrayed on maps and incorporated into the computerized resource information.

- aggregate potential
- aggregate potential with wetlands
- existing gravel mining areas
- prairie resources
- prairie and gravel resources combined
- public land management units/prairie easements
- ownership (public vs private)



Combining map layers

After a general review of the maps, the Forum observed that both the prairie and the gravel resources are variable. Gravel is not found everywhere in the eastern half of the county but only in certain locations. Likewise, significant parcels of prairie are not found uniformly on the beach ridges but in some well defined locations. The maps also revealed that prairie is found in areas of low aggregate potential. At the same time, high aggregate potential can be observed in areas that do not contain prairie.

In addition to maps, the Forum relied on the personal knowledge of its members, speakers who presented information on key topics, information gained from a field trip, and other data gathered for the project.

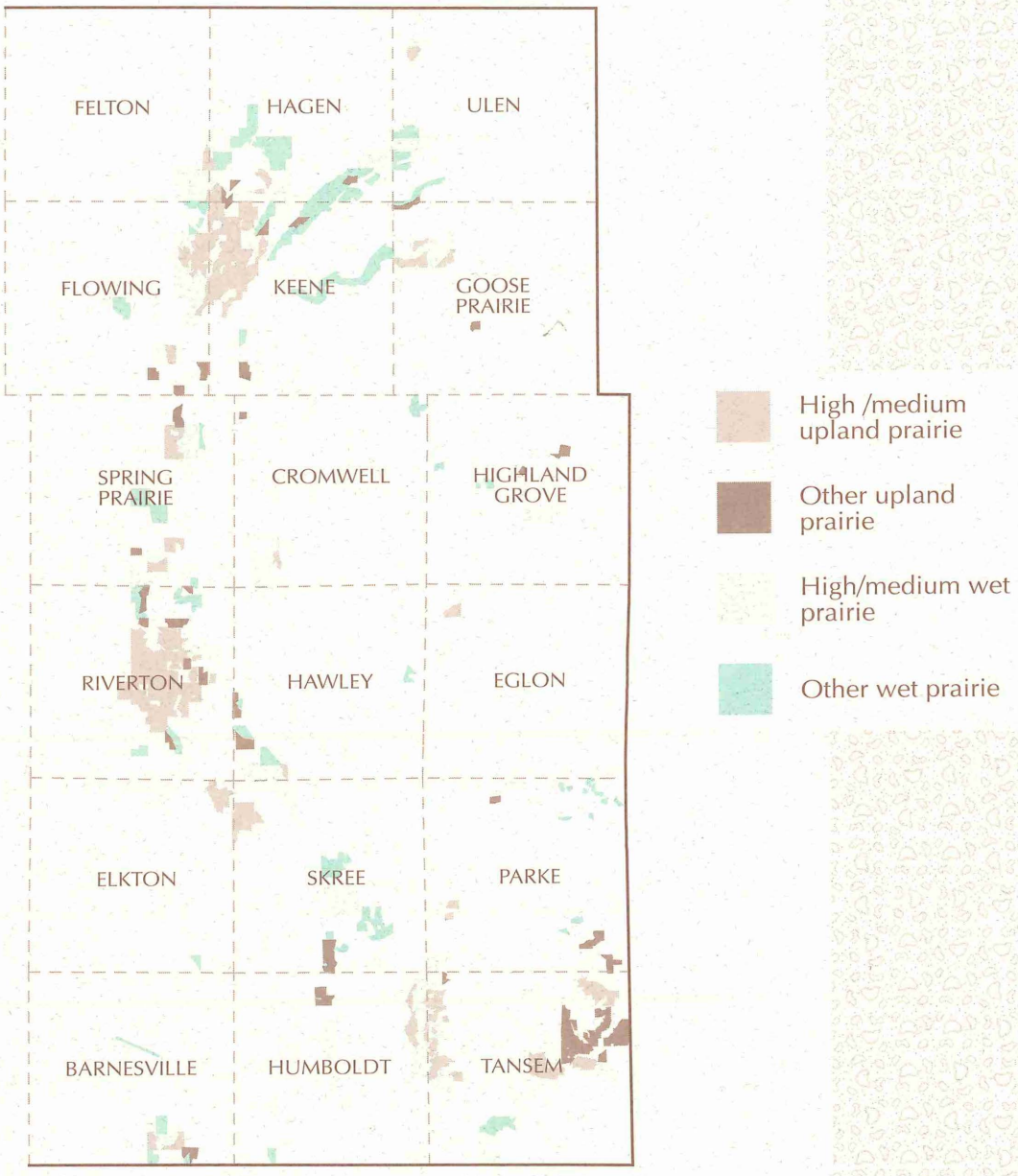


Figure 8. Prairie resources in Clay County based on the natural community and biodiversity significance data from the Minnesota County Biological Survey, Minnesota Department of Natural Resources.

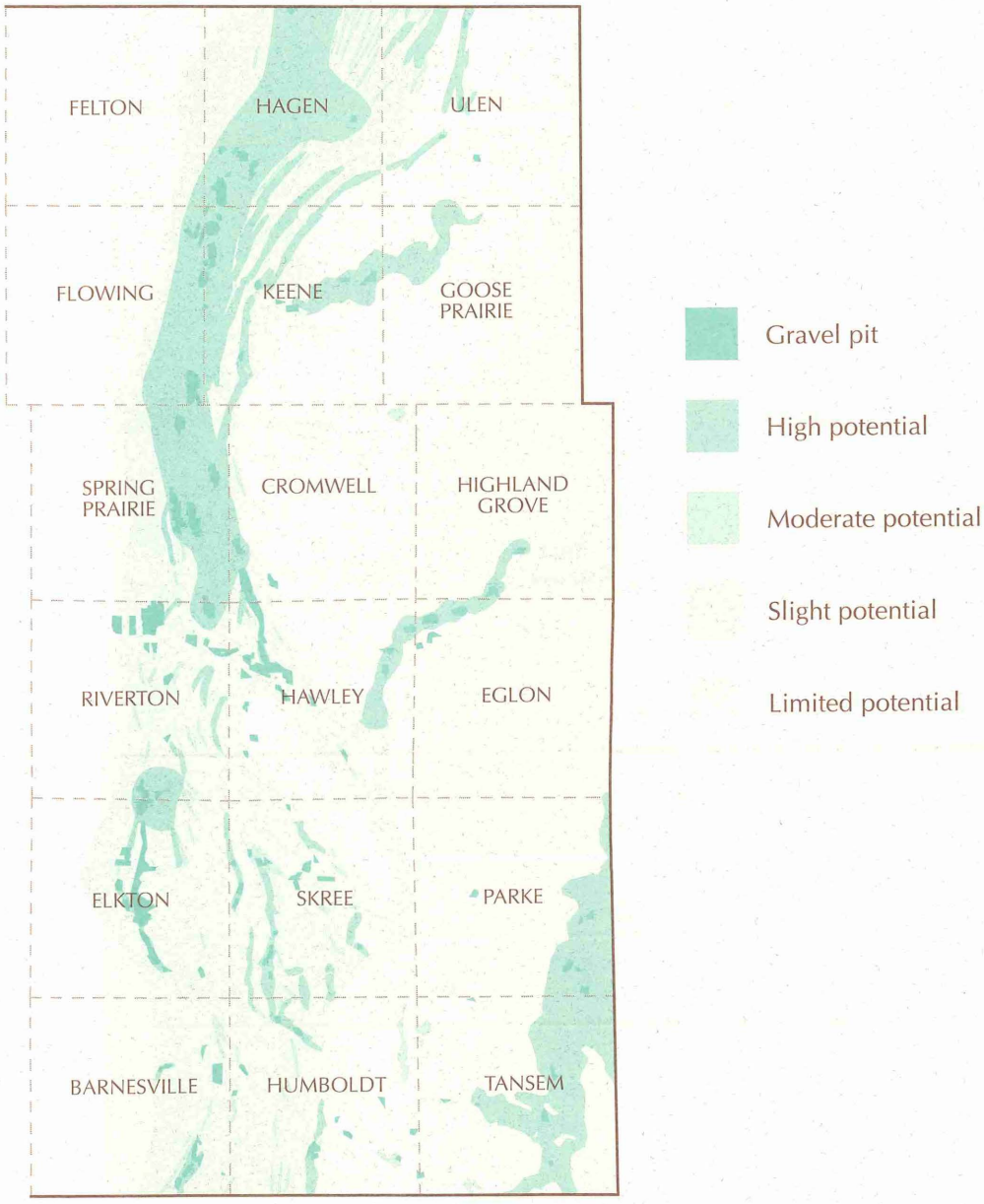


Figure 9. Aggregate resources in Clay County based on the Aggregate Resource Potential data from the Aggregate Mapping Program, Minnesota Department of Natural Resources.

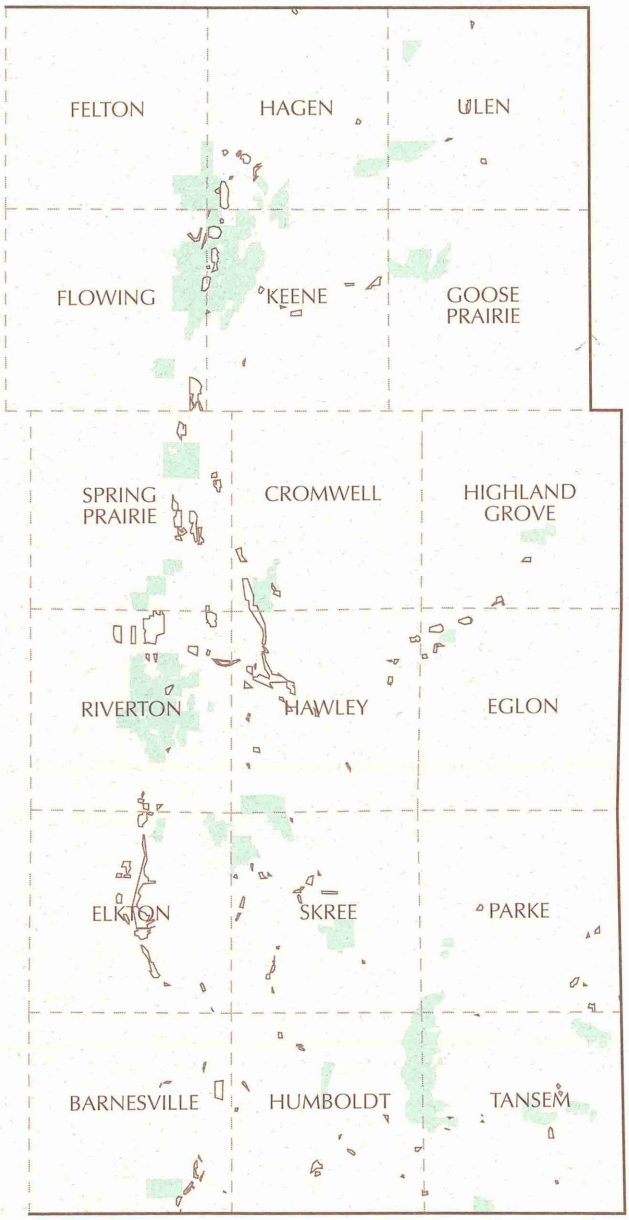


Figure 10. An example of how prairie and gravel resource data can be combined.

Only a general overview of the datasets and the computerized resource information is provided in this report. Documentation about the technical aspects of each dataset and a user's guide accompany the computerized resource information. See Appendix A for more information.

Methods used

After developing a general understanding of the individual map layers, the Forum formulated questions to ask the computerized resource information relating to prairie and gravel resources in the eastern half of Clay County. The Forum posed the questions and technical staff at the DNR developed a methodology to "answer" those questions. (The entire description of the technical methods is found on the CD-ROM containing the datasets in the document subdirectory.)

The analysis undertaken by the Forum is one of the first applications of Geographic Information Systems (GIS) technology to a specific land use question in Minnesota in a public setting.

The map layers of greatest interest to the Forum were prairie resources, aggregate potential and ownership. That interest led the Forum to ask five questions of the resource information. The five questions outlined below form the sequential steps that were followed in the analysis. It is essential to point out that other questions can and should be asked of the data. It should further be emphasized that the order in which the questions are asked can influence the results.

Step 1. How many acres of prairie are in Clay County?

Step 2. How many of these acres are high/medium prairie?

Step 3. How many acres of the high/medium prairie are not in a management unit?

Step 4. How many acres from step 3 have high aggregate potential?

Step 5. What is the ownership of the acres from step 4?

The Forum's analysis began by first considering the prairie resource map, denoted as step 1. The five questions or steps in the analysis are summarized below and in Figure 11. Figure 12 shows the analysis in map form.

Step 1. How many acres of prairie are in Clay County? The analysis began by creating a map of the eastern 18 townships showing all prairie resources including prairie of low significance, prairie of modest significance, prairie with medium significance and prairie of high significance. All together, there are approximately 21,310 acres mapped as prairie. The Forum observed that the significance of the prairie varies widely.

Step 2. How many of these acres are high/medium prairie? For the purposes of this analysis, the Forum focused on the prairie with high or medium significance. Another map was created from the Step 1 map by eliminating all other prairie except for the high/medium prairie. The resulting map showed that in the eastern 18 townships, about 14,290 acres are covered by high/medium prairie.

Step 3. How many acres of the high/medium prairie are not in a management unit? The Forum then wanted to know how much of the high/medium prairie was not already being managed for prairie. The Forum first had to determine which lands were being managed for prairie. Land

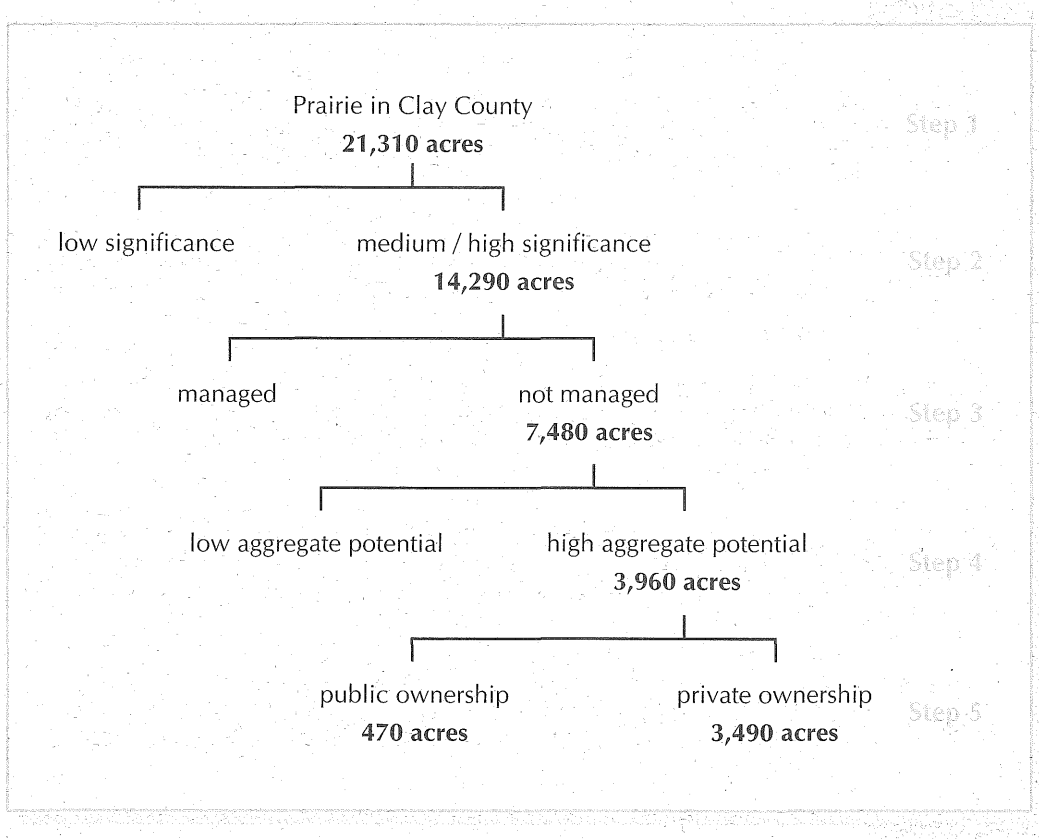


Figure 11. Flowchart illustrating steps in the analysis.

was considered as being managed for prairie if it met one of three criteria: 1) prairie land owned by The Nature Conservancy, 2) prairie land owned by private landowners that was enrolled in a prairie conservation program, or 3) prairie land that was in a public land management unit. It was assumed that prairie land in a public land management unit (such as a wildlife management area, park or a waterfowl production area) would continue to be managed, either actively or passively, for prairie. A new map was made from the Step 2 map by eliminating the high/medium prairie that met the above criteria. The new map revealed that 7,480 acres of high/medium prairie are not in a management unit. This is about 48% of the total for high/medium prairie in the county (7,480 of 14,290 acres).

Step 4. How many acres from step 3 have high aggregate potential? Next, the Forum was interested to know how aggregate potential related to the high/medium prairie not in a management unit. The map from Step 3 was compared to the aggregate potential map and a new map was created displaying high/medium prairie not in a management unit but with high aggregate potential. The results showed that about 3,960 acres in the eastern 18 townships contain high/medium prairie not in a management unit but with high aggregate potential. This acreage represents about 28% of the high/medium prairie in the county (3,960 of 14,290).

Based on this review, the Forum observed that the 72% of high/medium prairie in the county is in a management unit or is located in an area of lower aggregate potential. The Forum further observed that the greatest potential for future conflict may lie on the 28% of the high/medium prairie not in a management unit but with high aggregate potential. Maps were used to identify where these lands are located.

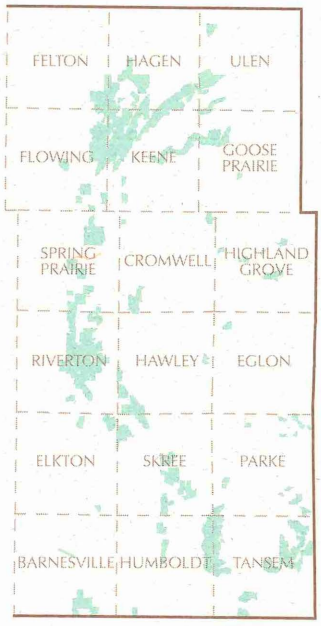
Step 5. What is the ownership of the acres from step 4? The Forum was then interested to determine how many acres of the land identified in Step 4 are in public and private ownership. The map from Step 4 was compared with an ownership map and new maps were made that display public and private ownership. The maps show that 3,490 acres of these lands are in private ownership with the remainder in public ownership (470 acres).

Future analysis.

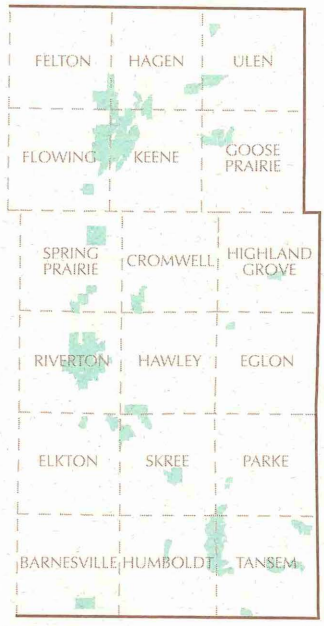
This analysis in part was the basis for some of the recommendations that follow. It is important to emphasize that the maps generated by the computerized resource information have limitations (those with an interest in the data should consult the documentation for more informa-

tion). The Forum recognized the limitations of the maps and did not base their findings solely on them. The maps provided a backdrop for discussion and were used as reference.

Many other analyses are possible using the computerized resource information and should be considered in the future. The Forum conducted one analysis based on the five questions described above. With the completion of the computerized resource information system, other users could look at the data in a different light. For their analysis, the Forum began with prairie resources because it seemed an appropriate starting point. It would now be interesting to start with aggregate potential and go through a similar sequence. Although it is only one analysis, this study helped the Forum focus attention on where the key areas of potential conflict may lie.



Step 1[1]



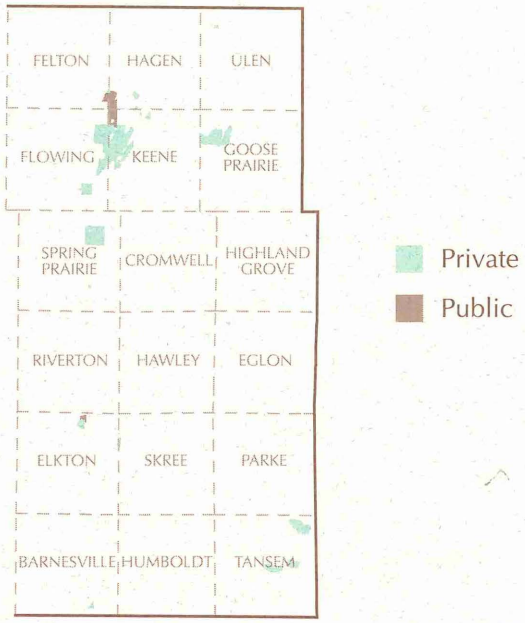
Step 2[2]

Step 3[3]

Step 4[4]

[1] Total Prairie
[2] High/medium prairie
[3] High/medium prairie not in management unit

Figure 12. Map display of the steps in the analysis. For Steps 2-4, lighter areas are those eliminated in the step. For Steps 2-4, darker areas are those remaining after the analysis.



Step 5[5,6]

PRAIRIE AND AGGREGATE RESOURCE ANALYSIS

	Eastern 18 townships	Northern six townships	Central six townships	Southern six townships	Felton Prairie
Total Area in acres	405,040	134,360	134,610	136,070	10,460
STEP 1[1]	21,310	9,040	5,950	6,320	7,460
STEP 2[2]	14,290	5,780	4,330	4,180	4,340
STEP 3[3]	7,480	3,980	1,140	2,410	3,010
STEP 4[4]	3,960	2,790	600	570	2,070
STEP 5[5]	3,490	2,360	600	540	1,640
STEP 5[6]	470	430	0	30	430

[4] High/medium prairie not in management unit with high aggregate potential
[5] High/medium prairie not in management unit with high aggregate potential in private ownership
[6] High/medium prairie not in management unit with high aggregate potential in public ownership

Figure 12., con't.

Other observations.

In addition to the analysis, the Forum reviewed maps generated from the computerized resource information for each block of six townships. The Forum made observations from the maps and discussed other relevant information known to the group. Below are the observations made by the Forum for each block of townships - northern six, central six, and southern six.

Northern six townships. The map review shows that 40% of all high/medium prairie found in the eastern 18 townships is located in the northern six townships. The maps further show that 70% of the high/medium prairie not in a management unit but with good aggregate potential is found in the northern six townships (2,790 of 3,960 acres). Almost all of this land is concentrated in the area known as the Felton Prairie (Figure 13).

The Felton Prairie covers about 10,460 acres in eastern Flowing, western Keene, SW Hagen, and SE Felton townships and contains a variety of land uses with mixed ownership. Within this area are found active gravel mining operations, several inactive gravel mining sites, agricultural lands, and lands that are being managed for prairie.

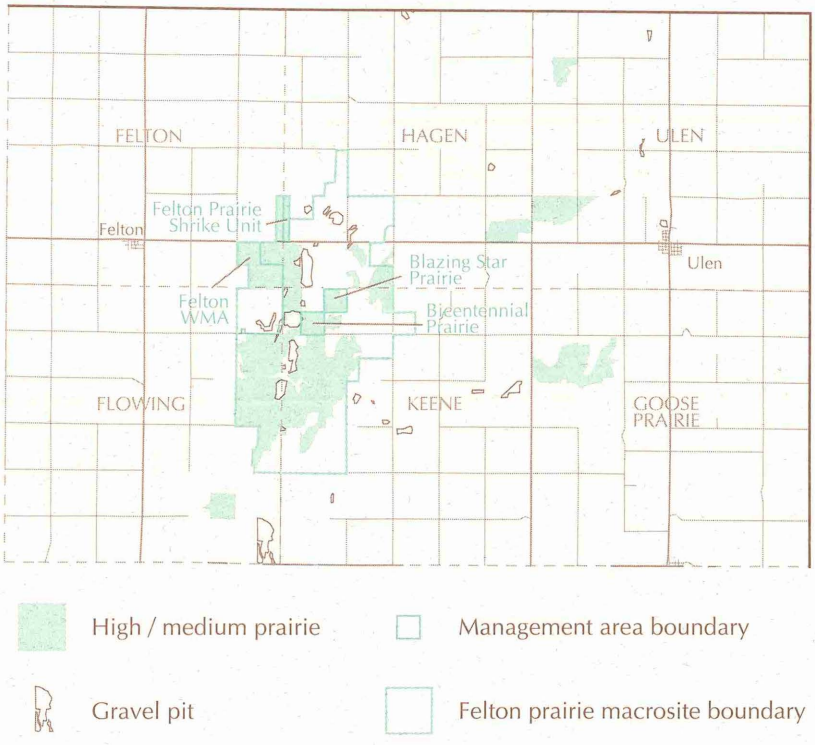


Figure 13. Northern six townships.

The Felton Prairie represents the best and largest example of dry prairie remaining in the state. Several endangered plant and animal species are known to occur. Within the Felton Prairie are several parcels of high/medium prairie, some of which are protected or managed for prairie. There are also tracts of less significant prairie and disturbed lands as well as high/medium prairie that is not protected or in a management unit. Four calcareous fens are also found in the Felton Prairie. The public lands within the Felton Prairie that are being managed for prairie include:

- Bicentennial Prairie owned by Clay County
- Blazing Star Prairie owned by The Nature Conservancy
- Felton Prairie Shrike Unit managed by the Department of Natural Resources
- Felton Wildlife Management Area managed by the Department of Natural Resources

There are about 6 to 8 companies that mine gravel in the northern 6 townships, the number depends on current road projects and contracts. Approximately 70 gravel mining areas are found here with roughly 22 having been recently active. Most of the gravel mining occurs in Hagen, Flowing, and Keene Townships. The gravel mining industry has expanded over the last 20 years in this location. In the past five years, several new sites have opened while some existing sites have expanded. Gravel mining also occurs near the Wild Rice River.

There are two active gravel mining operations on public land. The largest is on School Trust Land owned by the State of Minnesota and managed by the Department of Natural Resources. This land is leased for gravel mining to a private company. A second gravel mining operation is owned and operated by Clay County. This source has been used exclusively for the maintenance of county highways.

A high quality concrete aggregate deposit found in the Felton area is buried by varying depths of overburden which must be stripped to expose the aggregate. The aggregate deposits are being mined below the water table using dredges in two locations. Lesser quality aggregate deposits are also found in the Felton area and elsewhere in the northern six townships.

Haul distance from the Felton area to the Fargo/Moorhead market is approximately 25 to 35 miles. Trucks haul about 24 tons per load. Loaded trucks leave for the Fargo/Moorhead area every few minutes

during the construction season. Minimizing haul distance is a big part of the business and can easily define a company's profit margin.

Central six townships. The map review shows that 30% of the high/medium prairie found in the eastern 18 townships is located in the central six townships (Figure 14). The maps further show that 15% of the high/medium prairie not in a management unit but with high aggregate potential is found in the central six townships (600 of 3,960 acres). Almost all of this land is within Spring Prairie Township.

In many ways, the early history of gravel mining in the county is apparent in the central six townships along the Trunk Highway 10 corridor. The maps show many old, long and shallow gravel mining areas that were probably used to build the infrastructure for the area. Many of these old sites have overgrown with brush and cottonwood trees. There are about 83 gravel mining sites in the middle six townships with approximately 25 of those being recently active. The haul distance to Fargo/Moorhead from this area is much shorter than in other locations. A substantial volume of material is being mined for fill and other lower value aggregate products.

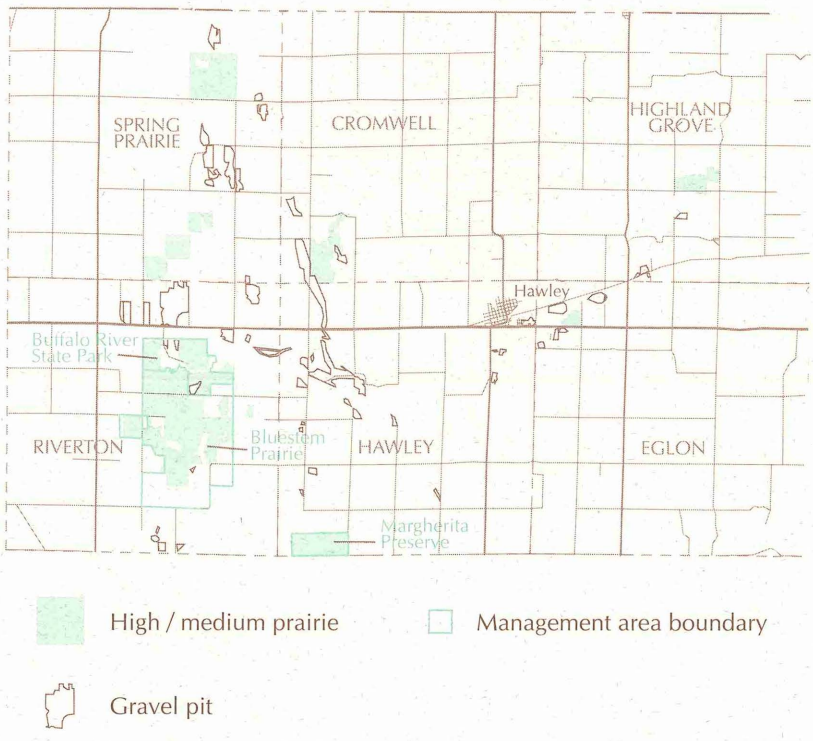


Figure 14. Central six townships.

A corridor study for Trunk Highway 10, Trunk Highway 336 (formerly known as County Road 11) and Interstate 94 near Moorhead has been initiated by MnDOT. Traffic loads indicate a need to upgrade these segments of highway. The work will be done in the future and some of the aggregate needs for these projects will likely come from the central six townships.

There is a large area of high aggregate potential in the eastern portion of Spring Prairie Township and in Riverton Township. A third area of high potential is along the floodplain of the Buffalo River near Hawley. Smaller areas of high aggregate potential are found mainly on the beach ridge features in Spring Prairie, Cromwell, Riverton, and Hawley Townships and along the Buffalo River in Hawley, Eglon and Highland Grove Townships. It was noted that the area of high aggregate potential is somewhat limited. Gravel is not evenly distributed in these six townships but found in only certain areas.

Much of the prairie that remains in this area is on public land being managed for prairie or on land owned by The Nature Conservancy. The Bluestem Prairie is a large contiguous block of land containing native prairie as well as disturbed lands that are being restored to prairie. Most of Bluestem Prairie is owned by The Nature Conservancy. Buffalo River State Park is part of the Bluestem Prairie site. Margherita Preserve is a smaller parcel of wet prairie/marsh in Hawley and Skree Townships owned by The Nature Conservancy. Neither Bluestem Prairie nor Margherita Preserve are in areas of high aggregate potential but gravel mining is taking place near by. Other scattered prairie parcels are found throughout the central six townships with the greatest occurrence in Spring Prairie Township.

The approximately one-mile wide corridor along County Road 23 (road to the sanitary landfill) was the site of some of the earliest gravel mining in Clay County. By the early 1960's, there were about 16 gravel mining areas between Trunk Highway 10 and the present landfill. Many of these sites have expanded since then and about six new sites have opened recently. It was noted that the west edge of the sanitary landfill site is good prairie. A question about the possible impact of mining below the groundwater table on lands near or adjacent to prairie was raised. Although no operations in this area are now mining below the groundwater table.

Several active and inactive gravel mining sites can be observed along the Buffalo River. The floodplain of the Buffalo River has high aggregate

potential. Some of these operations are not under permit. A question was raised about the possible long-term impacts to the Buffalo River.

Also noted were the 270 acres in Riverton Township that has been impacted by gravel mining and is the present site of the demolition landfill. It was further observed that black dirt or clay fill operations are not a regulated land use in the county. Black dirt operators have been active in recent years along Trunk Highway 10.

Further noted that only a small amount of prairie remains in the corridor of Trunk Highway 10. The need for an interpretative roadside pullout in the Trunk Highway 10 corridor to present visitors with information about the beach ridges was discussed.

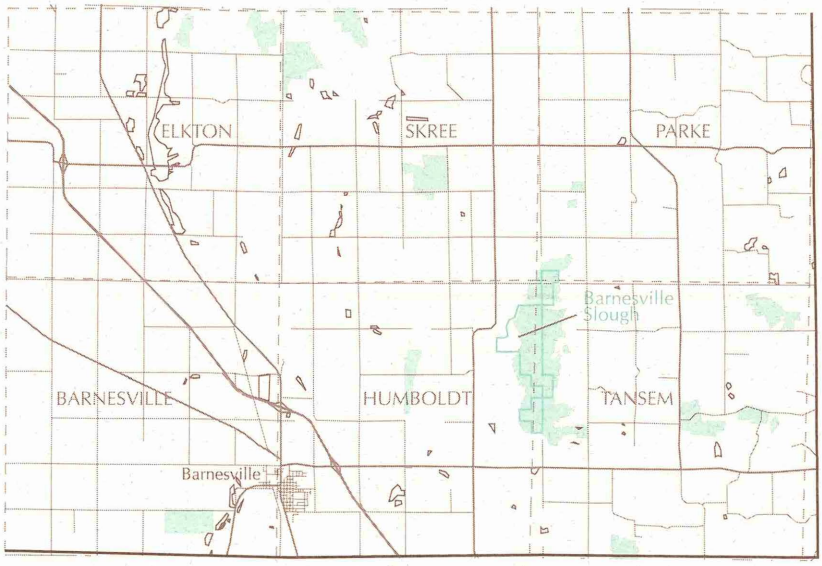


Figure 15. Southern six townships.

Southern six townships. The map review shows that 30% of the high/medium prairie found in the eastern 18 townships is located in the southern six townships (Figure 15). Approximately 15% of the high/medium prairie not in a management unit but with high aggregate potential is located in the southern six townships (570 of 3,960 acres).

Long, linear and shallow gravel mining areas are observed along Trunk Highway 9, many have been inactive for a long time. About 85 gravel mining sites are found in the southern six townships, approximately 21 have been recently active. The largest area of high aggregate potential is in eastern Parke and eastern Tansem Townships. Another area of high potential is found in Elkton township.

There has been new and increased gravel mining activity in Parke and Tansem Townships. This area has high aggregate potential and may represent a new area of interest. There is also gravel mining across the county line in Becker County. In some locations, aggregate resources are being blended into a higher quality product. This area represents a long haul to the Fargo/Moorhead market.

An area of shrub swamp and marsh with scattered prairie remnants is found in the southeastern corner of the county and is known as the Barnesville Slough. Also found in this general location is a concentration of prairie/savanna/woodland remnants. The Barnesville Slough is in an area of limited aggregate potential and does not have a history of gravel mining. Other smaller parcels of prairie are scattered throughout the area.

Prairie conservation easements in the southern six townships were recently negotiated with willing landowners. Some of the prairie in this area is in public ownership and currently being managed for prairie. There are four parcels with high/medium prairie that are not in a management unit and also have high aggregate potential. Three of these are in private ownership in Tansem township. Another parcel in Elkton Township is owned by the county. A total of six calcareous fens are found in the southern six townships; five in the Barnesville Slough and one in Tansem Township.

Part IV. RECOMMENDATIONS

General Recommendations.

The people participating in the Forum invested considerable time to learn about Clay County's prairie and gravel resources and to systematically review the information. What follows are their recommendations after more than a year of thoughtful work. The Forum will pass on this final report to the public, the Clay County Board of Commissioners and the Clay County Planning Commission for their consideration. Implementation of recommendations outlined in this report depends on the future action of some other entity.

The Forum presents here a set of general recommendations that are backed up by specific actions. The general recommendations are to:

- Emphasize both the economic and natural heritage resource values of the beach ridges to the public through a variety of educational materials.
- Maximize utilization of aggregate resources whenever possible.
- Promote aggregate recycling.
- Consider aggregate resources in future land use decisions.
- Promote prairie conservation programs with willing private landowners.
- Provide incentives through the permitting process to avoid native prairie whenever possible.
- Use aggregate drilling to identify the presence of economic gravel deposits on certain public lands to assist in the long-term management.
- Use the computerized resource information generated by this project in land use planning decisions in the county.
- Minimize development of new haul roads across prairie whenever possible.
- Reclaim abandoned gravel mining sites on both private and public lands.
- Develop mining and reclamation plans for active operations on both private and public lands.
- Promote the concept of progressive reclamation whenever possible.
- Use prairie grasses and forbs for gravel pit reclamation whenever possible.
- Acknowledge the ongoing need to work in partnership to continue the efforts begun by this Forum.

Specific Actions.

The following are specific actions and recommendations drafted by the Forum to provide the details needed to accomplish the general recommendations listed above.

The recommendations reported here are generally supported by the Forum as a whole. The issues are complex and certain recommendations were more enthusiastically supported by some members than others. In certain cases, when other opinions were strongly voiced, it is reported as another viewpoint. The Forum wished to present varying viewpoints as needed to reflect the complexity of the issues considered.

1. THE FUTURE OF THE FORUM. The Forum has learned much about the prairie and gravel resources in Clay County. After more than a year of discussion, debate and deliberation, the issues remain complex. Throughout the process, the Forum tried to consider the needs of the future in terms of the gravel and prairie resources. The Forum believes that the recommendations that follow are balanced and built on a foundation that represents many different viewpoints. The Forum further acknowledges that these recommendations will serve only as a beginning towards resolution of the ongoing land use questions. Many of the recommendations brought forward by the Forum depend on future consideration by other entities with authority to make changes. The work of the Forum is a starting point upon which others can build.

> *The Forum recommends that the Clay County Board appoint a subcommittee representing a broad range of interests on the beach ridges to continue the work begun by the Forum. Coordination and leadership would come from the Clay County Planning Office. The charge to the subcommittee would be: 1) to move ahead on the Forum's recommendations; and 2) to maintain the relationships that have been fostered through the Forum.*

2. BEACH RIDGES EDUCATIONAL MATERIALS. The Forum compiled an abundance of information about the resources found in the eastern half of the county. The beach ridges in Clay County are important from both an economic and natural heritage point of view. The Forum recommends that gravel and prairie resource values be incorporated into all levels of the educational curriculum. Below are some specific actions.

Coloring Book and Earth Day.

A coloring book produced by the Forum was distributed to all 3rd graders in Clay County on Earth Day 1997. The coloring book was also

distributed at the 1997 Clay County Fair. As long as supplies last, copies of the coloring book will be distributed locally at several locations.

The Forum recommends that the coloring book be reprinted when the first printing is depleted and that the coloring book distribution to 3rd graders on Earth Day become an annual event. The distribution could be expanded to include schools in Fargo. The subcommittee appointed by the County Board will follow up.

Primary grade curriculum.

Hundreds of 3rd and 4th graders from around the Red River Valley region as well as many other students, annually visit the Moorhead State University Regional Science Center to learn about prairie landscapes. The coloring book prepared by the Forum was an effort to incorporate aggregate mining into the primary grade curriculum.

The Forum recommends that efforts continue to incorporate gravel resources into the curriculum, perhaps with a field trip. A field trip would be an especially effective way to study prairie and gravel resources due to the occurrence of both on or near the Regional Science Center. Regional Science Center staff, DNR staff, and the aggregate industry will follow up with local teachers to discuss future possibilities.

Use of Information Handbook.

A handbook prepared by the Forum ("The Beach Ridge Landscape: An Information Handbook") contains information on key topics relating to prairie and gravel resources. Each topic is confined to one page and can be used as a separate fact sheet.

The Forum recommends that these one page topics be circulated to local newsletter editors and to the media on a regular schedule to be used as sources of future news stories. The subcommittee appointed by the County Board will follow up.

Computerized Resource Information in Secondary Education.

The computerized resource information generated by the Forum offers exciting future opportunities for more study and analysis. Public access to the computerized resource information at the public library and on CD-ROM affords an exceptional opportunity for integrating the infor-

mation into secondary and adult education curricula. The computerized resource information could be considered in the science curriculum at area high schools and colleges (such as Moorhead State University, North Dakota State University, Concordia College, Vocational Technical Colleges). The Forum organized a technical session in June 1997 for all parties interested in the computerized resource information.

The Forum recommends that more sessions be planned in the future to provide opportunities for interested educators at all levels to access the data. A teachers workshop at the Regional Science Center has been suggested as a future possibility. The subcommittee appointed by the County Board will follow up.

Internet Access.

The feasibility of providing access to the information compiled by the Forum on the Internet is being explored. Information that may be viewed on the Internet includes data, maps, coloring book, and this final report.

The Forum recommends that DNR place appropriate information in a regional Red River Valley website at the conclusion of the project.

Beach Ridges Exhibit.

The Clay County Historical Society is considering the possibility of a new Beach Ridges display in the Society's museum area in the Hjemkomst Center to open in February 1998. Such an exhibit could draw upon the work of the Forum as well as historic and pre-historic artifacts and documents from a variety of sources.

The Forum recommends that information compiled by the project be passed on to the Clay County Historical Society for use in the proposed beach ridges display. DNR will follow up with Clay County Historical Society staff.

3. MAXIMUM UTILIZATION OF AGGREGATE RESOURCES. Maximum resource utilization involves two related concepts. The first is to minimize surface disturbance on the land by maximizing use of the aggregate resource whenever economically or environmentally feasible. This could mean mining deeper in some locations rather than expanding in area. The second concept is to use aggregate resources for the highest and best use. Because gravel deposits vary in quality and characteristics, high quality gravel deposits are best used in higher value

products. The concept is to promote the use of high quality aggregate for the highest and best use whenever feasible.

The Forum recommends maximum utilization of aggregate resources as a general principal while recognizing that many site specific environmental and economic factors must be considered. Resource utilization should be considered in the permitting process.

4. AGGREGATE RECYCLING. The Forum recognizes the importance of aggregate recycling. Recycled aggregate, however, will never replace the need for freshly mined aggregate. The Forum commends the high degree of aggregate recycling that is already occurring in the Fargo/ Moorhead area and understands that demand for recycled material is market-driven.

The Forum believes that the importance of aggregate recycling should be more widely known and recommends that aggregate recycling be promoted among contractors, landowners and the public by making an information fact sheet about aggregate recycling.

5. AGGREGATE RESOURCES CONSIDERED IN FUTURE LAND USE DECISIONS. The gravel resources found in Clay County vary in quality and distribution. The county contains some exceptionally high quality aggregate deposits not commonly found elsewhere in the region. The potential to discover future deposits of good gravel reserves is limited to certain locations. In Clay County and across the state, good aggregate deposits are not being mined because other land uses preclude their development. As gravel resources become more scarce, it will be even more important to consider aggregate resources in future land use decisions.

The Forum recommends that aggregate resources be considered in future land decisions throughout the county.

6. PRAIRIE CONSERVATION BY PRIVATE LANDOWNERS. The review conducted by the Forum indicates that most of the remaining prairie in the county is owned by private landowners. Some private landowners have willingly entered into prairie conservation programs to preserve their prairies. Private landowners have a key role in the future of the beach ridges.

The Forum commends the Clay County Board for their past approval of conservation prairie agreements by willing landowners and recommends that future agreements continue to be given serious consideration.

7. INCENTIVES. The Forum discussed the idea of creating incentives for aggregate producers to locate future gravel mining sites outside of prairie areas or to more fully utilize an existing site (for example, go deeper or expand an existing pit if economically or environmentally feasible). One possible incentive is to develop an expedited permitting process for proposals sited outside of prairie areas. This concept along with other possible incentives should be reviewed and discussed more thoroughly.

Because more study and research is needed on this topic, the Forum recommends that incentives be taken up by the subcommittee appointed by the County Board.

8. AGGREGATE DRILLING. Drilling into the ground to obtain samples of the underlying material is a common method used to evaluate aggregate deposits. After reviewing the data, the Forum observed that approximately 12% (470 of 3,960 acres) of the high/medium prairie not in a management unit but with good aggregate potential is on public land. Most of this public land is within the Felton Prairie and is in county ownership. Little information is available about the aggregate resources on these parcels. At Felton and elsewhere, the depth of overburden material covering the gravel in part determines if the gravel is economically feasible to mine.

The Forum recommends that a proposal be written and funding sought for a rotosonic drilling program to be conducted on certain public lands within the Felton Prairie with high quality prairie on the surface to determine the presence of an economically-recoverable aggregate resource. The purpose of the drilling program would be to determine the presence of an aggregate resource and the overburden thickness. If an aggregate resource is encountered, more drilling would be needed to adequately quantify the volume of gravel. The aggregate information gained by the drilling program could assist in future management.

Other viewpoints were brought up during discussions. One view was that a drilling program would be of little value because it is already assumed that there are large reserves of aggregate within the Felton Prairie

and drilling would be a costly way to confirm it. Another view expressed was that the value of the prairie is well known at Felton and it was further suggested that funding efforts would best be used to secure other gravel lands for exchange.

9. COMPUTERIZED RESOURCE INFORMATION. The Forum developed a computerized resource information system for the eastern half of the county which integrates many existing resource datasets. This information is available to the public and to agencies responsible for land use planning. In addition, map sets displaying prairie and gravel resources were distributed to all community centers and townships.

For the casual user, a copy of the computerized resource information has been placed in the Lake Agassiz Regional Library in Moorhead where it is installed on a computer available to the public. Another set is available at the Moorhead State University Regional Science Center for use by science center visitors. Users will be able to view a short demo that explains the data.

For the more advanced user, the information will be available on CD-ROM. The CD-ROM contains the demo, complete data sets, user's guide, data documentation, and selected maps. Copies of the CD-ROM will be distributed to interested parties until supplies run out. These users will need the appropriate hardware and software to access the information on the CD-ROM.

The Forum recommends that the computerized resource information depicting prairie and gravel resources developed by this project be considered by the County Board and the Planning Commission in future land use decisions and that the information be updated regularly.

The Forum conducted one analysis with the computerized resource information starting with prairie resources. Many more analysis are possible and should be conducted in the future. The Forum recommends that future analysis be conducted starting with aggregate potential.

10. NEED FOR A COUNTY-WIDE MINING ORDINANCE. Gravel mining is a conditional land use in Clay County which means that a project proposer must obtain a Conditional Land Use Permit from the Clay County Planning Commission. Guidelines have been developed for gravel mining but they are offered only as guidelines and do not address reclamation concerns. A draft county ordinance was contemplated in 1978 but no action was taken at that time.

After lengthy discussions, the Forum concluded that mining and reclamation plans should be prepared in a consistent and fair way for all gravel mining operations within the county. The Forum further concluded that reclamation planning should begin with operations located within the Felton Prairie and that reclamation plans on public lands should be coordinated in that location. This conclusion ultimately led to the following recommendation for a county-wide mining ordinance that is reasonable, fair, and timely and a second recommendation for changes to the current permitting system that allows integration of the computerized resource information generated by this project.

Mining Ordinance. *The Forum recommends that Clay County adopt a county-wide general mining ordinance that contains reasonable mining and reclamation standards that are fairly applied in a timely manner. Some provisions that should be included or considered in a county-wide ordinance are listed below:*

- The ordinance should apply to all extractive uses including but not limited to sand and gravel mining, black dirt removal and clay removal.

- The ordinance should require the preparation of mining and reclamation plans for all active operations.

- The ordinance should contain an effective date of compliance that would apply to all active operations (and allow a reasonable amount of time for operators to comply).

- The ordinance should be short and contain general provisions with the intention that site specific questions can be most effectively considered within the existing permitting structure.

- Since several townships already have ordinances relating to gravel mining, it is important to work with townships in order to draft an ordinance that complements their needs.

- The provisions of any new mining ordinance or permitting process should apply equally to operations on public lands. Although public agencies operating on public lands are generally not required to obtain permits for gravel mining, the expectations of a new mining ordinance should be made clear to all public land managers in the county including the U.S. Fish and Wildlife Service, MN Department of Natural Resources, MN Department of Transportation, Clay County, and townships. The Forum recommends that all public

land managers in the county participate in drafting a new ordinance and that compliance with any new ordinance be sought from public land managers.

- With the consent of the Clay County Board, the Forum is taking the next steps to draft an outline for a reasonable, fair, and timely mining ordinance and to describe how an ordinance could fit with the existing permitting process.

Two track permitting approach. *The Forum recommends that the Planning Commission consider adopting a two track approach to permitting of gravel operations that would utilize the computerized resource information developed by this project. The two track permitting system would complement a new mining ordinance. Under this approach, all projects would first be screened by the Planning Office using the computerized resource information as outlined below.*

- Track 1. Screening of new project proposals would be done in the Clay County Planning Office. A checklist would be developed to use in conjunction with the resource information. Projects would be screened for proximity to and significance of prairie. Other environmental and cultural resource concerns should be incorporated. For gravel mining proposals that do not propose to impact prairie, an expedited permitting process would be followed.

- Track 2. For those proposals that propose to impact prairie or are close to prairie, greater scrutiny of the project proposal would be needed in the permitting process, possibly in the form of a discretionary Environmental Assessment Worksheet (EAW). In some cases, a biological survey may be needed to further identify the prairie resource. Access to the proposed project site for inspection purposes or to obtain additional information may be needed.

- With the consent of the Clay County Board, the Forum is developing draft screening procedures, a checklist, and a time frame for each of the two tracks in the proposed permitting process. Like any new mining ordinance, it is imperative that the permitting process be reasonable, fair, and timely.

Need for interim measures. *It could take a substantial amount of time before an ordinance or a two track permitting system can be drafted and implemented. In the interim period, the Forum recommends that the Planning Commission screen all new proposals with the*

aid of the computerized resource information to determine proximity to prairie and give a closer review to those that propose to impact prairie. The Planning Commission should also consider how other permitted and conditional land uses could impact the availability of gravel resources in the future.

11. AGGREGATE MATERIAL TAX. The Aggregate Material Tax is a state law administered by the counties who impose the tax. The Forum discussed the tax at great length and eventually identified: 1) areas of concern within the law that would require a statutory amendment to improve; and 2) areas of concern within the existing statute where local government has discretion. The Forum made recommendations relating to both areas.

Concerns that require statutory amendment. Below are three concerns regarding the Aggregate Material Tax that would require statutory amendment to address. At this writing, legislation relating to the tax is pending during the 1997 Legislative Session. The Forum offers these comments for the possible benefit of any future unit of government or organization interested in modifying the current legislation.

Compliance. There is concern that the tax is not being paid in full by all eligible operators in Clay County. Operators are required to file a quarterly report and payment with the County Auditor. Compliance with the tax by the operators appears to range from payment in full to underpayment to no payment.

Reporting. There is a concern that the reporting requirements specified in statute do not allow the auditor enough time to accurately review the records. According to the statute, the County Auditor has 14 days after the calendar quarter to review all aggregate reports that are filed and determine the accuracy. The auditor has 14 days beyond that time to estimate tax due and notify the operator by registered mail. It appears that if the auditor does not take action during the prescribed time frame, collection of back taxes cannot be considered.

Distribution of revenue. There is concern about the distribution of revenue. According to the statute, 90% of the revenue generated by this tax goes to county and township road funds to support road maintenance. The remaining 10% of the revenue is allocated to a special reserve fund for restoration of abandoned pits on public lands. Most people agree that the majority of revenue generated from this tax is best used on the maintenance of county and town-

ship roads and would be concerned if the focus changed. Most people also support the 10% allocated for restoration but are concerned that it has not been used more often. There is speculation that the reserve fund would be used more often if restoration were interpreted to include a broad range of activities relating to the management of aggregate resources on public lands (such as aggregate inventory and mine planning) or if the funds were available to private landowners.

The Forum recommends that funds from the restoration set aside account be spent first to reclaim pits on public lands according to statute. When these sites have been restored, the Forum recommends that the statute be amended to allow private landowners access to these funds in a cost share or small grants program similar to tree planting programs. Since the majority of gravel mining areas in the county are found on private land (approximately 200), there will be limited opportunities for restoration projects on public lands in the future. The gravel tax could provide a form of assistance and an incentive for private landowners to reclaim old pits that were mined out long ago. The intent is not to substitute for an operator's obligation to reclaim an active mining site.

Local government discretion. The Forum identified and discussed three areas in the existing statute in which local government has apparent authority and discretion.

Township road and bridge accounts. The statute specifies that 30% of the tax revenue is to be distributed to township road and bridge accounts in a manner to be determined by the County Board. A formula was developed in 1985 for the distribution of funds to townships in Clay County. The formula distributes half of the revenue from this portion of the tax to all of the townships in the county. The remaining half is apportioned equally among those townships with active gravel pits. The funds have been allocated to the townships according to this formula since 1985.

After discussion, the Forum concluded that townships can at any time bring a recommendation to the County Board to revise the current formula. The Forum recommends that this report be distributed to all townships for their information. The townships can then take whatever action is appropriate in the future.

Restoration set aside account. The statute specifies that 10% of the tax is to be allocated "to a special reserve fund which is established for the restoration of abandoned pits, quarries, or deposits located upon public and tax forfeited lands within the county". Because mining and reclamation are so closely tied, the term "restoration" can be broadly interpreted to include many activities that would lead to the development of a mining and reclamation plan. Activities such as aggregate drilling could be considered "restoration of a deposit". Some people feel that the County Board has the discretion to more broadly interpret how the 10% portion of the gravel tax money is used as long as it ultimately leads to good reclamation.

After discussion, the Forum concluded that the county should seek and provide clarification on how the restoration portion of the gravel tax revenue could be used. There is a question about whether this portion of the tax revenues could legitimately be used for aggregate drilling to expedite the removal of any remaining gravel on public land to hasten restoration. The Forum recommends that the County Attorney be consulted for an opinion and that the range of reclamation activities that could be funded by this portion of the tax be clarified.

Restoration of pits on public lands. The 10% of the tax allocated for restoration has not been used widely for this purpose for a variety of reasons. The County Board has authority to turn the restoration money back to the road and bridge accounts if no pits on public lands are identified for reclamation. Some people have the opinion that this money should not be turned back but remain available for reclamation even when no projects are identified. Others believe that the money could be turned back if the balance goes beyond a certain minimum value. After discussion, the Forum concluded that if there were a list of potential projects that met the criteria cited in statute, the balance in the reclamation account should not be turned back.

There are more than 20 gravel mining areas known to occur wholly or partially on public land in Clay County. Public lands are those owned by municipalities, townships, county, state, and federal governments. The Forum appointed a subcommittee with representatives from the county, state and federal governments to look more closely at the properties and determine which if any are ready for reclamation, which could be ready for reclamation if more material were removed, and which are adjacent to prairie.

The Forum will review all gravel pits on public lands and develop a prioritized list of possible projects. The Forum recommends that this list of possible reclamation projects be considered by the County Board for partial or total funding under the gravel tax.

Possible future project proposals

Four possible projects were identified by the Forum and are described below (Figure 16). For each of these, the Forum recommends that the subcommittee appointed by the County Board review the feasibility and then draft project proposals and seek funding as appropriate.

Accommodating visitors at Felton Prairie. Identify, design and build a safe place for visitors to view the prairie and gravel resources found on Felton Prairie. This would include interpretive signs and a brochure for the Felton Prairie that incorporates gravel mining/ reclamation into the message. Any proposal must consider liability concerns and stress safety because of the truck traffic and active mining occurring in the area.

County Road 34 ISTEA proposal. This proposal was funded in the early nineties (under a federal program known as ISTEA) but never acted on. The purpose of the project was to link isolated parcels of prairie along the County Road 34 corridor. The proposal should be reviewed to determine if there is interest in reviving the project.

Beach Ridges Pullout on Trunk Highway 10. The existing pullout at the entrance to Buffalo River State Park south of Trunk Highway 10 (the rock with the plaque containing information about the Campbell Beach) could be improved to include more information about the beach ridge landscape and the economic and natural heritages values found there. This pullout would accommodate traffic moving east on Trunk Highway 10. Another pullout for traffic moving west might be found on the north side of the highway.

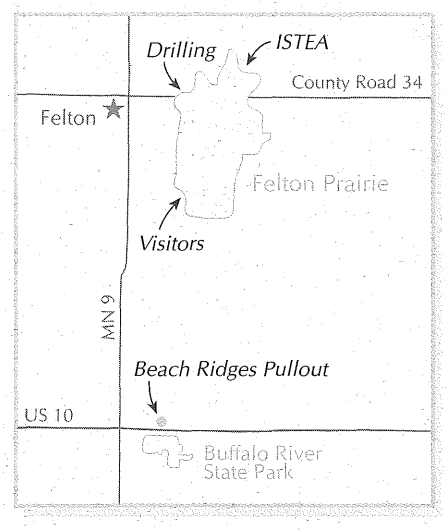


Figure 16. Location of possible project proposals.

Rotosonic aggregate drilling program. Prepare a plan and seek funding for a rotosonic aggregate drilling program to be conducted on certain public lands within the Felton Prairie that have high quality prairie on the surface to determine the presence of an economically-recoverable aggregate resource. The purpose of the drilling program would be to determine the presence of an aggregate resource and the overburden thickness. The aggregate information gained by the drilling program could assist in future management.

Other areas of concern.

In reviewing the resource information compiled for this project, other areas of concern were noted by the Forum and are briefly described here.

Gravel mining along the Buffalo River. Maps generated by this project show many old and some active gravel mining sites along the Buffalo River. This same observation was made for the Wild Rice River. The floodplain of the Buffalo River has high aggregate potential and it is likely that aggregate mining will continue. A question was raised about the possible long-term impacts to the Buffalo River from gravel mining.

Future mining along the County Highway 23 corridor. County Road 23 (road to the sanitary landfill) represents an expanding corridor of gravel mining. Several new mining areas have opened recently and other expansions are proposed. Reclamation is an important consideration in this location and there is a need to look at this corridor with a 50 or 100 year perspective. The nearest prairie resources to this area are the Bluestem Prairie and Margherita Preserve. Although there are no operations in the area mining below the groundwater table, the possible hydrologic impact of mining below the groundwater table on lands near or adjacent to the prairie was noted as a possible future concern.

Groundwater issues. In Clay County, only a few gravel mining operations are currently mining within the groundwater table and these operators must comply with existing regulations regarding groundwater appropriation and storm water discharge. A question was raised about the impact gravel mining may have on the groundwater if this type of mining expands greatly in the future. This is a topic that needs further research.

Where to obtain more information

Final Report, Coloring Book, Information Handbook.
While supplies last, additional copies of the final report, coloring book and information handbook can be obtained from the Clay County Courthouse or the Department of Natural Resources at the following addresses. In addition, copies of all these materials were sent to the Lake Agassiz Regional Library.

Clay County Courthouse
807 11th Street North
PO Box 280
Moorhead, MN 56560-0280
Telephone: 218/299-5002

Department of Natural Resources
Division of Minerals
2115 Birchmont Beach Road NE
Bemidji, MN 56601
Telephone: 218/755-3955

Department of Natural Resources
Division of Minerals
500 Lafayette Road
St. Paul, MN 55155-4045
Telephone: 612/296-4807

Computerized resource information.
For a casual user in the general public, a copy of the computerized resource information has been placed in the Lake Agassiz Regional Library in Moorhead at the address shown below where it is installed on a computer available to the public. Another set is available at the Regional Science Center for use by science center visitors. Users in these locations will be able to work through a short demo and learn about the datasets. The system is also housed in the Clay County Courthouse for use by county staff.

For advanced users, the information is available on CD-ROM. The CD-ROM contains the demo, complete datasets, user's guide, data documentation and selected maps. Users of the CD-ROM will need the appropriate hardware and software to access the information. While supplies last, copies of the CD-ROM can be obtained by contacting the DNR.

Lake Agassiz Regional Library
118 South 5th Street
Moorhead, MN 56560
Telephone: 218/233-7594

Moorhead State University
Regional Science Center
The Science Center is located east
of Moorhead on Trunk Highway 10.
Enter by way of Buffalo River State Park
Telephone: 218/498-2904

Department of Natural Resources
Division of Minerals
2115 Birchmont Beach Road NE
Bemidji, MN 56601
Telephone: 218/755-3955

Department of Natural Resources
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500 Lafayette Road
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ACKNOWLEDGMENTS

The Clay County Beach Ridges Forum gratefully acknowledges funding for this project from the Minnesota Future Resources Fund by the Minnesota Legislature, ML 1995, Chapter 220, Section 19, Subdivision 5(e), as recommended by the Legislative Commission on Minnesota Resources.

In addition, the Forum would like to recognize the efforts of Deborah Sroka for layout and design; Rhonda Schrader and Vera Wong for line art. Historic photographs were used with permission of the Clay County Historical Society.

Resource information was supplied by the MN Department of Natural Resources, MN Department of Transportation, Clay County Planning Office, Clay County Highway Department, Clay County Historical Society, Fargo-Moorhead Metropolitan Council of Governments and the sand and gravel industry of Clay County.

This report prepared for the Clay County Beach Ridges Forum by the Minnesota Department of Natural Resources. For more information, contact:

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Minnesota
DEPARTMENT OF
NATURAL RESOURCES