The purpose of this section is to identify areas of high environmental and natural resource value. These features will often determine what kind of land use may occur and the intensity of that use. Some areas contain limitations to development or may function best if left in a natural state. Preservation of significant natural resources is a legitimate goal for any local government. Protection of important sensitive areas not only allows them to be enjoyed for generations to come, but also contributes to the quality of life for residents of the County today.

In addition to the ecological and aesthetic benefits of preserving and/or enhancing natural resources, communities are increasingly recognizing the economic benefits of such resources. For example, the Minnesota Department of Tourism and Economic Development has data showing that during recent years, more than 617,000 people traveled in Minnesota each year to see wildlife, spending more than $125 million annually. Thus, the County's natural resources should be considered important economic resource as well, particularly the birding opportunities and native prairie areas available in Clay County.

GEOLOGY

Clay County encompasses 675,026 acres or 1,053 square miles and is located in the fertile Red River Valley in northwestern Minnesota. (Clay County GIS Office, May 2000).

The Red River Valley is the youngest major landscape in the contiguous United States. It is also one of the flattest land surfaces in North America. About 9,300 years ago, glacial Lake Agassiz receded and left clay-rich sediments that would be prairie grasslands for many years. Today, this area is one of the most fertile farming regions in the world.

The native vegetation prior to settlement by Europeans consisted of tall bluestem prairie in the river valley and cottonwood, elm and willow groves along watercourses. With the exception of the river and stream bottoms, all of Clay County was once covered by prairie vegetation. Today, native prairie remains over just 3% (21,310 acres) of the County.

The geology of Clay County is a direct result of the glaciers that once covered the area. The western portion of the County is made up of glacial drift (ground moraine) resulting in flat topography. The eastern part of the County is a result of terminal moraine creating undulating, hilly topography.

The varying levels of Lake Agassiz and an ancient streambed that flowed between two ice sheets caused several linear beach ridges to form. These ridges are made up of sandy soils and are recharge areas for surficial aquifers. These areas are also home to some of the largest and best examples of native prairie remaining in Minnesota and the entire Midwest.

The eastern highlands can be severely eroded if inadequate groundcover and without proper land use management. Water resource protection in these areas is very important.

Clay County ranges in elevation from 1,500 feet in the eastern highlands to 900 feet in the Red River Valley to the west, resulting in an average of 600 feet of maximum relief. The highest elevations (1,550 ft. above sea level) in the County are on the hills near Rollag, with the lowest point (880 ft. above sea level) in the northwest corner of the County near the Red River. The western half of Clay County is flat with slopes averaging 0 to 0.5 percent. The eastern half of the County is more undulating with slopes of 3 to 10 percent, and in some cases, 20 percent or more.

Much of the information in this section has been taken from the *"Clay County Comprehensive Local Water Plan Update: 1998-2003"* , the *"Revised Watershed Management Plan of the Buffalo-Red River Watershed District - 1997"* and the "*Clay County Beach Ridges Forum for Gravel Mining and Prairie Protection: A Final Report",* published in 1997.

SOILS

Figure 2-7, *General Soil Map,* illustrates the soils in the County. The following is a summary of those soils.

Fargo Association: The Fargo Association covers approximately 16% of the western portion of Clay County on nearly level, poorly drained areas. Fargo soils have silty clay surfaces and subsurface horizons. Associated minor associations range from mucky to silty clay loams. This association has severe restrictions for urban, industrial and recreational uses due to its wetness, frost action and shrink-swell properties. It has good agricultural potential despite its wetness and tillage difficulty.

Bearden-Colvin: This association covers about 17 percent of the County and is nearly level with low rides, depressions and draws. These soils are silty clay loams; Bearden soils are somewhat poorly drained and Colvin soils are poorly drained. These soils are fertile; however, they are strongly calcareous under the surface so nutrient imbalance can be a problem. The main concerns for cropping are wetness and wind erosion. Limitations for other uses include wetness, high water tables, shrink-swell and frost heave potential.

Viking-Donaldson-Glyndon: This association is found on about 2% of the County where nearly level areas contain micro-relief with ridges, swales and draws. The poorly drained, sandy-clay loam Viking soils occupy the depressions and the fine sandy loam Donaldson soils and the loam Glyndon soils, the remaining area. Both of the latter soils are somewhat poorly drained. These are good agricultural soils with the major management problem being wind erosion. Drainage can improve production. Nutrient imbalance can occur due to calcareousness. Concerns for other uses include high water tables, wetness, a high potential for frost action and moderate potential for shrink-swell.

Glyndon-Wyndmere-Wheatville: These soils cover about 18% of the County on nearly level to gently sloping areas with some shallow draws and depressions. These soils run north south, through the middle of the County. Wyndmere soils are poorly drained and are fine sandy loams, while Glyndon loams and Wheatville silt loams are somewhat poorly to moderately well drained. All three soils are strongly calcareous below 8-10 inches, which causes nutrient imbalance.

Drainage will improve production and wind erosion is a problem on these fertile soils. Major factors affecting other uses include wetness, high water tables, and frost action.

Ulen-Arveson-Flaming: This association covers 10% of the County on level areas characterized by pronounced ridges, deeper depressions and shallow draws. Ulen soils are fine sandy loams over strongly calcareous material and are somewhat poorly drained to moderately well drained. Arveson soils are poorly drained to very poorly drained calcareous clay loams while Flaming soils are somewhat poorly drained to moderately well drained fine sands. Soils of this association are all susceptible to wind erosion and may suffer from nutrient imbalance due to calcareous. Flaming soils also have only modest fertility levels. Drainage in some, but not all sites due to topography can elevate wetness. Limitations for other uses include wetness, frost action and flooding.

Lohnes-Sioux: This association occurs on about 12% of the County on nearly level to very steep relief containing hills, ridges and broad flats. The moderately well drained to well drained Lohnes loam occupy the level to gently sloping areas while the excessively drained sandy loam Sioux soils occupy the steeper slopes and crests of hills and ridges. Minor soils make up over one-half of this association and range from poorly drained to excessively drained soils depending on local topography and landform. This association is not well suited to cropping because of low fertility and available water capacity and susceptibility to wind erosion. When steepness is not a factor, these soils have few limitations for other uses except where high permeability is not desirable.

Barnes-Langhei: This association is found on nearly level to hilly upland areas with local relief containing deep depressions, complex slopes, well-defined drainages and small valleys. The association covers about 22% of the area in the eastern one-third of the County. The strongly calcareous Langhei loams are found on the knobs and steeper upper slopes and the calcareous Barnes loam soils are found farther down slope on more level areas. Minor associated soils vary according to diverse local relief and micro-topography. These soils are fairly well suited to cropping although erosion is a hazard. Fertility is moderate and calcareousness may cause nutrient imbalance. Slope is a limitation for other uses. Due to the complex nature of the soil pattern, topography, and local relief, use suitability needs to be determined on a case-by-case basis.

Waukon-Langhei: The Waukon-Langhei association covers about 3% of the County, and is found on nearly level to hilly uplands that are well to excessively drained. The loamy Langhei soils which are found on the knobs, ridges and upper slopes are strongly calcareous which causes nutrient imbalance. The fine sandy loam Waukon soils are found on the down slope and more level areas. The region contains numerous potholes, marshes and lakes and the minor soils of the association found in these areas are heavier in texture. Both soils are good agricultural soils, although steeper areas are best utilized as pasture. Wind and water erosion can be a problem. Limitations for other uses include steepness of slope and shrink-swell potential.

VEGETATION

As mentioned earlier, Clay County is located in the Red River Valley, which was once the lakebed of glacial Lake Agassiz. Tall grass 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 tall grass prairie. The original vegetation map of Clay County (Figure 2-8, *Original Vegetation of Clay County*) shows that only the river and stream bottoms were wooded in the County. The rest of the County was tall grass prairie.

Drought, fire and extreme temperatures and large grazing animal herds such as bison shaped the prairie landscape. 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 deep 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 the entire 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.

The remaining prairie and other natural communities in the eastern half of Clay County was mapped by the DNR in 1997 (see Figure 2-9, *Natural Communities and Biodiversity Significance*). About 21,310 acres in the County were identified as having some prairie characteristics. Prairie resources in the County vary in quality from those of low, modest, medium and 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 includes some of the best prairie in the State and approximately 10% of the entire prairie remaining in Minnesota.

Two main concentrations of prairie found in Clay County are the Felton and Bluestem Prairies. 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. Bluestem Prairie is located south of Trunk Highway #10 near Buffalo River State Park. It is an 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 can be seen in Figure 2-10, *Major Prairie Areas in Clay County* and combine to account for most of what remains of the County's original prairie vegetation. Other parcels of prairie are scattered throughout the eastern part of the County.

Some of the best prairie in the County is protected by designation as Scientific and Natural Areas (SNA's) or through conservation efforts of private landowners or conservation organizations like the Nature Conservancy. In addition, other large tracts of the high quality prairie are owned by the County. Most of the remaining prairie is in private ownership and will take the efforts of these landowners to protect these areas in the future.

Some of the prairie areas contain wetlands which are protected by the Minnesota Wetlands Conservation Act (WCA) and require mitigation if allowed to be filled. Others may be classified as calcareous fens, which is a unique type of wetland that is protected through the WCA. Ten calcareous fens are located in Clay County out of a total of 103 statewide. Also, some plants and animals that live on prairie remnants are threatened or endangered species because of the loss of prairie. These areas would require careful review to be developed.

Some areas of disturbed native prairie have been restored, while many others have not.

SPECIAL ANIMALS AND PLANTS IN CLAY COUNTY

The Minnesota Department of Natural Resources (DNR) County Biological Survey began in 1987 to systematically identify and catalogue rare biological features and has been completed in 41 of Minnesota's 87 counties. The Endangered Species Act of 1973, which is regulated by the U.S. Department of the Interior, Fish and Wildlife Service, protects rare, endangered and threatened species, but there are currently no regulations pertaining to the natural communities identified by the DNR. However, any project funded in whole or part with federal dollars must be reviewed by the DNR, as do projects that require the preparation of an Environmental Assessment Worksheet (EAW) or Environmental Impact Statement (EIS). During this review process, the DNR may provide site-specific development recommendations if natural communities are present.

In Clay County the loss of prairie habitat has caused many plants and animals to be considered endangered or threatened. Seventeen (17) animal species and nineteen (19) plant species have been identified by the state as threatened, endangered or special concern species. One of these, the western prairie fringed orchid is a federally listed species. Most, but not all of these species are found on the beach ridges. The plants and animals are listed below.

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 (fish)
Plains pocket mouse
Yellow rail

Special Plants in Clay County

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

Source: MN Department of Natural Resources

Each year, 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.

AGGREGATE DEPOSITS

Gravel deposits are an important source of construction material in Clay County. The glaciers left behind beach ridges that contain sand and gravel, most predominantly in eastern Clay County. Sand, gravel, rock, and crushed stone are referred to as aggregate materials. These materials are important to a variety of construction products. They are used in concrete, asphalt, road base, fill, snow and ice control and other uses. These deposits contribute significantly to the economic base of the local economy. Much of these deposits are located under the remaining native prairie vegetation. This has created a conflict between the use of the aggregate resources and the possible loss of the native vegetation.

Sand and gravel deposits vary widely in quality. In 1995, a local forum was organized and met to discuss gravel mining and prairie protection on the beach ridges in Clay County. This was an opportunity for landowners, native prairie supporters, gravel producers, governmental agencies, and interested members of the community to meet and learn about the prairie and gravel resources in the County and to discuss the future of both in a neutral setting. This work was concluded in 1997. During the process, 18 eastern townships were studied and maps were produced that show existing gravel mining activities, gravel deposits and the quality of the deposits, and the location and quality of remaining native prairie vegetation in this area.

Because sand and gravel are relatively inexpensive to mine but expensive to transport, it is important to locate operations close to where the resource will be used. Gravel pits are found in every county in Minnesota. Figure 2-11, *Aggregate Resources,* shows the aggregate potential for eastern Clay County completed by the DNR. This map indicates where there is potential within the eastern half of the County to find future gravel deposits.

It shows that gravel resources vary throughout the area and future deposits of good gravel is limited to certain locations. 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.

Gravel mining is concentrated in 18 eastern townships and there are approximately 236 gravel mining sites. These sites include inactive, reclaimed and active pits. About 3,700 acres have been affected by gravel mining. Of the 236 sites, about 75 have been recently active. A major concern throughout the County is the reclamation of inactive pits.

Eight to twelve companies are currently mining gravel in Clay County. The exact number depends on current construction projects. It is estimated that 500 people are employed by the industry during peak construction season.

The demand for aggregate material is expected to rise to keep up with the high demand for construction materials in the Fargo-Moorhead metropolitan area. Some estimates for future aggregate consumption has been done based on population projections to the year 2010. These are included in Table 2-25 below.

Table 2-25
Projected Population Growth and Aggregate Consumption
Fargo-Moorhead Area
1980-2010

Year	Population: Cass & Clay Counties	Estimated Aggregate Consumption: tons/year
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

Source: Clay County Beach Ridges Final Report, 1997

These estimates are based on a per capita rate of 8 tons/person/year multiplied by the rural population and 10 tons/person/year multiplied by the urban population. The rural rate was taken from an average of 8 tons per capita per year for projects such as road building and infrastructure development. The 10 tons per year for urban residents is due to the special needs of that market and the growth rate that has been seen in the area.

Gravel mining in Clay County requires a conditional land use permit from the County. A township permit may also be required for new gravel mining operations, depending on the location. About 25 permits had been issued between the late 1980's and 1997. Permit guidelines have been developed but they do not address reclamation. Some state permits may be required if there is a need to appropriate water, or if there is storm water discharge, water quality concerns, air emission or above ground storage tanks. Wetland mitigation may also be necessary if wetlands are impacted by the operation.

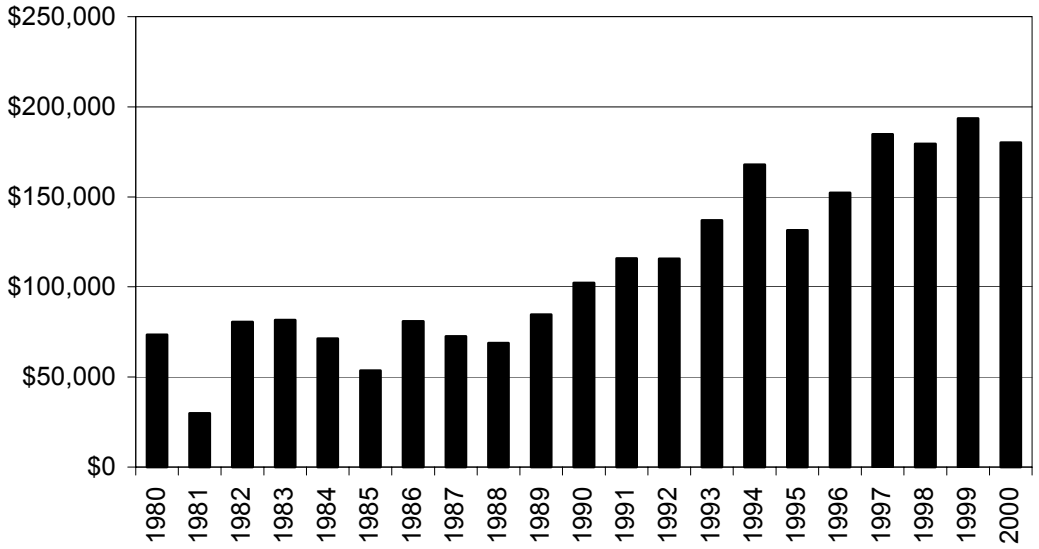
An Environmental Assessment Worksheet (EAW) is required when a gravel mining operation exceeds 40 acres in size and a mean depth of 10 feet. Environmental Impact Statements (EIS) are mandatory for operations exceeding 160 acres. Clay County completed three EAW's in 1996 relating to gravel mining and no EIS's have been conducted.

Clay County has a "gravel tax" that is a production tax on the removal of gravel material. The tax is calculated on a per cubic yard or per ton basis. This tax is imposed upon operators (any person engaged in removal of aggregate material from the surface or subsurface for the purpose of sale) at the rate of ten cents per cubic yard & seven cents per ton of gravel produced in the County.

The state statute for this tax requires all counties to distribute the proceeds as follows: 60% to the County Road and Bridge Fund, 30% to the Township Road and Bridge Fund, and 10% to a special reserve fund for the restoration of abandoned or depleted pits on public lands. Governmental units that own pits and use them for public uses are exempt from this tax. Figure 2-12 summarizes the amount of gravel tax revenue Clay County received from 1980 to 2000.

Through the mapping process, existing and future potential for conflict between gravel producers and native prairie vegetation is more clearly shown (see Figure 2-13 *Prairie and Gravel Pits*). The maps reveal that gravel is not found everywhere in the eastern half of the County but only in certain

Figure 2-12
Clay County Gravel Tax Revenue
1980-2000



locations. Likewise, significant parcels of prairie are not found uniformly on the beach ridges but in some well-defined locations. The maps also show that prairie is found in areas of low aggregate potential. High aggregate potential can be observed in areas that do not contain prairie. But, there are areas of potential conflict where both high aggregate potential and significant prairie co-exist, according to the maps. Further testing for aggregate potential would be necessary in specific areas. More detailed information can be found in the report titled "*Clay County Beach Ridges Forum for Gravel Mining and Prairie Protection: A Final Report"*. This document contains much useful information for land use planning in Clay County.

The work of the Forum helped the County focus attention on where areas of potential conflict may lie and gave them better information for future planning. Recommendations were also given for future use of the areas studied. At the present time, the County planning office is using this information when Conditional Use Permits are being considered.

HYDROLOGY

Drainage

Generally, movement of ground water, like surface water, follows the topography. Figure 2-14, *Major Watersheds*, shows the major watersheds in Clay County.

Surface water drainage in Clay County is generally to the north and west, except for a very small portion, which drains south to the Otter Tail River Watershed. The major watersheds include the Red River, Buffalo River, and Wild Rice/Marsh River Watersheds. These watersheds drain the western, central and northern parts of the County, respectively. The Buffalo River and the Wild Rice River are the primary tributaries to the Red River of the North.

Most of the man-made drainage systems are located in the western lakebed area. This is due to the lack of natural drainage systems in the Lake Agassiz plain. Drainage systems within the beach ridge area are practically nonexistent because of the abundant supply of natural drainage with sufficient gradient. Artificial drainage in the glacial moraine area in the eastern part of Clay County is significantly less than that in the western region of the County.

Most of the drainage systems were constructed prior to 1920 and maintenance was almost nonexistent until the establishment of the Watershed Districts. Any new drainage requires a watershed district permit and environmental review. Any unpermitted drainage is illegal. Currently, the artificial drainage systems or public ditches within the County are administered by the Watershed Districts. Assessments are based on who is determined to benefit from each particular ditch system or whose land experiences an increase in market value, due to a ditch project. Most of these ditches are oriented in an east-west direction, perpendicular to the Red River. The drainage system in Clay County is quite extensive and thousands of acres of farmland have benefited from drainage. Drainage has made the Red River Valley a dominant agricultural force. Figure 2-15, *Drainage Ditches*, shows the public drainage system in Clay County.

Spring flooding is an annual problem in the area and is exacerbated by the flat slope of the watershed and channel obstructions such as logs, ice and dams. Annual average flood damage (in 1996 dollars) in the Buffalo River Watershed is estimated at $2,705,710 and is 99.5% rural damage. Floodwater can spread many miles through municipalities and over fields and is called overland flooding. This occurred during the flood of 1997 when much of the Red River Valley was under water due to overland flooding.

Groundwater Levels

High groundwater levels are experienced throughout the County on a consistent basis. Exceptions are during drought periods. The clay soils present in most of the agricultural areas have low infiltration rates and recharge deep subsurface aquifers very slowly. This results in waterlogged conditions in the upper strata of the clay soils, which have resulted in very low permeability. These conditions, when combined with the occurrence of excessive rainfall, have contributed to considerable damage to growing crops through inundation of the root zones.

The County has experienced little or no situations of drastically reduced groundwater levels because of drought or excessive pumping.

Wellhead and Source Water Protection

Since 1974 the U.S. Environmental Protection Agency has been responsible for regulating the nation's public water supply systems, under the provisions of the Safe Drinking Water Act. However, most states, including Minnesota, have assumed responsibility for enforcing the Act within their borders. To be considered "public" a water supply system must have its own water source and provide water to 25 or more people or have 15 or more service connections.

In Minnesota there are two programs that address protection of public drinking water: the Wellhead Protection Program (also called Source Water Protection), and the Source Water Assessment Program. The Source Water Protection Program requires wellhead protection plans for all community and noncommunist, nontransient public water suppliers. A source water assessment will be completed for all public water supply systems, (transient systems included). The assessement is limited to delineating the area that supplies water to the system, identification of potential contaminants that are of concern to users of the system, and to the extent practical, the location of potential contaminant sources. A wellhead protecion plan goes further and identifies issues applicable to protection of the source water and establishes action items that implement management strategies to address those issues.

In 1995~~7~~, the Minnesota Department of Health (MDH) adopted the Wellhead Protection Program with rules to safeguard public wells that supply drinking water against pollution. The goal of the program is to prevent contaminants from entering the area that contributes water to public water supply wells. For transient public water supply wells, an inner wellhead protection zone (IWMZ) is the wellhead protection area .This is defined as the 200-foot radius around the well. The state Wellhead Protection Rule requires an inner wellhead management zone be established for all such wells and that potential contamination sources be managed within it. There are approximately 40 transient public water supply systems in Clay County.

For all community and non-community, non-transient public wells, a "wellhead protection area" must be determined through a detailed hydrologic and geologic analysis. Once this area is delineated and an assessment of vulnerability is completed for a particular well, possible sources of pollution are identified and the supplier is required to develop a Wellhead Management Plan to mitigate existing and potential pollution problems. Because of the large number of community and non-community, non-transient systems in the state, the MDH is implementing these requirements in phases, targeting the most vulnerable wells first. In Clay County there are 13 community systems and no non-community, non-transient systems.

Public water supply systems including Moorhead, Glyndon, Barnesville, and Georgetown are currently in the wellhead protection program and are in the process of developing wellhead protection plans. Other vulnerable public water supply systems expected to be brought into the program in the next five years include Brentwood Acres, Dilworth, Sabin and Comstock. Some public water supply systems enter the wellhead protection program due to construction and connection to service of a new well.

A Source Water Assessment is currently being developed by the Department of Health for the surface water intake of the City of Moorhead. Upon completion of this assessment, the Cities of Moorhead and Fargo are expected to start a non-mandated process to develop a source water protection plan for this surface intake. This process will require the coordination and cooperation of all local governments in the identified protection area for it to be successful.

Although it is the public water suppliers that will be required to develop management plans once wellhead protection areas have been delineated, some of the wellhead protection areas will likely extend into surrounding townships. Because cities generally do not have land use authority outside their boundaries, it will be very important for townships and the County to work with cities in developing these plans, particularly with regard to land use policies.

Lakes, Rivers and Wetlands

Rivers in Clay County include the Red River of the North, North and South Branches of the Buffalo River, the South Branch of the Wild Rice River and many meandering streams. Probably the most significant of these rivers is the Red River of the North. The river provides important natural, recreational and economic benefit to the County. According to the Department of Natural Resources, eighty-four species of fish have been identified in the Red River and it is known as the premier channel cat fishery in North America, while the walleye fishery is equal to any walleye lake in the state. The best walleye habitat is found in the headwaters of the tributaries leasing out of the beach ridge area of Clay County. These rivers offer fishing opportunities in a part of the state where there are few natural lakes.

There are over 200 DNR-protected water bodies, which cover over 7,200 acres in the County. Figure 2-16, *Surface and Ground Hydrology*, shows the surface hydrology and aquifer recharge areas of the County.

Four lakes, all located in the eastern third of the County, have moderate to intensive development within their shoreland. These include Turtle Lake, Silver Lake, Lee Lake and Lake Fifteen. Each has a public access and some degree of recreational development around them.

According to the DNR classification system of lakes over 25 acres, there are approximately 74 lakes in Clay County; 71 of which are classified as Natural Environment lakes. Most of these lakes are less than 100 acres in size. There are two Recreational Development lakes in the County, Turtle and Sand, both of which are also partially located in Becker County. One lake, Flora, is classified a General Development lake due to its proximity to a municipality (Hitterdal).

Clay County currently has a little more than 37,000 acres of wetland areas, which translates, to about two percent of pre-settlement wetland areas. Most wetlands are found in the eastern half of Clay County.

Wetlands have generally been regarded as obstacles to development rather than opportunities. Only recently have public attitudes changed and brought destruction of these productive areas to an end. Most wetlands are valuable for storing essential surface waters to alleviate the danger of droughts and floods and support wildlife habitat areas. They also serve as the primary method of recharging aquifers to insure a continued supply of water to serve an area's needs. Wetlands also serve to cleanse and purify the water by removing nutrients and other contaminants in storm water runoff.

Minnesota Statutes require counties to identify high priority areas for: 1) wetland preservation, 2) wetland enhancement 3) wetland restoration, and 4) wetland establishment. Clay County has preliminarily identified all wetlands east of State Highway #9 and wetlands located within the shoreland zone as high priority wetlands. The Clay Soil and Water Conservation District (SWCD) is currently spearheading the development of a Comprehensive Wetland Protection and Management Plan. Prior to implementation, the plan needs to be reviewed by appropriate state agencies. Once the review process is completed, the County needs to enact a wetland ordinance to implement the plan. State review is expected to be completed in late 2001/early 2002. Under MN Rules, part 8420.0650, as an alternative to Wetland Conservation Act Rules governing certain wetland impacts, a local governmental unit (LGU), i.e., the Clay SWCD, may develop a comprehensive wetland protection and management plan to provide for alternative standards for the management of wetland resources based on the needs and priorities of the LGU (and county).

Surface Water Quality

The Red River Basin was designated as a study area for a National Water Quality Assessment (NAWQA) in 1991.

The potential for contamination by human activity is high in Clay County from several sources. Agricultural activities have the greatest potential to contribute pollutants to surface water resources. Pollutants would likely include sediment, fertilizers and pesticides. Urban centers and food processing plants also have a potential to pollute surface waters. Treated effluent, coliform bacteria, organics, pesticides and fertilizers all would be possible pollutants. Transportation arteries and pipelines that transect the County represent possible toxic-waste spill sites and discharges of contamination to water sources.

Although pesticides are used extensively in the Red River Valley, only small amounts have been detected in streams. Organic soils, flat land, pesticide degradation and pesticide management limit the amount of pesticide contamination that reaches Red River Basin streams.

Lake water quality in Clay County is a concern. Lake Thirteen and Lee Lake's water quality is listed as threatened, while Silver Lake and Tilde Lake's quality is impaired according to an assessment of lake water quality based on the 1994 Minnesota 305b report to the U.S. Congress. Some streams and rivers are also significantly impacted by land use.

The Red River, Buffalo River, South Branch of the Buffalo River between Whiskey Creek and Stoney Creek and Hay Creek are judged to be impaired. Pollution sources include sediment, feedlots, agricultural chemicals, urban runoff, animal holding/management areas, and septic systems.

Sedimentation is a concern for the County's streams and rivers. These may have been impacted and degraded by increased sedimentation over the past 100 years. High levels of total suspended solids (TSS) in the Red River have raised concern by the MPCA and the City of Moorhead as to continued use of Red River water for domestic consumption. Municipal and commercial facilities also have discharges, which have raised the level of free ammonia in the Red River to levels, which sometimes exceed State and Federal discharge standards.

Overall, the surface waters in the County are generally of good quality with the exception of previously noted water bodies.

Flood Plain

Flood plains often determine the land use around a water body. The DNR administered Floodplain Management Program is intended to minimize the threat to life and property resulting from flooding. This program restricts development in Flood plains by preventing structures from being built at too low an elevation in areas that have a high risk of flooding. It also controls encroachment so the Flood plain's capacity to hold water will not be reduced, causing flooding of even properly located structures. Figure 2-17, *Floodplains*, also shows the 100 and 500-year floodplain in Clay County. According to the 1997 Clay County Water Plan, spring flooding is an annual problem in the Red River Valley. The shape of the Red River Valley is a result of a glacial lake plain as opposed to a river valley. As a result, the floodplain is relatively undefined, and floodwater can spread many miles through municipalities and over fields. This occurred during the spring flood of 1997 when much of the Red River Valley was under water due to overland flooding.

Flooding in the Red River Valley has caused extensive damage in numerous past years as well. According to records, since 1873 , major flooding has occurred in the Red River Basin in 1882-83, 1893, 1897, 1916, 1943, 1947-48, 1950, 1952, 1965-66, 1969, 1975, 1978-79, 1989, and 1997. Due to the flat topography of Clay County, spring flooding often occurs along the Red River and Buffalo River. In addition to the area's relatively flat topography, several factors contribute to the degree of flooding include: greater than normal precipitation; deep frost penetration prior to the first snowfall; greater than normal snowfall in late winter; rapid warming following below normal temperatures in March and April; and greater than normal precipitation during the spring snowmelt. Flooding may occur at other times of the year from saturated soils and higher than normal precipitation.

There are concerns that agricultural drainage is contributing to the severity of flood events experienced in the past few decades. According to the County's Water Plan, these concerns may be warranted as studies indicate that increased streamflow in some eastern North Dakota streams may have been aggravated by drainage activity. For these studies, changes in precipitation patterns do not account for increased streamflow. However, statistics suggest that the increase in drainage area by landowners has caused this effect.

Conversely, a study by J.R. Calton states that no sound hydrologic analyses have been found to support the view that drainage (and other human activities) has had a measurable effect on major flood peaks on the main stem of the Red River at Emerson, Manitoba. Similarly, other studies suggest that large floods are the result of rare combinations of weather conditions, not human activities (i.e., drainage). It is also suggested that drainage of cropland reduces soil saturation, thus infiltration of precipitation is actually increased. It is clear that relationships between flooding and land use are complex. It is also clear that more research is necessary to determine such relationships.

In addition to the obvious monetary damages and threat to human life, flooding has other environmental ramifications. According to the County's Water Plan, flooding can increase risks of water pollution, increase erosion and cause excess sedimentation of surface waters.

Due to its flat topography, the Red River Valley has been susceptible to flooding throughout its geologic history. Further, flooding and associated flood damages will occur in the future. The County should continue to work with the SWCD, watershed districts and others to address future flood concerns.

Ground Water Quantity and Quality

There are three primary aquifers in Clay County; the Buffalo, Moorhead, and Kragnes aquifers. The Buffalo Aquifer is the primary source of groundwater in the County. It is approximately one to eight miles wide and 32 miles long. It lies about five miles east of Moorhead. Glacial sediments overlay more than half the aquifer at a depth from 20 to 120 feet. The thickness of the aquifer ranges from 0 feet at the edges to around 200 feet at the center with the flow generally northward or toward adjacent streams. Pump tests of the aquifer resulted in a decrease in the level of the Buffalo River indicating a direct link between the surface and groundwater resources, thus illustrating the potential for pollution on the aquifer.

Until recently, Moorhead used the aquifer for about 30 percent of its annual water needs while Sabin uses it as a primary water source. Irrigation water is also withdrawn from this aquifer. Sabin and Moorhead also use the Moorhead Aquifer for water supply. Moorhead hopes to decrease annual withdrawals from groundwater to twenty percent of annual demand.

Intense irrigation occurs in Clay County, which is a concern for groundwater quality as most irrigation occurs in the eastern part of the County in areas of sandy soil where aquifers are recharged and easily contaminated. There are concerns that contamination of groundwater is occurring, as there is a combination of irrigation and application of pesticides and fertilizer in these sensitive areas.

Groundwater to streams and wells is mostly from surficial aquifers or those near the land surface or those 100 to 300 feet below the land surface (buried aquifers). Surficial aquifers are more prone to contamination than buried aquifers.

The quality of surficial aquifers is typically a calcium bicarbonate type with dissolved solid concentrations of 300 to 700 mg/l. As water moves toward the Red River or west, these concentrations tend to increase. At the present time, groundwater quality is thought to be of good quality. The Clay County Environmental Health Office offers a comprehensive water well testing program for nitrates and coliform bacteria. The Minnesota Pollution Control Agency and Department of Natural Resources have also been conducting groundwater tests in the County.
Clay County participates in a cost-sharing program for proper sealing of abandoned wells, which has been a priority for several years. The abandoned well sealing program is funded through the Clay County Comprehensive Water Plan and is currently administered by the Clay SWCD. Presently, 114 wells have been properly sealed through this cost share program, and the demand for cost share dollars is strong. As of 1997, only three townships - Highland Grove, Goose Prairie, and Keene had not been inventoried for abandoned wells.

Studies have been conducted on the Buffalo Aquifer due to concerns for potential contamination from abandoned wells, industrial development and land use. The Aquifer has been the focus of a Clean Water Partnership study from 1990 to the present. Only one sulfate level has exceeded EPA recommended limits. All other concentrations are well below EPA limits. Water quality is generally good. Concentrations of nearly all constituents increase towards the west, although not severe. The Moorhead and Kragnes Aquifers have satisfactory water quality.

The Beach Ridge area of eastern Clay County is an area highly susceptible to water resource contamination. Several wells were sampled for nitrates in 1994. Twenty-one percent of those sampled were found to have elevated nitrate levels, while 15% had levels exceeding EPA drinking water limits. The source of contamination has not yet been identified, but was identified as a priority task for the 1997-98 water plan update.

Activities of concern for the contamination of groundwater include gravel mining, improperly sealed wells, major highways, industrial development, petroleum pipelines, railroads, sewage lagoons, and land use on sensitive groundwater areas.

WIND ENERGY

The Upper Midwest has tremendous wind resources and has been called the Saudi Arabia of Wind Energy. Measurements of how hard and how consistently the wind blows show that the southwestern and western parts of Minnesota, in general, have the greatest potential for wind energy. The City of Moorhead constructed a wind turbine in 1999 to capture the wind for generating electricity and is constructing an additional turbine in 2001. In addition, there are three 750 kw turbines operating in rural Clay County on the western edge of Keene Township. These turbines feed into the Excel Energy (the area's electric service provider) grid, providing an alternative energy source for the area.

Moorhead's program is called "Capture the Wind" and generates electricity through the process of capturing the wind. The City provides residents with electricity through it's own public utility department and residents have eagerly supported this endeavor. Customers agreed to purchase a certain amount of electricity that is generated through the wind turbine.

Moorhead State University is the largest customer participating in the program and agreed to purchase 83,000-kilowatt hours of electricity each month at the wind power rate over a period of 10 years. During this time, the University will prevent an estimated 7.3 million pounds of greenhouse gases from being emitted into the air by using wind-generated electricity.

The City's existing wind turbine is a 750-kilowatt turbine and weighs 92 tons. The tower is 180 feet tall and the total height of the turbine is 250 feet. The blades of the turbine each weigh 4 tons and are 78 feet long. The one-third of Moorhead resident's electricity that came from coal, now comes from wind-generated electricity, with the rest from hydro power.

Wind Energy can also be captured on an individual basis. The Minnesota Project conducted a survey of farmers in 1995 that showed nearly unanimous support for wind development, both for environmental benefits and rural economic development. The potential for wind development on marginal farmland particularly interested Conservation Reserve Program (CRP) landowners. Small turbines can be purchased from $6,000 to $30,000 and can produce the energy needed to run a farm. Electricity generated beyond the farm's needs could be sold to a local utility. Minnesota law requires local utilities to buy energy generated from small wind systems (up to 40 kilowatts) at the retail rate.

Wind energy is a resource that is being pursued and studied throughout Minnesota. The Minnesota Department of Public Service conducted a wind resource assessment of annual wind power speeds from 1984 to 1993 at 36 sites around the state. Sites capable of producing more than 320 watts per square meter were determined to be suitable for commercial development for wind energy. The Clay County area falls into this category.

Wind is an endless resource that is never used up. Using wind benefits the environment, as there is almost no pollution associated with producing wind energy. Long-term costs to society are lower than those associated with coal and nuclear energy.