Introduction

In 1984, the Nebraska Unicameral passed legislation requiring the State's natural resources districts to develop groundwater management plans by January 1, 1986. The plan was to evaluate the status of the district's groundwater and develop a procedure for protecting it in to the future. Along with the other 22 NRDs, the Middle Niobrara NRD developed such a plan. At the time the Middle Niobrara NRDs Management Plan was developed, the district had limited background data particularly on the quality of the groundwater. Without the appropriate data it was difficult to put together a plan that accurately reflected the needs of the people and the groundwater resources. At that time, the District's board of directors realized that they had an adequate supply of good quality groundwater and knew they wanted to keep it that way. The district submitted a final plan in 1985. That plan was never approved by the Nebraska Department of Water Resources. Since that time, the NRD has implemented a ground and surface monitoring program that has provided some of the data needed to put together a top quality management plan. Monitoring has pointed out areas of the district that are threatened by contamination from various sources. It has also helped demonstrate the importance of having a management plan in place and the costs that might be involved to carry it out.

We are now in the 90's and the Middle Niobrara Natural Resources District Board and staff feel that major revisions are required to update the District's management plan so that it can best serve the people of the Middle Niobrara NRD. In developing this plan, the Middle Niobrara NRD will utilize data collected both prior to and since the original plan was written in 1985. The district will also utilize knowledge gained from other districts throughout the state as they proceed in carrying out their plans.

Information Gathering and Public Input

Information and data for the plan was collected in 2 stages. Much of the groundwork was developed for the original plan in 1986. This includes information on climate, geology, topography and the groundwater reservoir. Since most of this information is not time sensitive, it is still applicable in 1993. Additional information has been collected since the 1986 plan was authored. This includes baseline data on both groundwater quality and quantity. Groundwater quality data was limited in 1986, so the addition of this data will greatly benefit the development of the plan. In 1989 and 1990, the District undertook an extensive groundwater quality analysis program, with sampling done throughout the NRD. In addition, the NRD has continued to collect water level data from throughout the District. To involve the public in the development of the plan, the district held public information meetings in Ainsworth and Valentine. These meetings were scheduled after the initial draft was completed to gather input from the public on the plan. Meetings were held far enough in advance of the final draft to allow the District's Board of Directors to take the input of the public into consideration when revisions to the plan were made.

A public hearing was held in Valentine on August 9, 1994 to take official testimony on the plan. Other methods used to inform the public on the status and contents of the plan included local newspaper, radio, and the NRD's newsletter which has a circulation of 700 people covering most persons who will be impacted by the management activities.

Background

Bordering South Dakota, the Middle Niobrara Natural Resources District lies in north central Nebraska along a middle stretch of the Niobrara River. The District is made up of the northern two-thirds of Cherry County, western Keya Paha, northern Brown, and a small parcel of western Rock County (see appendix 1). One of the largest NRDs in the State, the Middle Niobrara has an area of 2.9 million acres. 2.7 million acres is rangeland, 200,000 acres is farmland, and the remainder consists of forest, wetlands, and waste ground. (Condition Trends of Nebraska's Rural Lands 1986)

Table 1 – Approximate Area in the Middle Niobrara NRD, by County (Nebraska Statistical Handbook, 1989)

Cherry County	2,396,160 acres
Brown County	389,160 acres
Keya Paha County	167, 040 acres
Rock County	30, 720 acres
District Total	2,983,690 acres

Table 2 – Land Use in the Middle Niobrara NRD (SCS, 1986)

Rangeland	2,719,780 acres
Irrigated crop land	96,400 acres
Non-irrigated cropland	128,900 acres
Forest land	18,400 acres
Other land	20,200 acres
Total	2,983,680 acres

Major communities in the District are Valentine, population 2,826, Ainsworth, population 1,870, Long Pine, population 396, and Merriman, population 151. The total population of the Middle Niobrara NRD is 9,177 people. A majority of the persons living in the District reside in the eastern half of the NRD with most of the NRD being sparsely populated. Average population density across the NRD is 2 persons per square mile, with many of the rural areas under 1 person per square mile.

Table 3 – Population Breakdown of the Middle Niobrara NRD (1990 Census)

Valentine	2,826
Ainsworth	1,870
Other Villages	1,017
Rural	3,464
TOTAL	9,100

The area's economy is almost all related to agriculture, with both rural and urban income linked to farming or ranching. Most of the farming in the District is limited to the area near Ainsworth with a few small pockets scattered throughout the NRD. Most of the land in western Brown, and Cherry Counties are devoted to the production of livestock. Much of this area is unsuitable for crop production due to precipitation, topographic and soil limitations.

In recent years tourism and outdoor recreation has become an important secondary industry in the area. The construction of Merritt Reservoir and increased publicity of the Niobrara River has helped bring thousands of campers, fisherman, hunters, and canoers to the area.

Climate

As is associated with the Great Plains, the Middle Niobrara NRD is in a semi-arid to humid continental climate (Critchfield, 1974). Summers are usually characterized by temperatures in the upper 80s to mid-90s with occasional readings above 100 degrees Fahrenheit. Unlike eastern Nebraska, summer humidity remains low to moderate.

Winter mean temperatures average between 20 to 30 degrees Fahrenheit with the potential for low temperatures to fall well below zero. Temperatures during the spring and fall tend to vary greatly with the passing of weather systems. It is not uncommon to have a 20 to 30 degree change as a front passes through.

Table 4 – Temperature Information (from the U.S. Weather Bureau)

Month	Normal Monthly High Temperatures in Valentine (°F)	Normal Monthly Low Temperatures in Valentine (°F)
January	32	7
February	37	11
March	44	19
April	59	33
May	71	44
June	81	54
July	89	60
August	87	58
September	76	47
October	65	34
November	47	33
December	37	11

Annual precipitation in the District ranges from below 17 inches in the far west to over 21 inches in Brown and Rock Counties. Most of the District's rainfall occurs during the late spring and summer. Summer storms are sometimes intense and result in a wide variance in rainfall amounts. Spring and fall precipitation is usually more general although the total for any given event is normally small. Snowfall for the area averages around 40 inches per season.

Table 5 – Precipitation Data (from the U.S. Weather Bureau)

Average Annual Precipitation

Ainsworth 21.9 inches

Valentine 17.1 inches

Merriman 17.2 inches

Normal Monthly Precipitation at Valentine (inches)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
0.28	0.52	0.83	1.82	2.86	2.97	2.42	2.42	1.42	0.83	0.41	0.33

Topography and Vegetation

Approximately sixty percent of the district is part of the large Nebraska Sandhills Region (see appendix 3). This area is characterized by large sand dunes which until as recently as 500 years ago were very active changing size and shape as the wind acted on them. The establishment of grass and other vegetation has stabilized the movement of these dunes. Located in the northern and western portion of the NRD, the Niobrara River tends to act as a natural boundary for the Sandhills with same dunes extending north of the river in western Cherry County.

The Niobrara River valley runs east-west across the NRD and forms a deep canyon made up of various breaks and drainages (see appendix 3). Formed by the cutting of the river, and its numerous tributaries, the canyon has but through the Ogallala Sandstone into the Pierre Shales. Many of the canyon slopes are now lined with pine trees, with stretches of oak, birch and other hardwoods. In general, hardwoods are limited to the eastern portion of the NRD.

North of the Niobrara River in western Keya Paha and eastern Cherry County, lies a 200,000 acre area known as the Dakota/Nebraska Eroded Tableland (see appendix 3). This plain is nearly level to gently rolling with steeper slopes along streams and drainage ways. Unless plowed for agriculture, warm season grasses are the predominant vegetation.

The Ainsworth table is an area located in western Rock, and northern Brown Counties (see appendix 3). The 60,000 acre region is nearly level with numerous subirrigated meadows and wetland areas. Because of the soil types and topography, this area is well suited to crop production.

An eastern extension of the Northern Pandhandle Tableland extends into the Middle Niobrara NRD (see appendix 3). Located along the Cherry-Sheridan County line, this area is characterized by nearly level to tolling hills and comprises approximately 13,000 acres. The topography and sandy loam soils make this area well suited to crop production and as a result, much of the native rangeland has been converted to small grain and row crop production.

Geology

The geology of the Middle Niobrara Natural Resources District can be generally discussed in two sections, the first is activity that took place prior to the formation of the Sandhills and the second, a discussion on the formation of the Sandhills themselves.

Most of the early geological activity took place during the Cretaceous Period some 65 to 100 million years ago (see appendix 34). It was during that time period that shallow seas covered the great plains region and sediments were deposited that now form the Dakota Sandstones and Pierre Shales. As the water receded, these deposits because subject to weathering from wind and

water (Bleed and Flowerday, 1989). Today, the Pierre Shale is the oldest exposed formation in the district, generally occurring in the eastern third of the NRD along the Niobrara River. The Dakota Sandstone, although not exposed, does serve as a secondary aquifer north of the Niobrara River (Flowerday, 1986).

During the Tertiary period from 25 to 65 million years ago, the White River and Arikaree groups, which include the Chadron, Brule, and Gering Formations were deposited (see appendix 34). The White River group, which consists of sandstone and siltstone, are windblown volcanic deposits believed to have originated in present day Colorado (Bleed and Flowerday, 1989). In western Cherry County the White River Group reaches a thickness of over 1,000 feet and the top of the formation serves as the base of the main aquifer. The White River group serves as a secondary aquifer in the District. The Arikaree group overlies the White River Group and consists of fine grained sandstones. It serves as a primary aquifer in western Cherry County.

The most recent formation is the large Ogallala Group, deposited in the later stages of the Tertiary Period some 5 to 19 million years ago (see appendix 34). The Ogallala formed as a result of several episodes of stream erosion that occurred following the formation of the Arikaree group. Fine sands, which originated from the mountainous areas of Wyoming and Colorado, accumulated into what because a large sedimentary basin. The Ogallala ranges from 100 to 180 feet in thickness, and its sandstone formation are a prime source of groundwater in the Sandhills (Bleed and Flowerday, 1989).

Most of the waterways as we see them today began their formation some 20,000 years ago. As the final pulse of the Wisconsin Ice Age retreated, it shaped the Niobrara River canyon. Prior to this time, the Niobrara River is believed to have been three times as wide as it is today (Bleed and Flowerday, 1989).

The development of the Sandhills is a relatively recent event. Evidence indicates that the Sandhills were first created during dry periods 5,000 to 10,000 years ago as winds blew sands deposited in the late Tertiary and early Quaternary periods (see appendix 34). During this time it is believed that limited precipitation (estimated at less than 10 inches per year), prevented vegetation from stabilized the dunes causing them to be very active. Dunes went through a period of stability then became active again as the climate became drier. WE are presently in a period of stability which began approximately 1,500 years ago. Many experts have theorized that the Sandhills will again go into an active period as the climate becomes drier (Bleed and Flowerday, 1989.)

Soils

The Sandhills, the largest of the four topographic regions in the district, is comprised of two general soil associations, the Valentine and the Valentine-Tryon-Els. The Valentine association are deep,

nearly level to hilly, excessively drained sandy soils formed in eolian sand (Hammer, 1989). Although similar, the Valentine-Tryon-Els Association includes the wetter sandhills valleys consisting of deep somewhat poorly to very poorly drained sandy soils formed in sandy alluvium. These two associations are found in nearly 75% of the district Their fragile nature and steep slopes make them unsuitable for farming and they are usually limited ' to grazing and hay production (see appendix 4).

The Ainsworth Table, a large generally level area in northern Brown County, consists of several soil associations including: Valentine-O'Neill-Pivot, Johnstown-Jansen and Jansen-O'Neill-Meadin (see appendix 4). Generally, these soils can be described as level to strongly sloping, well to excessively drained, sandy and loamy soils that are deep to shallow over sand and gravel on Uplands. The Loup-Els-Tryon Association is found on drainage ways and are poorly drained, deep, loamy, and sandy soils. (Hammer 1989). With appropriate soil conservation and fertilizer management these soils can produce respectable yields with a minimal loss of topsoil.

The Dakota-Nebraska Eroded Table, the topographic region north of the Niobrara River in eastern Cherry and Western Keya Paha Counties, consists of the Valentine-Tassel soils ere gently sloping to steep, well drained sandy soils that are formed in windblown material or sandstone residuum. The Tassel-Duda-Ronson soils tend to be shallower and contain loamier soils than do the Valentine-Tassel soils (Plantz and Zink, 1980). Agricultural activities with this region include: livestock grazing, hay production, and corn production where sufficient irrigation water can be secured.

The Niobrara Canyon region, an area characterized by its rough broken landscape, consists of the Tassel-Mariaville-Ronson Association in the eastern portion of the NRD, and the McKelvie-Tassei-Inavale Association in the west (see appendix 4). These soils are described as; shallow to moderately deep steep to very steep, well drained, sandy, loamy and silty soils formed in the residuum of sandstone and siltstone (Piantz and Zink, 1980). Limited fertility and steep slopes generally make these soils unsuitable for agricultural activities.

Two other areas of the NRD contain soil association that be noted. Along the western edge of the district near the Sheridan-Cherry County line lies area of deep, nearly level to strongly sloping, well drained loamy--soils in the Tuthill-Busher Association. These soils are well suited to dryland and irrigated agriculture and do have some small grain and com production. There is also an area of nearly level to strongly sloping, excessively drained and well drained sandy to loamy soils located in the north central part of Cherry County. Valentine-Hennings-Sandose and the Valentine-Duda soil associations dominate this area (Hammer, 1989).

The Groundwater Reservoir in the Middle Niobrara NRD

Two Primary Aquifers, the Ogallala and Arikaree, are the major sources of groundwater for 90%

of the Middle Niobrara NRD. Secondary aquifers include the Dakota and White River.

The aquifers of the Ogallala group provide the primary source of water for the Sandhills region. Tertiary sandstones, sands, and gravels makeup the groundwater reservoir. The saturated thickness of the Ogallala Aquifer ranges from 100 to over 500 feet (see appendix 5). The groundwater reservoir has the greatest saturated thickness along the southern boundary of the NRD where it has been estimated to be from 600 to 700 feet. Closer to the Niobrara River, the thickness of the groundwater reservoir reduces to less than 100 feet. Movement of the groundwater is generally towards the southeast, with the exception of groundwater near the Niobrara River which expectantly moves towards the waterway. The lateral movement of groundwater in the Sandhills has been estimated from 5 to 500 feet per year. Movement would be much greater near pumping wells and streams (Bleed and Flowerday, 1989). The base of the primary aquifer ranges from 3,300 feet in northwestern Cherry County to 1,900 feet in Brown County.

Because of the wide variance in Sandhills topography, the depth to the water table varies dramatically from being at the surface to over 100 feet to water (see appendix 6). The sandy soils do allow for ample groundwater recharge even though most of the area receives less than 20 inches of precipitation per year. The high transmissivity of the sands and gravels (from 20,000 to over 100,000 gallons per day per foot), means that the aquifer is capable of supporting high yielding wells normally associated with irrigation (see appendix 9). The topography and soils have limited irrigation development, thus the aquifer remains mostly undeveloped except for occasional center pivots used to irrigate alfalfa or grass.

Perhaps the most important resource that the Ogallala Aquifer provides is as the source of water for wetlands, lakes, and streams. Sandhills wetlands and lakes are low areas that are totally dependent on groundwater for their existence. As the water table rises or declines, it has a direct impact on surface water in the Sandhills. It is believed that the groundwater acts as a regulator, slowly releasing water during drier periods reducing the impacts of many short term droughts (Bleed and Flowerday, 1989). Sandhills streams are also dependent on groundwater. Streams that have cut below the level of the regional water table act as drains for groundwater.

The water quality of the Ogallala Aquifer in the Middle Niobrara NRD is normally very high. Nitrates in wells monitored by the NRD in 1989, that are not being impacted from agricultural or domestic sources, were all below 2 parts per million (ppm). Chlorides, phosphorous, and dissolved solids were also very low (see appendix 24).

A second primary aquifer, the Arikaree, is located along the Cherry/Sheridan County line along the Niobrara River. The aquifer is an important source of water in northwest Nebraska but it is limited to approximately 75,000 acres in the Middle Niobrara NRD. It does however act as a source of water for domestic and agricultural purposes in that part of the NRD. The sandstones of the Arikaree group make up the aquifer which has a saturated thickness of 20 to 60 feet (see

appendix 5). Because of its close proximity to the Niobrara River the groundwater tends to flow towards the river. Transmissivity is under 20,000 gallons per foot per day which is considered not very suitable for high capacity wells (see appendix 9). Around 35 irrigation wells located in the Middle Niobrara NRE) presently utilize the aquifer as a source of Water. Depth to water ranges from 50 to 200 feet (see appendix 8). Water quality in the Arikaree formation tends to be that of the Ogallala. All samples collected by the Middle Niobrara NRD in 1989 had nitrate levels below 3 ppm.

Cretaceous sandstones form the Dakota Aquifer, a secondary aquifer in the Middle Niobrara NRD. It is utilized mostly for stock and domestic Wells in Western Keya Paha County where the Ogallala formation thine or no longer is present. Saturated thickness of the Dakota aquifer ranges from nonexistent to around 60 feet (Flowerday, 1986). Depth to the water table ranges from 150 to over 200 feet. The aquifer has a low transmissivity of under 20,000 gallons per day per foot. High yielding wells can be developed but are usually limited to small areas. Wells pumping in close proximity can impact each other's- performance. Water quality is acceptable in most cases, however not comparable to that of the Ogallala aquifer. Groundwater from the Dakota aquifer is highly mineralized and tends to be alkaline.

Another secondary aquifer in the District is the White River group. Although this formation is not usually considered a source of dependable groundwater, cracks and fractures produce seeps and springs along the Niobrara River in eastern Cherry and western Keya Paha Counties. It serves as a source of water for livestock and some farmsteads may depend on these seeps as a source of domestic water.

Uses of Groundwater in the Middle Niobrara NRD

The most widespread use of groundwater in the Middle Niobrara NRD is for watering livestock. Since the State of Nebraska did not require stock wells to be registered prior to 1993, it is impossible to determine the exact number of stock in the District. Reviewing 260,000 acres of rangeland, the District calculated that the average stock well supports approximately 370 acres. Utilizing this figure, it can be estimated that 7,300 stock wells exist in the NRD.

Perhaps even more difficult than determining the number of livestock wells in the District, is the volume of water they withdraw from the groundwater reservoir. Normally livestock wells are used intermittently throughout the year depending on the presence of livestock. Since most stock wells are wind powered, weather conditions impact pumpage. The average stock well pumps about 8 gallons per minute. If the average well is used 60 days per year, then the 7,300 livestock Wells in the NRD withdraw approximately ‘15,000 acre-feet of groundwater annually.

In 1986I SCS estimated that 96,000 acres of cropland was irrigated in the Middle Niobrara NRD (SCS, 1986). Surface water sources account for 41,000 acres, meaning that approximately 55,000 acres is irrigated from groundwater. Registered well data compiled by the Nebraska

Department of Water Resources indicated that as of January 1, 1992, there were 856 registered wells in the District (see appendix 17). However, many of these wells are no longer used, abandoned in the 1980's as a result of poor economics and the Conservation Reserve Program. Thirty-five to percent of these wells may longer be in use. When abandoned, landowners often fail to report their status to the State. Assuming that 18 inches of water per acre is applied annually, 82,500 acre feet of groundwater would be withdrawn for irrigation in the District. Corn and alfalfa are the largest irrigated crops in the District. Other irrigated crops include: milo, soybeans, potatoes, grass, and small grains. Corn generally requires 25 to 30 inches of moisture per season to produce a crop. Other crops (soybeans, sorghum, potatoes, and small grains), generally require less water because they are more efficient and/or their growing season is shorter. Depending on rainfall, farmers will apply from 15 to 30 inches of water during a growing season. Factors that impact the amount of irrigation Water applied include: soils, type of system, and efficiency. Gravity systems tends to use more water than center pivots. This is particularly true in areas with sandy soils as a considerable amount of water is needed to "push" the water from the top to the bottom end of the field. Center pivots allow for much higher efficiency having the ability to apply water evenly across the field.

All domestic water used in the district is supplied by groundwater. In 1985, the NRD determined that communities in the district used 1,800 acre-feet annuity. 3,600 of the Districts 9,100 residents live outside communities and depend on private wells to supply their domestic water needs. Assuming that the average person uses 200 gallons of water per day, the total annual Water use for rural District residents is 800 acre-feet.

Other uses of groundwater in the district include: manufacturing, light industry, and fisheries production. Their total water use is minimal and has a limited impact to the groundwater supply. The District's 1986 groundwater management plan estimated that 75 acre-feet per year was used for manufacturing outside municipalities.

Table 6 – Estimated Annual Groundwater Use in the Middle Niobrara NRD (in acre-feet)

Irrigation Wells	82,500
Livestock Wells	15,000
Domestic Wells	800
Other Wells	75
TOTAL USE	99,375

The Impact of Groundwater to the Area Economy

Groundwater is highly important to the economic base of the Middle Niobrara NRD. Groundwater used to irrigate crops has increased and helped stabilize yields. Some crops such as corn and potatoes could not be grown without the use of irrigation water in most years. To see the economic impact irrigation has to the area, one can compare Brown County which has an ample supply of groundwater to nearby Boyd County where groundwater is limited or absent. Even though Boyd County had 100 more farms in 1986, farm income for that year was $4,246,000 compared to

$8,959,000 in Brown County (Nebraska Department of Economic Development, 1989).

In addition to irrigation, groundwater supplies water for stock wells in the District. There are approximately 250,000 cattle grazing on rangelands in the Middle Niobrara NRD. The cattle alone represent from 16 to 20 million dollars. This does not include the jobs created by the livestock industry. Hay is needed to feed the cattle during the winter months. In 1988, 68,000 tons of alfalfa hay was harvested in Cherry County (Nebraska Department of Economic Development, 1989). If ranchers were required to buy this hay from outside sources, the cost would approach 1 million dollars. In addition to alfalfa, much of the native grass hay grown in the NRD is harvested from meadows sub-irrigated by groundwater.

In recent years recreation and tourism has become an important addition to the area economic base. Key attractions include canoeing the Niobrara River and fishing area lakes and streams. In 1992, the Fish and Wildlife Service estimated that 45,000 persons canoed the Niobrara River beginning at the Fort Niobrara Wildlife Refuge. Assuming that each person on the river represents 50 dollars spent in the area for items such as gas, canoes, lodging, and food, 2.2 million dollars was added to the area economy. Groundwater is essential to tourism and recreation as it maintains river and lake levels throughout the year, particularly during the summer months when flows in other waterways in the Great Plains will not support canoeing.

Groundwater Recharge

Due to the sandy nature of the soil, groundwater recharge rates in the Middle Niobrara NRD are very high, particularly considering the limited precipitation that occurs. Information put together for the District's 1986 groundwater plan indicated that the average annual recharge across the NRD ranges from 1/2 to 6 inches per year. The average districtwide is about 3.2 inches per acre. The highest annual recharge occurs in the southeast portion of the NRD in Brown County. The eight townships located in the Ainsworth area have an average annual recharge rate of 4.8 inches per acre. This is a result of the higher precipitation rates that occur in the eastern end of the NRD. Ironically, the lowest recharge occurs only a few miles to the north in Keya Paha and eastern Cherry Counties, where recharge rates are below 1 inch per acre per year. Layers of less permeable sandstone and siltstone do not allow water to percolate to the aquifer as easily as in other parts of the NRD. Recharge rates in most of the central and western regions of the District range from 3 to 4 inches per acre annually.

Table 7 – Estimated Annual Groundwater Use Verses Recharge in the Middle Niobrara NRD (in acre-feet)

Estimated Total Recharge	775,000
Estimated Total Water Withdrawals	99,375
Estimated Surplus Recharge	675,625

In the event that the groundwater reservoir is being depleted by excessive withdrawals, one option often considered is artificial recharge. There is no doubt that artificial recharge is physically possible. The groundwater reservoir underlying the area served by the Ainsworth irrigation District

has increased dramatically since the completion of that project (see appendix 14). In general because of the physical size of the aquifer it appears that the impact of an artificial recharge project would be negligible. It would seem that if areas of the District are experiencing declines due to excessive withdrawals, reducing those withdrawals to allow natural recharge to replenish the aquifer would be the most feasible option. There may be some potential for artificial recharge in those areas of the NRD where natural recharge is lower such as the Dakota-Nebraska Table region.

Correlation of Groundwater to Surface Water

Perhaps there is no place in Nebraska where the connection between ground and surface water is more evident or important than in the Sandhills. Essentially all naturally occurring surface water in the District is a result of groundwater. When developing a plan for managing the groundwater resource, the impact to surface water must be considered. Changes in the quality or quantity of surface water has an impact on wildlife, fisheries, vegetation, ranching, and farming operations. Utilizing data from the "Nebraska Sandhills Cooperative River Basin Study" (USDA, 1989) it can be determined that approximately 287,000 acres of wetlands are present in the Sandhills region of the Middle Niobrara NRD. This includes lakes, marshes, riparian areas and sub-irrigated meadows. Exact acreages are hard to determine as climatic condition- have a dramatic impact on surface Water. Lakes that are 2 to 3 feet deep one year may be no more than a marsh the next. Water levels in wetlands/lakes, are generally the highest during the spring and decline gradually throughout the summer as evapo-transpiration increases. Hummocky terrain causes groundwater mounds to form, directing groundwater flow towards the low areas and minimizing seepage, thus resulting in standing water in low areas of the Sandhills.

Table 8 - Estimated Wetlands in the Middle Niobrara NRD (USDA 1989, Game & Parks, 1977)

Lakes	16,300 acres
Sub-irrigated Meadows	260,000 acres
Marshes	9,700 acres
Riparian Areas	1,000 acres
TOTAL WETLANDS	287,000 Acres

Sandhills lakes and marshes serve as important habitat for wildlife, particularly migratory waterfowl. Because of the quality and relatively cool temperature of the water, they support many species not found in other Nebraska water sources. In addition to wildlife habitat, Sandhills lakes provide an important source of livestock water. They also support recreational fishing both on public and private lands. Lakes located on the Valentine National Wildlife Refuge are an important fishing resource for both the area and state. Most of the sport occurring in Sandhills Lakes have been introduced for that purpose.

A Nebraska Game and Parks Commission inventory completed in 1977 indicated 95 natural lakes existed in the Sandhills portion of the NRE) totaling 16,300 surface acres of water,

although acreage varies depending upon climatic conditions. (Game and Parks, 1977). These lakes are typically very shallow averaging around 3 feet in depth. Shorelines are generally undefined with vegetation encroaching into open water.

It has recently been decided that manmade ponds resulting from overflowing livestock tanks may have some value to Wildlife (Bleed and Flowerday 1989). Water in tanks and associated ponds tends to be cooler and fresher than water in lakes thus supports plants and organisms that will not survive elsewhere. ln areas where no lakes or wetlands are present, many insects normally associated with open water thrive due to the presence of these manmade ponds.

Sub-irrigated meadows are an important part of the Sandhills environment. They support plants that require constant soil moisture for growth. These areas provide food and cover for wildlife. Sub-irrigated meadows are also important to ranchers in the Sandhills. Because plants growing in sub-irrigated meadows are provided moisture throughout the summer, they provide a reliable source of grazing and hay. Hay particularly is important to ranchers as it becomes their- source of winter feed. Using data collected by the USDA' in 1989 for the Nebraska Sandhills Cooperative River Basin Study, it can be estimated that 260,000 acres of sub-irrigated meadows are present in the Middle Niobrara NRD.

Rivers and streams in the Middle Niobrara NRD are almost totally dependent on groundwater for their existence. It has been estimated that groundwater makes up 80% of the flows in the major streams of the District. Using data from the Gordon, Sparks and Mariaville gaging stations on the Niobrara River, it can be estimated that 700,000 acre-feet per year leaves the NRD with over 600,000 acre-feet generated from sources in the Middle Niobrara NRD (USGS, 1992). Eighty-five percent of the flow (520,000 acre-feet) generated in the Middle Niobrara NRD is the result of groundwater (Bleed and Flowerday, 1989). As waterways cut deeper channels they will tend to increase flows largely because more springs are exposed and the streams become longer.

Table 9 - Total Annual Streamflows in the Middle Niobrara NRD (USGS, 1992)

Plum Creek	85,490 acre-feet
Long Pine Creek	107,200 acre-feet
Minnechaduza Creek	24,710 acre-feet
Snake River (at Doughboy)	119,500 acre-feet
Snake River (at Burge)	111,000 acre-feet
Niobrara River (at Gordon)	82,590 acre-feet
Niobrara River (at Berry Bridge)	557,000 acre-feet

Table 10 - Estimated Annual Streamflows Attributable to Groundwater in Middle Niobrara NRD (Bleed & Flowerday, 1989)

Plum Creek	75%	84,120 acre-feet
Long Pine Creek	80%	85,760 acre-feet
Minnechaduza Creek	80%	19,800 acre-feet
Snake River (at Burge)	80%	89,280 acre-feet
Niobrara River (at Berry Bridge)	90%	500,000 acre-feet

Rivers and Streams in the District provide a wide variety of benefits. Riparian areas serve as sources of water and cover for livestock and wildlife. Many streams provide excellent sources of game and non-game fisheries. For example, Long Pine Creek is considered one of the best trout streams in the state. Several endangered or threatened species of fish exist or potentially exist in some district streams. They include: Finescale Dace, Blacknosed Shiner, Pearl Dace, and Northern Red-bellied Dace (see appendix 32 & 33). Because all the streams in the NRD that support these fish are dependent on groundwater for flows, the fish may be affected by changes in groundwater levels. Lower portions of the Niobrara River are potential habitat for migratory birds particularly cranes, terns, and piping plover. Bald Eagles are known to frequent the Niobrara River during certain times of the year. In recent years, recreation has become more and more popular. In 1992, the Fort Niobrara Wildlife Refuge used an electronic counter and determined that 44,000 people used the portion of the Niobrara River going through the refuge. Other streams such as Long Pine Creek and Snake River provide recreational fishing opportunities.

MANAGEMENT POLICY

Quantity

The groundwater resource in the Middle Niobrara Natural Resources District is unique compared to most of the state. Because of the high recharge rate, particularly in the Sandhills, water tables tend to be highly variable and will fluctuate with yearly precipitation. District observation wells indicate that a year or two of below average precipitation can potentially result in a one foot or more drop in groundwater levels. The opposite would be true for years of above average precipitation.

The dramatic impact of the climate on the groundwater reservoir makes it more to determine the impact of man on this resource, as well as establishing goals and objectives for this management plan. In many parts of Nebraska, you can simply establish benchmarks that when reached, trigger specific management activities. However, in the Middle Niobrara NRD establishing these benchmarks is extremely difficult as severe declines may be a result of a drought cycle rather human influenced phenomenon. Misuse of this resource by man could produce tragic consequences.

To formulate a groundwater reservoir life goal for groundwater quantity, the impact of climate and the environment must be taken into consideration. With this in mind, the district establishes the following goal:

IT SHALL BE THE GOAL OF THE MIDDLE NIOBRARA NATURAL RESOURCES DISTRICT TO FOREVER MAINTAIN THE PRESENT LEVEL OFV GROUNDWATER WITHIN HISTORIC NATURAL FLUCTUATIONS THAT OCCUR.

Objectives

l. Monitor the status of the district's groundwater levels a minimum of once annually.

2. Collect and incorporate precipitation data into the district's well monitoring efforts.

3. Increase district education efforts stressing the importance of maintaining the historic groundwater level and the impact that groundwater has on the area environment.

4. Develop an information and education program demonstrating the importance of water conservation and methods for reducing water use.

5. Working with the appropriate agencies, better determine how changes in surface Water (wetlands, wet meadows, rivers, and streams) relate to changes in groundwater levels.

6. Monitor changes in surface water and incorporate data into the well observation program.

7. Closely monitor well registration activities to determine areas that experience increases in well installations.

8. Determine the district staffing and funding requirements needed to carry out the groundwater quantity management plan.

9. Utilize regulatory authority under the Nebraska Groundwater Management and Protection Act, when necessary, to manage areas displaying moderate groundwater level declines.

Threats to Groundwater Quantity in the Middle Niobrara NRD

Presently there appears to be no activity that threatens the quantity of the District's groundwater supply. The district has been monitoring groundwater levels since 1975. From 1975 to 1990, wells measured by the Middle Niobrara NRD rose an average of 2.5 feet. Data collected for the District's 1986 groundwater management plan determined the average annual recharge from precipitation throughout the NRD was 3.8 inches. The highest rates were in the Sandhills and the lowest in Keya Paha County where soils restrict percolation (see appendix 10).

The 1980 irrigation withdrawals were compared against the annual recharge throughout the District and it was determined that only 5 townships had well equivalents in access of the recharge rate for those townships. All 5 townships were located in northeast Cherry and Keya Paha Counties (see appendix 19) in the remainder of the NRD the recharge rate was far greater than 1980 withdrawals.

That research also evaluated potential irrigable acres and compared them to the recharge rate and it was determined that 51 out of 141 townships in the NRD had the potential for irrigation withdrawals to exceed recharge. Most of the 51 townships were located in northeast Cherry

County, Keya Paha County, and Brown County (see appendix 21). It should be noted that when determining recharge rates for Brown County the impact of imported surface water provided through the Ainsworth Irrigation District was not included in the calculation (Nebraska Natural Resources Commission, 1982).

In Nebraska the greatest threat to groundwater supplies has been withdrawals for irrigating farmland. The information outlined in this section would seem to indicate that over much of the Middle Niobrara NRD the potential for irrigation depleting the groundwater reservoir is minimal. In those areas of the NRD where the potential irrigatible ground is less than what average recharge would support, it would appear that to jeopardize the groundwater reservoir wells would have to be installed at very high densities, perhaps as part of a domestic or industrial well field. In recent years there has been some, speculation and concern that large municipalities in need of domestic water may target the Sandhills as a potential source. To date no such effort to acquire water has been made. Studies done in 1987 by the now defunct State Water Management Board indicated that under present conditions moving water through a pipeline became cost prohibitive after 150 to 200 miles. Because of the distance of the Middle Niobrara NRD to metropolitan areas such as Denver and Kansas City, it appears the threat of municipal well development in the District is minimal under present conditions. As the demand for water increases and economics change, this may not be true in the future.

Irrigation appears to be a potential threat to groundwater levels in those 51 townships where irrigable lands would exceed the average annual recharge rate. According to 1980 information, only 5 of those 51 townships presently have greater withdrawals than recharge can support. Since 1975, the District has monitored 7 wells in those 5 townships. During this time period, 6 of those 7 Wells have displayed increases in groundwater levels (see appendices 11 & 19).

Current Groundwater Quantity Management Activities

The Middle Niobrara NRD measures water levels biannually in approximately 45 wells throughout the district (the number varies slightly from year to year). Most of these wells were first measured in 1975 (see appendix 11). Water level records are updated and published in the District's Annual Report. In addition, the Ainsworth irrigation District has monitored water levels in their service area since 1966 (see appendix 13). Water level data has also been collected by the Fort Niobrara and Valentine Wildlife Refuges on their lands. Both agencies make their data available to the District when requested.

Well registration information is kept on file by the District. Copies of the registrations are provided to the NRD by the Nebraska Department of Water Resources. Prior to 1993, all wells which pump in excess of 100 gallons per minute are required to be registered with the State. These documents provide information such as location, static water levels, depth of the well, purpose of the well, pumpage rate, and well logs. As new wells are drilled, copies of the registrations are forwarded to the NRD.

During the 1980s, the District was a participant in the Long Pine Rural Clean Water Program. This is a federal program that provided cost share incentives to landowners that implemented water quality and quantity protection practices. One of the more popular Best Management Practices (BMPs) were irrigation reuse many were installed through the help of this program and

will help to reduce the use of groundwater. The RCWP program ended in 1992.

The Nebraska Soil and Water Conservation Program is another existing source of cost share assistance for landowners in the Middle Niobrara NRD. In addition to assistance to construct reuse pits, the program would provide cost share to install surge valves. These valves improve the intake efficiency of surface irrigation systems.

Over the years, the District has provided information to the public about the importance of conserving water. This is done through news releases, radio interviews, and articles in the District's quarterly newsletter.

Managing Groundwater Quantity in the Middle Niobrara

Under the present conditions, threats to groundwater quantity in the Middle Niobrara NRD appear to be minimal. Over the past 6 to 8 years only a small number of new wells have been drilled in the NRD. Throughout much of the District, projections indicate that the groundwater reservoir could support some development with minimal impact to Water levels (see appendix 21). The district's quantity groundwater management plan will consist of Collecting data to monitor the resource and learn more about groundwater in the Sandhills and outlining the actions that will be taken in the event that groundwater levels are threatened as a result of non-environmental activities. It will also better educate the public on the present condition of the resource, why it needs to be protected, and what can be done to assure that water levels are maintained. Specific management practices to be implemented include:

- The District will continue to monitor water levels throughout the NRD on a bi-annual basis. Monitoring results will be shared with the USGS for use in their statewide monitoring effort. To improve the program, the District will look at methods to obtain additional water levels from those parts of the NRD that are not adequately covered. This might include adding additional existing wells or the installation of monitoring wells. To better determine how precipitation affects groundwater levels, the district will begin collecting annual precipitation data. Data will be obtained from the U.S. Weather Bureau and local Weather observers. This will allow the District to detect changes in groundwater levels and better determine the cause of the changes.
- Beginning in 1996, the District, in conjunction with the U.S. Fish and Wildlife Service, Soil Conservation Service, University of Nebraska, and other agencies, will select 3 to 5 wetlands and monitor naturel changes in surface water levels. As the water levels fluctuate, the impact to the wetland ecosystem will be monitored. This project will incorporate groundwater level and precipitation data to determine changes on surface water. Data collected through this project will be important in determining the impact changes in groundwater levels have on wetlands. Water levels can decline before they impact wetlands. This information will be important if future development threatens groundwater quantity and the NRD considers options to protect the resource. Information gathered could also prove beneficial to ranchers providing them insight on how to best manage wetlands.
- The district will continue to maintain records on registered wells located in the NRD. The Department of Water Resources provides the NRD with well registrations for all wells

drilled in the district. This includes irrigation wells, private domestic wells, livestock wells, monitoring wells, industrial wells, and wells used for public water supplies. These wells are mapped and well registrations are kept on file, allowing the District to detect any trends in well development that might occur and if it is determined that the increase in pumpage could threaten water levels, the appropriate actions will be put into place.

- Encourage the voluntary use of water conservation measures by irrigators. This could include installing irrigation reuse pits, adopting irrigation scheduling, installing flow meters on wells, or utilizing surge valves for gravity irrigated fields. To promote the use of Water conservation practices, the District may provide cooperators with access to equipment, provide technical assistance, or utilize cost share incentives. In many cases, practices that conserve Water also help reduce the leaching of nitrates and other soluble chemicals into the aquifer. Because of documented declines in groundwater quality, the District will be embarking on an aggressive effort to protect groundwater quality. By promoting and in some cases requiring the use of management tools which will help reduce groundwater contamination, they will also be protecting groundwater quantity.
- The district will routinely Collect and update groundwater withdrawal data. Withdrawals for this plan were calculated by using pumpage and acreage data available on well registrations. To simplify calculations, this information was converted into well equivalents. Each well equivalent represents 150 acre feet of groundwater. The total number of well equivalents for each township is multiplied by 150 acre feet to determine the total groundwater withdrawal for that township. Initially, the withdrawal data developed for this plan which' used ' well registration information will be used districtwide (see appendices 18-22). That data will be updated by reviewing registrations and reviewing the status of those wells and the acres irrigated. The district will also begin collecting annual pumpage data where it is available. Where deemed appropriate, the district will assist irrigators in the collection of this data providing necessary expertise and/or equipment. Because of the size of the NRD and number of wells involved, updating will begin with areas with the most intense irrigation and areas declared as groundwater level watch areas. The entire district will be reviewed and updated within five years following approval of the plan.
- Recharge-data was developed for this plan by utilizing data from maps developed by the University of Nebraska Conservation and Survey Division, to develop the maps factors such as precipitation, soils, geology, and hydrology were considered. One inch of recharge over a township is approximately equal to 1,700 acre feet of groundwater annually, which will supply 11 well equivalents. Recharge calculations were done district wide and data compared to annual withdrawal data to develop policy. Recharge data will be reviewed every 5 years, however it is not anticipated dramatic changes will occur. Withdrawal and recharge calculations as outlined in this plan are intended to reflect average conditions over time. They are not intended to reflect conditions and changes that may occur on any given year.
- The District will develop an information and education program that will provide the public with more opportunities to learn about groundwater and its importance to the District. Much of program will focus on the impact that groundwater has on Sandhills lakes,

wetlands, and sub-irrigated meadows. Information will be provided to users of groundwater on what they can do to use groundwater more efficiently.

Four audiences will be targeted: irrigators and other high quantity users, agricultural businesses, domestic water suppliers, and youth. Programs geared towards irrigators and Ag businesses will include information on the District's groundwater program and educational items on using water more efficiently. Efforts designed for youth and domestic water users will be general education items on the importance of groundwater and using it more efficiently.

Several methods for conveying information to the public will be utilized. The primary source wiil be the NRD newsletter which is mailed on a quarterly basis to over 800 people and businesses throughout the District. News releases will also be utilized particularly when disseminating information about the NRD program. Public meetings will be used when it is necessary to convey key information about the management program. For educating youth, the District will utilize conservation days, and water fairs. The NRD has recently purchased a groundwater model to help tell the story about groundwater.

- The District will work with the Nebraska Game and Parks Commission to monitor the presence of Threatened or Endangered plant and animal species in the NRD. Protecting groundwater quantity and quality has several benefits, including the protection of the habitats of the threatened plant and fish species confirmed to occur in the District (see appendices 32 & 33). Any groundwater management activities proposed this plan could have some impact on these species.

Should specific adverse effects on these species- from changing groundwater levels be identified, it may be necessary to modify the groundwater management plan in the future. Any modifications, which could include actions such as: data collection, voluntary management activities, or regulatory activities, should be targeted at maintaining a groundwater level that will reduce adverse effects to these species and must be consistent with the Nebraska Groundwater Management and Protection Act.

Establishment of Groundwater Level Watch Areas

- The District will establish Groundwater Level Watch areas in those parts of the NRD where groundwater levels have the potential to be threatened by non-environmental activities. This could include: agricultural wells, industrial wells, or well fields for public: water supplies. A watch area will be established when the following condition is met:
- Estimated average annual groundwater withdrawals from wells in a defined area exceeds 50% of the estimated average annual recharge for the same area. Withdrawal and recharge information will be determined as outlined on page 22. Since watch areas will not include regulatory activities, using general withdrawal and recharge data is acceptable.
- The watch area will be established within 6 months after the 50% or baseline trigger has been met. A public hearing will be held prior to establishment of the watch area.

The district‘s board of directors may also choose to establish groundwater level watch areas in

areas of the NRD where groundwater levels are being threatened but conditions do not meet the above criteria. This could include: proposed well fields, user conflicts, interference between existing wells. Public notice and a public hearing would be held prior to watch area establishment.

Any watch area cannot be smaller than 36 square miles and boundaries will consist of townships, county lines, NRD boundaries, Irrigation Districts, watersheds, and/or waterways.

Areas where it has been determined that a continuous and reliable source of artificial recharge is maintaining groundwater levels, will not be designated as watch areas.

Once established, the Middle Niobrara NRD will implement the following actions in the designated watch area:

- Review and refine groundwater withdrawal data. This will be accomplished by doing field checks to determine the status of existing registered wells contacting well owners to obtain use and pumpage data. If the watch area was established using the withdrawal method, and the review determines that the area did not exceed the 50% baseline, the watch status will be dropped.
- Establish e well monitoring network with a minimum density of one well per six square miles. Use existing wells or install monitoring wells if necessary. To produce accurate data, monitoring wells will be distributed as evenly as possible throughout the district. Wells will be monitored a minimum of two times per year.
- Use data collected to determine if boundaries that have been established for the watch area are adequate or need to be adjusted to better reflect the concern.

Develop an information and Education Program that will focus on the following areas:

- Provide information to the public regarding the reasons for the watch designation and how the NRD plans to address the concern.
- Increase educational efforts in the watch area, informing groundwater users on how they impact the resource and what they can do to use water more efficiently.
- Provide groundwater users in the watch area greater access to cost share, technical assistance, and management tools such as flowmeters, surge valves, and irrigation scheduling.
- Withdrawal and recharge data will be updated a minimum of once every five years. If it is determined that annual average withdrawals in all or a portion of the watch area have fallen below 50% of the annual recharge, the watch area status will be dropped for the area meeting this criteria.
- A baseline groundwater level will be established for the watch area. The baseline will be determined by calculating the average static water level in the watch area using the 25 year period ending on the year which the groundwater watch area is established. The primary source of groundwater level data for calculating the baseline will be the groundwater level monitoring. Wells measured by the district (see appendices 11 and 12). If it is determined that water level data from the monitoring wells is not adequate to calculate the baseline,

secondary sources of data could include Wells monitored by other agencies or Weil registration information.

- Review program annually to determine effectiveness

General Outline for the Establishment of Groundwater Management or Control Areas

- A groundwater control or management area will be established in all or part of a watch area if one of the following occurs:
- If average groundwater level declines in wells monitored by the district totals 2 feet in any 4 continuous calendar years, and during that same period the average groundwater level is below the established baseline.
- If the average water level monitored by the district stays below the baseline for 12 consecutive years.

The establishment of a management or control area will allow the use of additional regulatory authorities and will allow the NRD the option to levy additional property taxes to help fund the administration of a management or control area. Prior to establishing a groundwater management or control area, the district would update its groundwater management plan. In that update changes in the groundwater resource or its use would be documented; A timeframe for the establishment of a management or control area would be outlined; and the activities to be implemented in the proposed area described the following management activities would be initiated in the control or management area:

- All watch area activities
- Require well permits on all new and replacement wells above 509pm
- Require well spacing greater than feet for irrigation wells
- Require groundwater users (including irrigators, municipalities and industries) to report annual usage
- Require the use of approved flow measuring devices
- Establish limits or allocate water use
- Review program annually to determine effectiveness

In addition, one or more of the following management activities could be implemented in all or a portion of a control or management area as deemed appropriate:

- Require reporting of irrigated acres
- Require the use of 1 or more best management practices approved by the district. This could include:
    - Irrigation/use scheduling
    - Switch to more efficient equipment or production methods
    - Incorporate devices that reduce water use

- Utilize/produce more water plants or products
- Switch to alternative sources of water
- Perform efficiency tests on pumps and/or distribution equipment
- Other BMPs approved by the district

- Require groundwater users to develop and implement a water use management plan.

Establishment of Groundwater Level Watch Areas

In Cherry and Keya Paha Counties

Presently 10 townships in the Middle Niobrara NRD meet the criteria for the establishment of a Groundwater Level Watçh Area (see appendix 22). The largest' area is located in Keya Paha County, with other townships located in Cherry, Brown, and a small portion of Rock Counties. The townships in Keya Paha and Cherry Counties are located in areas where groundwater is limited, thus the aquifer is unable to support a large number of irrigation wells. The townships in Brown and Rock Counties are located in an area that has good supply of groundwater, however because the area is well suited for row crop agriculture, a large number of irrigation wells have been drilled over the years resulting in a high level of withdrawals. Much of this area is presently being irrigated with surface water from the Ainsworth Irrigation District, which provides a reliable and continuous source of artificial recharge. Data collected from this area indicates that the aftificial recharge has raised the static water level.

On July 10, 1995, the following townships were designated as Groundwater Level Watch areas:

Area 1	Area 2
Twp 34N, 28W	Twp 33N, 22W
Twp 35N, 28W	Twp 34N, 22W
	Twp 34N, 23W
	Twp 34N, 24W
	Twp 34N, 25W
	Twp 35N, 22W
	Twp 35N, 23W
	Twp 35N, 24W
	Twp 35N, 25W

See map in appendix 33

During the period from July 10, 1995 to December 31, 1996, the following activities will take place in the areas designated:

- Groundwater withdrawal data will be reviewed and information updated to better reflect actual conditions. District staff will review well registrations and contact landowners regarding the status of wells and their use.

- Monitoring wells will be established to meet the 1 per 6 square mile density requirement. Wells will be spaced across the area as evenly as possible to achieve the most accurate results. Wherever possible existing Wells will be used. If necessary the installation of new monitoring wells will be considered.
- An information and Education program will be developed. Most of the program will be devoted to informing the public on the problem and how the NRD plans to address the concern. Because of the limited number of landowners involved much of work will be done with personal contacts and mailings.
- As appropriate, additional technical assistance will be provided to groundwater users.
- As additional data is collected, it will be determined if the Groundwater Level Watch Area boundaries should be Changed or adjusted to better reflect the potential problem.
- A baseline groundwater level for each watch area will be established by calculating the average water level in wells monitored by the district from the period beginning in1970 and ending in 1994.
- Annually review program to determine effectiveness
- If average water level declines in wells monitored by the district drop 2 feet in any 4 continuous calendar years, and during the same period the groundwater level is below the baseline; or the average groundwater level in wells monitored by the district stays below the baseline for l2 consecutive years, a groundwater management or control area will be established within 18 months from the time the trigger is reached. In addition to the watch area activities, the following actions will be included in the plan:
    - Require well permits on new and replacement well above 50 gpm
    - Establish a minimum well spacing requirement of no less than 1,000 feet for new irrigation wells
    - Require irrigators, municipalities, and industries to provide the NRD with annual water use data
    - Require irrigators to provide the district with irrigated acreage data
- Require irrigators to develop and implement groundwater use management plans that incorporate two of more of the following BMPs:
    - Utilize irrigation scheduling
    - Install and use surge valves
    - Install and use drop nozzles on irrigation systems
    - Utilize low pressure irrigation systems
    - Perform efficiency tests on pumps and irrigation systems
    - Install and use irrigation reuse systems
    - Switch from gravity to more efficient sprinkler irrigation
    - Rotate to more drought tolerate crops or crop hybrids
    - Other BMPs as approved by the district
- Require other groundwater users to develop and implement water use management

plans incorporating standards established by the district

- Require wells to be metered or equipped with another approved flow measuring device
- Establish limits or allocations on the use of groundwater

In all or a portion of the groundwater management or control area the district could require:

- The use of more restrictive groundwater use limits or allocations
- Require irrigators to implement additional BMPs
- Require groundwater users to develop and implement a water use management plan incorporating additional BMPs or more restrictive standards

The townships identified in Brown and Rock Counties will not be designated as watch areas as data collected by the NRD and Ainsworth irrigation District has indicated a substantial increase in the static groundwater level over the past 25 years.

Program Administration and Funding

The implementation of the activities proposed to protect the District's groundwater resource from depletion will not require a significant staffing or funding increase unless a management or control area is required. Many of the activities area presently being done by existing staff. Some additional funding may be required for specific projects such as the proposal to research water level changes in wetlands and implementing Watch Area activates. If the district would choose to utilize incentive programs such as equipment rental or cost share additional funding would be necessary. Many of the activities being proposed for this section can be carried out by the additional staff that well be required to administer the quality portion of this plan.

Most of the groundwater in the Middle Niobrara Natural Resources District is of good, to excellent quality. Although the sandy soils have a high potential for groundwater contamination, the absence of pollutants has helped maintain near pristine conditions in many parts of the NRD. There are some areas of the district that are beginning to show an increase in levels of contaminants, particularly nitrates (see appendices 24, 25, St 26). The most notable area is located in western Rook and eastern Brown Counties. This area has been under intensive crop production for over 25 years. Agricultural fertilizers are the most likely source of the nitrates found in this regions groundwater. To stop further degradation of this resource, some form of intensive groundwater quality management must be implemented for this portion of the district.

Because of the high potential for groundwater contamination in parts of the district with sandy soils and/or shallow aquifers, special management activities must be considered for those areas (See appendix 35). Areas with a moderate to high potential for agricultural development should also be given special attention in the plan.

Developing a groundwater reservoir life goal for quality presents an interesting challenge. Since parts of the district have water quality at or near pristine conditions, one is tempted to strive to bring all the groundwater back to this level. However, considering that other portions of the district already demonstrate nitrate contamination that appears to be approaching the state standard (10 ppm), this is not a realistic goal. Conversely, establishing the state standard as a goal for managing

nitrate levels would not be appropriate management for those areas, of the district where groundwater contains little or no contamination. Therefore the following goal will be established:

IT SHALL BE THE GOAL OF THE MIDDLE NIOBRARA NATURAL RESOURCES DISTRICT TO FOREVER MAINTAIN THE PRESENT GROUNDWATER QUALITY, WITH THE EXCEPTION OF THOSE AREAS WHERE CONTAMINANT LEVELS HAVE EXCEEDED STATE STANDARDS, WHERE THE DISTRICT WILL STRIVE TO REDUCE CONTAMINANT LEVELS TO MAKE THE WATER SAFER FOR ALL PUBLEC USES.

To achieve this goal several objectives have been established as follows:

Objectives

1. Continue well monitoring throughout the district, sampling wells in the network a minimum of one time every two years with increased monitoring in concern areas.

2. Identify the existing point source and nonpoint source pollution threats to the groundwater resource in the district.

3. Determine the level of contaminants and their movement through the vadose zone.

4. Increase general information and education efforts focusing on the present quality of water in the NRD and how good quality water can be maintained.

5. Establish a district wide well abandonment program. Utilize education and financial incentives to encourage landowners to properly abandoned wells.

6. Monitor the development of new wells in the District.

7. Determine the realistic potential for future degradation of the resource and utilize that information when developing the management plan.

8. Develop management schemes that encourage the voluntary use of management practices by landowners to protect and enhance the quality of the district's groundwater.

9. Utilize authorities provided NRDs under the Nebraska Groundwater Protection Act to manage areas of the district displaying present or the potential for groundwater quality problems.

10. Take into consideration critical water supplies in the district when developing the management plan.

11. Develop an information and education program directed at residents of cities and villages to make them more aware about the groundwater resources and what they can do to protect it.

12. Determine the staffing and administration requirements that will be necessary to carry out the plan. Identify potential sources of funding.

Threats to the Groundwater Resources in the Middle Niobrara NRD

Because of the abundance of sandy soils in the Middle Niobrara Natural Resources District, there is moderate to high potential for groundwater contamination throughout most of the NRD. The groundwater resource has remained of high quality largely because few sources of contamination exist. The greatest threat to groundwater quality in Nebraska has been the application of fertilizer on farm ground. Fertilizers, pesticides, and other chemicals utilized to grow more and higher

quality crops, often compromise water quality by leaching to the aquifer.

The production of row crops expanded across much of Nebraska in the 20th century largely because of the use of irrigation. Unlike most of the state, the Sandhills was spared from development because of two important factors: the sandy soils were not considered fertile enough to produce economic yields, and the steep rolling topography did not allow for a method of providing irrigation water to the crops. Even the center pivot, which can be utilized on moderate slopes, would not be economically and/or physically adaptable for use in most of the Sandhills today. As economics change, more areas of the Sandhills may become targeted for the development of row crop agriculture. It does appear that a large portion of the Middle Niobrara NRD will remain immune from development En the foreseeable future as the topography will not allow for economically farming those areas.

There are areas of the district that presently exhibit decreases in groundwater quality which appear to be the result of the application of nitrogen fertilizer on` agricultural crops (see appendix 26). In addition, other parts of the district may not presently have any quality problems, but have the potential for problems as a result of existing or future development. Since the use of nitrogen fertilizer on crops poses the greatest threat to groundwater quality in the Middle Niobrara NRD, the management plan will focus strongly on areas of the district where farming operations are present or areas displaying the greatest potential for future development. This approach will allow for the most efficient use of district funds and staff.

Another potential source of groundwater contamination in the Middle Niobrara NRD is the over-application and misuse of lawn fertilizers and chemicals. It is believed that in many cases the amount of fertilizer applied by a homeowner can be equal to or greater than the amount applied on row crops. The District's management plan will address this concern.

When protecting the groundwater resource, it is important to identify the point source pollution threats that exist. In the Middle Niobrara NRD the most common point source threats include: Sanitary landfill sites, fuel storage sites, grain handling facilities, feedlots, septic systems, and miscellaneous manufacturing faculties (for detailed list of potential point source pollutants see appendices 27-30). Although none of these point sources pose a threat to groundwater over a large area, many of them are associated with cities or villages where they could jeopardize public water supplies. Water monitoring efforts should take these sites into consideration. Options such as well head protection programs should be considered if it is determined that a threat to public water supplies exists.

Current Groundwater Quality Management Activities

Over the last decade, water quality management has been increased throughout the State. In the early 1980's, the Middle Niobrara NRD became a major participant in the Long Pine RCWP. This program provided cost share incentives to landowners who install Best Management Practices (BMPs) that help reduce the threat of contamination to both surface and groundwater. Nearly 1 million dollars of financial assistance was provided to cooperators in the 325,000 acre Long Pine Creek Watershed. Practices that impacted groundwater quality included: fertilizer management, integrated pest management, and irrigation water management. These 3 practices were implemented on 23,000 acres in the watershed over the decade. The RCWP project ended in 1992.

Part of the Long Pine Watershed was approved for federal Water Quality Improvement Project in late 1992. This will provide $200,000 in cost share assistance to landowners who implement practices that reduce the potential for groundwater contamination. Best Management Practices will be similar to that of the RCWP effort. This program, which will run for 3 years, will be limited to the Ainsworth Irrigation District Service Area.

The Middle Niobrara NRD has been cooperating with the University of Nebraska Cooperative Extension Service since 1989 on residual nitrate sampling in the District. This program which includes much of North Central Nebraska, involves collecting soil samples and developing fertilizer recommendations for landowners. Participants in the program have increased steadily over the years. In 1992, 180 cooperators were involved in the program. The Extension Service estimates that the program has reduced the applications by 15 to 100 pounds per acre per year. To continue this effort, the District applied for and received a $60,000 grant through the federal 319 program. This will help fund the project through 1996.

In 1986, the Nebraska Chemigation Act was signed into law. It requires that irrigation systems used to apply chemicals be permitted and have the proper safety equipment installed. The District is required to administer the program on the local level which includes inspecting the safety equipment on a regular basis. In 1992, the District handled 218 chemigation permits. Proper chemigation reduces the risk of backflows, and allows more efficient use of fertilizer.

The District monitored groundwater throughout the NRD in 1988 and 1989 (see appendix 24). Around 80 irrigation and domestic wells were monitored during the 2 year period. In addition to district wide monitoring, the NRD has assisted DEQ with groundwater monitoring in the Long Pine Creek watershed since 1980 (see appendix 25). This effort which was associated with the RCWP project and involved sampling 20 to 30 wells on an annual basis. To increase the quality of the District's monitoring effort particularly in the Ainsworth area, the NRD is cooperating with the Nebraska Department of Environmental Quality and USGS to install 11 monitoring in the Long Pine Creek watershed area. Wells were completed in 1993 and each site will allow for collecting samples at 2 or 3 different depths. DEQ and USGS will collect samples for 3 years after which the NRD will have access to the wells. The data collected will give the NRD an excellent picture of the groundwater quality in the eastern portion of the District.

Managing Groundwater Quality in the Middle Niobrara NRD

There is a long list of contaminants that could pose a threat to the District's groundwater. The realistic potential for a specific contaminant to degrade groundwater in the NRD varies depending on use, storage conditions, leaching potential, etc. In an effort to reduce this list to a manageable number of potential contaminants, the NRD has developed an inventory of those contaminants that are used or are known to exist within the district (see appendix 31), This list was further reduced by dividing contaminant into two categories: High potential for contaminating groundwater and low potential for contaminating groundwater (see appendix 31). Factors considered when placing contaminant into either category included: solubility, leaching potential, presence or use in the District, and breakdown period. Note: This list does not include nitrates which will be managed as outlined in the section entitled "Nitrate Management Program"

The Middle Niobrara NRD'S groundwater duality plan will focus on those contaminants

identified as having a high potential for contaminating groundwater. Periodically, the list will be reviewed and if the status of a contaminant changes or new contaminants are identified, they will be considered for removal or inclusion as deemed appropriate. Management activities outlined in this section are the minimum actions to be taken and the NRD could choose to require additional actions as deemed appropriate.

- The district will establish a biennial monitoring program for ail contaminants in the high potential category. All samples will be sent to laboratories equipped to analyze them for the contaminants in this category. To reduce the cost of water analysis, the district may choose to limit monitoring for some contaminants to areas where they are used or stored. There will be no regular monitoring program for contaminants in the low threat category.
- The district will monitor and manage pesticides in conjunction with the State Department of Agriculture's Pesticide and Groundwater State Management Plan
- If a specific contaminant is detected in an amount greater than 50% of the established maximum contaminant level (MCL) in 50% of the wells monitored by the district across a specific area, a groundwater management or special protection area Wilt be established within 18 months from the time the 50% baseline is reached. Areas used for this calculation will generally be townships or groups of townships displaying similar topography, soils geology, and hydrology. River or streams having an impact on groundwater flows may also be used as boundaries where appropriate. Activities in the groundwater management or special protection area would include:
    - Increased monitoring in area affected to a minimum of once annually.
    - Require permits for new and replacement wells above 50 gpm (groundwater management areas only)
    - Identification of sources and users of the contaminant
    - Require reporting use of products containing the contaminant
    - Information program outlining the district's plan for addressing the concern, programs available to users of the contaminant, and what actions will occur in the event that contaminant levels continue to increase.
    - Education program outlining the potential health hazards, risk to the environment, and how the threat can be reduced.
- Require users of products containing the contaminant to use 1 or more BMPs approved by the district. These might include:
    - Adopting techniques that use the product more efficiently
    - Switching to alternative products '
    - Monitor soil and water for levels of the contaminant
    - Switch/rotate to crops that require lesser amounts of the contaminant
    - Monitor pests to determine if and when it is appropriate to use contaminant
    - Utilize biological or mechanical methods of controlling pests
    - Other BMPs approved by the district
- Require reduction or discontinued use of the contaminant or products containing the contaminant.

- Require users of products containing the contaminant to be certified
- Review program annually to determine effectiveness
- If a specific contaminant is detected in an amount .greater than 100% of the established MCL in 50% or-more of the wells monitored by the district across a specific area activities will include:
    - All of the activities listed above
    - Require users of products containing the contaminant to periodically monitor groundwater, surface water, or soil to determine levels contaminant present
    - Require users of products containing the contaminant to implement additional approved BMPs
    - Greater restrictions on use of products containing contaminants
    - Review program annually to determine effectiveness

In the event no MCL has been established for a contaminant that monitoring determines to be present in groundwater, the NRD will consult agencies such as EPA, DEQ, the Department of Health, and the University of Nebraska for expertise on setting a threshold.

Presently, water quality monitoring indicates that the only contaminant that has reached the 50% of the MCL baseline in the Middle Niobrara NRD is nitrates. The highest levels of nitrates are found in Brown County and Rook County from Johnstown to the Middle Niobrara - Upper Elkhorn NRD boundary. Sampling has indicated that nitrate levels are nearing or have exceeded the MCL in several wells. The most likely source of the contamination is fertilizer applied on row crops as the area is extensively irrigated farmland. Other locations in the NRD are also showing elevated levels of nitrates, which needed to be addressed in this plan.

Nitrate Management Program

At this time, nitrate contamination has been identified as the maior threat to the District's groundwater. Much of the groundwater quality management plan Witt focus on the reduction of point and nonpoint sources of nitrogen. Many of the management activities that will be implemented for the reduction of nitrates, will also reduce the threat from other contaminants.

Establishment of Groundwater Management Area For Nitrates

Within 18 months from the date the groundwater management plan is approved, the entire district will established as a groundwater management area for nitrates. Activities in the in the groundwater management area will include those listed below. Any required actions will not be implemented until the groundwater management area is established. It is anticipated that the annual cost to administer the management area to range from $25,000 to $40,000 annually. The district would have the authority to levy an additional 1.8 cents per 100 dollars of valuation- in the designated area to provide additional funding for administering the management area. It will be necessary for the NRD to utilize the additional taxing authority at some time in the future.

Establishment of Management Zones

For the purpose of addressing nitrate contamination in the Middle Niobrara Natural NRD, management zones will be created effective July 1, 1996. These zones will allow the District to

tailor management to the potential for groundwater contamination in a specific area. It will also allow the NRD to channel its funding and staffing resources to those parts of the District with the greatest need. Areas used for calculating nitrate levels 'and establishing zones must be a minimum of 36 square miles and boundaries will normally follow state, NRD, county, or township boundaries. The board has the discretion to utilize natural, geologic, or hydrologic boundaries if deemed appropriate. Once an area/zone is defined, it will remain intact unless data suggests a portion should be treated as a separate unit or merged with another area/zone. Management Zones will be defined as follows:

Management Zone l

Less than 50% of the wells monitored by the District have nitrate levels above 5 ppm; and less than 20% of the land has been developed for cropping (see appendix 37and 38)

Management Zone 2

Less than 50% of the wells monitored by the District have nitrate levels above 5 ppm; and 20% or more of the land has been developed for cropping (see appendices 37 and 38)

Management Zone 3

50% or more of the wells monitored by the District have nitrate levels greater than 5 (see appendix 38)

Management Zone 4

50% or more of the wells monitored by the District have nitrate levels greater than 10 ppm (see appendix 38)

Management Zone Activities

Management Zone 1

- Require permits prior to drilling any new or replacement wells pumping greater than 50 gpm
- A network of wells will be monitored biennially (see appendix 36). All samples collected will be analyzed for nitrates. In addition, wells will be analyzed for the presence of pesticides that are commonly used in the area. Because of cost, the NRD will limit pesticide analysis to those areas where pesticides are known to have been utilized. As part of the monitoring program, the district will use accepted collection, storage, and shipping practices for quality control and assurance of samples. When necessary, the NRD will seek training from appropriate agencies such as the Department of Health and DEQ. Initially, all samples will be sent to water testing laboratories. If, in the future the district determines it practical to use field analysis, an appropriate number of samples will continue to be sent to appropriate laboratories to check the accuracy of the field analysis. As results of monitoring are evaluated, the district may choose to increase the number of samples collected particularly in those parts of the NRD demonstrating potential problems. A minimum goal of 3 monitoring wells will be established in each 36 section township in the NRD. Wells will be selected to present the most accurate portrayal of the aquifer as possible and attempt be evenly distributed across a given area. The district will attempt to utilize irrigation wells wherever possible. In some areas it may be necessary to utilize domestic, stock, or other wells. The district may choose to install monitoring in

areas with limited existing wells or to provide more accurate data. Data from these wells be used to determine average contaminant levels which will be used to set management zone boundaries and establish baseline data.

- Document the installation of new and replacement wells. Well registrations are presently received from the Department of Water Resources and documented by the District. Maps are used to plot registered wells in the NRD. This process allows the NRD to detect any trends in development that would occur. In the event an increase in well development is discovered, the NRD will be able to initiate the appropriate actions to assure the groundwater is adequately protected.
- Assist with the implementation of the WQIP project in the Ainsworth Irrigation District service area. This program includes cost share incentives to install best management practices (BMPs) that target improving water quality. Planned management activities will include: Fertilizer Management, irrigation water management, and, pesticide management.' These practices, will help reduce the threat to the groundwater resource in Brown County. It is also critical that it is being implemented in the Ainsworth Irrigation District where most of the irrigation water `is imported surface Water and not groundwater. Since the use of groundwater is limited in this area there is little opportunity to utilize nitrogen present in the groundwater. As a result, any excess nitrogen that leeches from the root zone will continue to build up in the groundwater. _
- Begin collecting fertilizer, pesticide and water use data from district producers. Data will be used to develop a baseline and help determine the types and extent of the programs needed to increase the efficiency of crop inputs and will also help identify where the highest potential for groundwater contamination exists. Information will be collected on annual basis providing the district with a year to year record and evaluate trends. Initial information will be collected in conjunction with existing projects such as WQIP and RCWP records.
- Encourage producers to voluntarily implement one or more of the following best management practices:
    - Collect and analyze soil samples annually to determine the amount of residual nitrogen available in the root zone. Utilize data to develop fertilizer recommendations for crop yield determined to be realistic for the existing growing conditions.
    - Collect and analyze deep soil samples (2' to 4') biennially to determine residual nitrogen available to the crop. Use data collected when calculating fertilizer recommendations.
    - Collect and analyze groundwater samples on an annually to determine the amount of nitrogen that may be available to the crop. Use data collected when Calculating fertilizer recommendations.
    - Limit or eliminate applying nitrogen fertilizer from September lst to October 31st on cropland to be planted the following spring
    - Apply fertilizer in smaller amounts throughout the growing season. This could include the use of techniques such as applying fertilizer during cultivation or with irrigation water.

    - Calculate and monitor irrigation Water use by utilizing flowmeters, hour meters or other methods approved by the district.
    - Utilize water conservation practices such as: irrigation scheduling, 'reuse' pits, surge valves, low pressure sprinklers, and system shutoffs to apply irrigation water more efficiently.
    - Develop a water use management plan for ail irrigated acres.
    - Additional BMPS approved by the district
- Begin assembling land use data for the district. Utilize existing data and technology such as GIS if and where available. Data will initially collected in areas where cropland density is highest. Land use data will be valuable in determining areas where potential exists for groundwater contamination end can also be used to establish boundaries for management or special protection areas.
- Establish activities outlined for management zones when implemented on July 1, 1996. This would include adding any necessary additional staff, equipment, providing information to affected producers etc.
- Increase District education efforts on groundwater and groundwater quality. The NRD presently has or cooperates on several groundwater education programs which will continue. There will be four main target audiences for the NRD's groundwater education program: Youth, agricultural producers, Ag product dealers, and the residents of communities. The district will incorporate a variety of methods to deliver information to target audiences including: news releases, radio programs, meetings, demonstrations, displays at fairs and expos, and the NRD's newsletter.
    - Youth programs would include water fairs, 4H programs, school programs, providing schools with the appropriate resources, and workshops for teachers. Although programs would be developed for all age groups most of the activities would be geared for grades 4 through 8. Past experience has demonstrated that these are the ages when students are most receptive to learning about the environment and are forming values that will be carried into adulthood.
    - Programs for agricultural producers would focus on understanding groundwater and what they can do to prevent groundwater contamination. Techniques for proper application of chemicals would be one of the major components of the program.
    - Programs for Ag chemical dealers would update them on the status of the District's groundwater program and inform them about the management programs that are in place. Information will promote the use of University of Nebraska fertilizer and pesticide application recommendations. Cooperation from the Ag chemical dealers will be important to the success of the program as they will be working with the producers on a direct basis. Their cooperation could 'help reduce the over-application of Ag chemicals on a voluntary basis reducing the need for mandatory regulations. -
    - General information would also be provided to city residents to better understand groundwater and the potential threats to the resource. Some specific programs would include the proper use of lawn and garden chemicals, identifying point sources pollution threats, and proper disposal of wastes. The district will utilize

area newspaper to disseminate information about the proper application of lawn and garden chemicals.

- Develop a well abandonment program. Program to include the identification of abandoned wells throughout the entire district. The District would work with the area well drillers to identify unplugged wells and educate the public on the proper procedure for abandonment. A cost share incentive would be used to promote the proper abandonment of wells. Open unplugged wells serve as a potential conduit for contaminants to get from the surface to the groundwater. Licensed well drillers will be used to better assure that wells are abandoned in accordance to State standards. Establishing a well abandonment program will accelerate the plugging of those wells, better protecting the groundwater resource.
- Annually review program to determine effectiveness

Management Zone 2

- All management zone 1 activities
- A voluntary fertilizer management program will be implemented beginning with the 1997 growing season. The program will use residual soil nitrogen and nitrates in the irrigation water to develop fertilizer recommendations. Fertilizer recommendations will be based on University of Nebraska research, which will be encouraged but not required under the voluntary program. The program will expand on the WQIP effort in the Long Pine Watershed, and the North Central Nebraska residual Nitrate Program. The start of the NRD's voluntary program will coincide with the completion of both of these programs and will essentially act as a continuation of these efforts. Initially, the District would provide staff to assist with the project. As the program progresses, it is hoped that in many cases private consultants or individual producers would provide these services. Because of the isolated nature of some Wells, it should be anticipated that the NRD might have to provide assistance continually to these areas. In addition to the development of fertilizer recommendations, the participants would be asked to provide the NRD with residual nitrogen, fertilizer application, and yield data. This information would be used to better track nitrogen use, as well as develop some base information in the event mandatory programs are necessary. It is hoped that the desire of producers to protest the groundwater supply and reluctance for mandatory regulations will provide the major incentive for producers to become involved with the program. Initially the District may consider additional financial incentives (cost share) to stimulate participation in the voluntary program. After the program is sufficiently in place the financial incentives could be reduced or dropped. If enough producers participate in the program on a voluntary basis, hopefully the amount of nitrates in the groundwater could be reduced or stabilized without the need for mandatory fertilizer restrictions.
- The District will develop a program to evaluate the vadose zone for movement of nitrates and pesticides. The data collected will be valuable in determining the potential for additional contamination to the groundwater reservoir and in some cases identify areas where future degradation of the resource could be anticipated. It will also serve to evaluate the effectiveness of management practices that have been implemented. Most of the vadose

zone work will be concentrated in areas where sources of nitrates and pesticides already are present.

- Implement information program that promotes the districts voluntary programs and the assistance available to producers. It will also disseminate information regarding the status of the groundwater management program and nitrate levels in the groundwater. In order for the voluntary program to work effectively, it will be important to keep the public informed. By encouraging voluntary participation the need for mandatory regulation will hopefully be reduced or if required the acceptance would be higher.
- Observation wells in management zone 1 will be monitored a minimum of once every other year. Observation wells in all other management zones will be monitored minimum of once annually. Additional monitoring will be done if determined to be necessary.
- On an annual basis the District will review the results of ground water quality analysis and note any increases in development throughout the District. The district will adjust boundaries in accordance to the following criteria:
    - If nitrate levels in any management zone increase above the established maximum allowable level for that zone for a period of 2 consecutive years, area will be moved into the next higher management zone. The board may choose to move the entire zone or a smaller area into the higher management zone if deemed practical and supported by- appropriate data.
    - If nitrate levels in any management zone decreases below the established level for that zone for a period of two (2) consecutive years, area will be placed into the next lower management zone. The board may choose to move the entire zone or a smaller area into the lower zone if deemed practical and supported by appropriate data.
    - If more than 20% of the land in a township or portion of a township in a management zone 1 becomes developed for cropping, those areas will be placed in management zone 2.
- Annually review program to determine effectiveness

Management Zone 3

- All management zone 1 and 2 activities
- Require producers to report annual fertilizer use
- Require producers to provide district with annual water use date
- No application of nitrogen fertilizer during a period beginning on September 1st and ending on October 31st on cropland to be planted the following Spring
- Require producers to complete a nitrogen management certification course once every 4 years
- Require producers to develop management plans that address fertilizer and irrigation water management
- Require producers to implement two or more best management practices from the approved list (see page 41)
- Require producers to monitor residual soil nitrogen levels and develop nitrogen fertilizer recommendations using realistic yield goals. Soil analysis must be done by a

laboratory/consultant approved by the district. Recommendations must be developed by a laboratory/consultant or procedure approved by the district.

- Review program to determine effectiveness

Management Zone 4

- All management zone 1, 2, and 3 activities
- Require soil sampling and fertilizer recommendations on all cropland. Applications must be in accordance to University of Nebraska recommendations. Producers will be required to provide the district with documentation that supports compliance with this requirement.
- Require irrigators to analyze groundwater for nitrogen and reduce fertilizer applications accordingly.
- Require producers to implement at least 3 best management practices from the approved list (see page 41)
- Review program annually for effectiveness

Program Administration and Funding

The groundwater quality management program described is an aggressive program to better assure the District quality management goals will be met in order to carry out the plan the Middle Niobrara NRD will be required to invest additional staff time and funds. It is estimated that preliminary management period activities will require up to 1,000 staff hours annually. Once the full plan is put into place in 1996, the total staff time will increase to a minimum of 2,000 hours which means the district should expect to have one staff member handling the program on a full time basis by 1996. Depending on the complexity of the program in 1996, the Districts financial commitment would increase significantly.

Costs could include staffing, basic administration, equipment, and cost share programs. Potential sources of funding for the management program would include: general property taxes, fees, and outside grants. Because of the Middle Niobrara NRD'S limited tax base, in order to accomplish the plan grant funding may play a key role in funding the program.

REFERENCES CITED

Bleed, Ann and Flowerday, Charles, 1989, An Atlas of the' Sandhills-University of Nebraska Lincoln, Conservation and Survey Division, Resource Atlas Number 5, Lincoln, Nebraska, 238 pages.

Boohar, Hoy and Steele, 1992, Water' Resources Data Nebraska, Water Year 1991: United State Geological Survey, Water Data Report`NE91-1, Lincoln, Nebraska, 354 pages.

Critchfield, Howard, 1974, General Climatology: Prentice-Hall Inc., Englewood Cliffs, New Jersey, 446 pages.

Fìowerday, Charles, 1986, The Groundwater Atlas of Nebraska: University of Nebraska Lincoln. Conservation and Survey Division, Lincoln, Nebraska, Resource Atlas Number 4, 32 pages.

Hammer, Roger, 1989, Conversation regarding Cherry and Brown County Soils.

McCarraher, D. Bruce, 1977, Nebraska Sandhills Lakes: Nebraska Game and Parks Commission, Lincoln, Nebraska, 67 pages.

Nebraska Department of Economic Development, 1989, Nebraska Statistical Handbook 198889: Nebraska Department of Economical Development, Lincoln, Nebraska, 313 pages

Nebraska Natural Resources Commission, 1982, Policy issue Study on Groundwater Reservoir Management: Nebraska Natural Resources Commission, Lincoln, Nebraska, 88 pages.

Nebraska Water Management Board, 1988, Report on the Water Transfer Study: Nebraska Water Management Board, Lincoln, Nebraska,.

Piantz, Merritt, and Zink, Richard, 1980, Soil Survey of Keya Paha County, Nebraska: United States Department of Agriculture, Soil Conservation Service, Lincoln, Nebraska 225, Pages.

United States Department of Agriculture, Soil Conservation Service, 1986, Condition and trends of Nebraska's Rural Land: Soii Conservation Service. Lincoln, Nebraska, 24 pages.

United States Department of Agriculture Soil Conservation Service, 1989, Nebraska Sandhills Cooperative Basin Study: USDA Soil Conservation Service, Lincoln, Nebraska, 166 pages.

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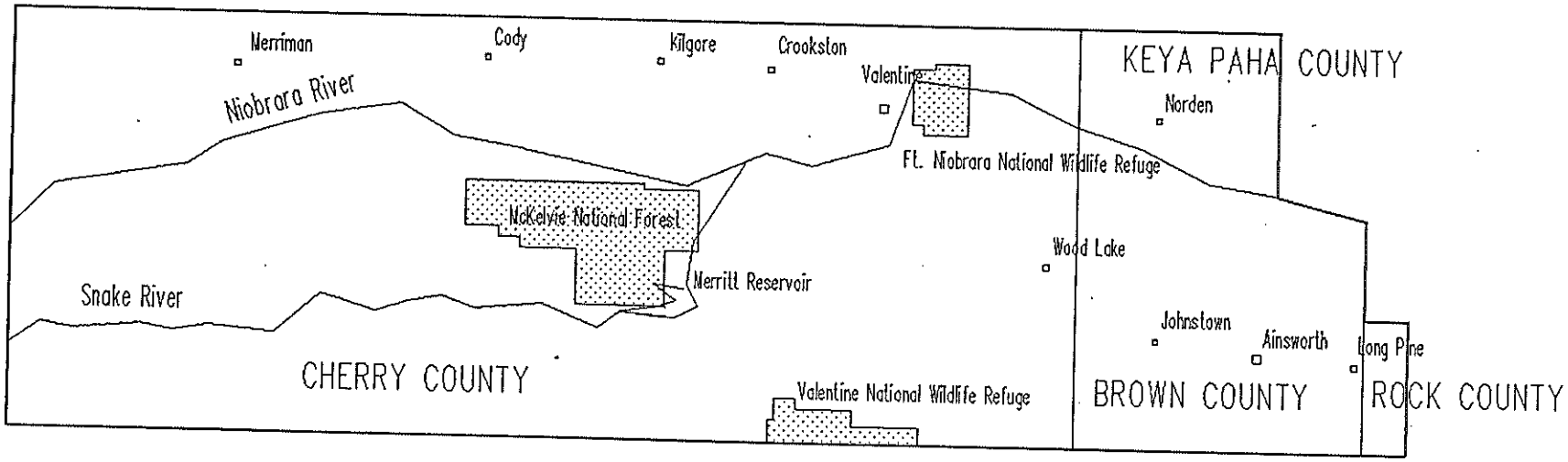
MIDDLE NIOBRARA NRD

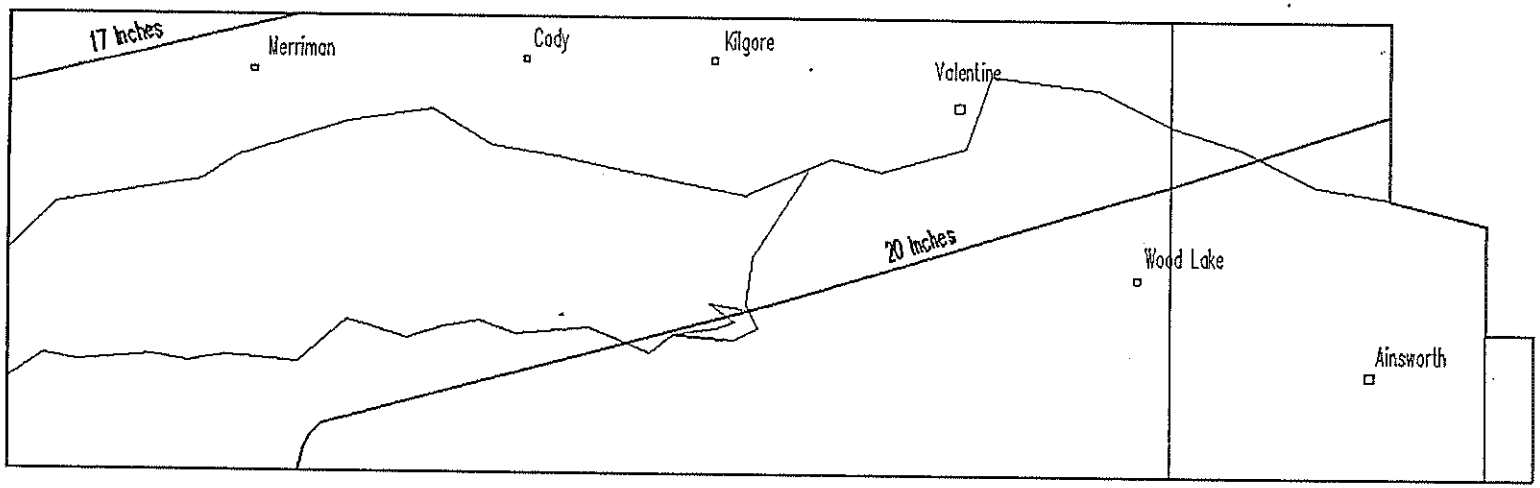
BASE MAP



APPENDIX 1

MIDDLE NIOBRARA NRD

AVERAGE ANNUAL PRECIPITATION

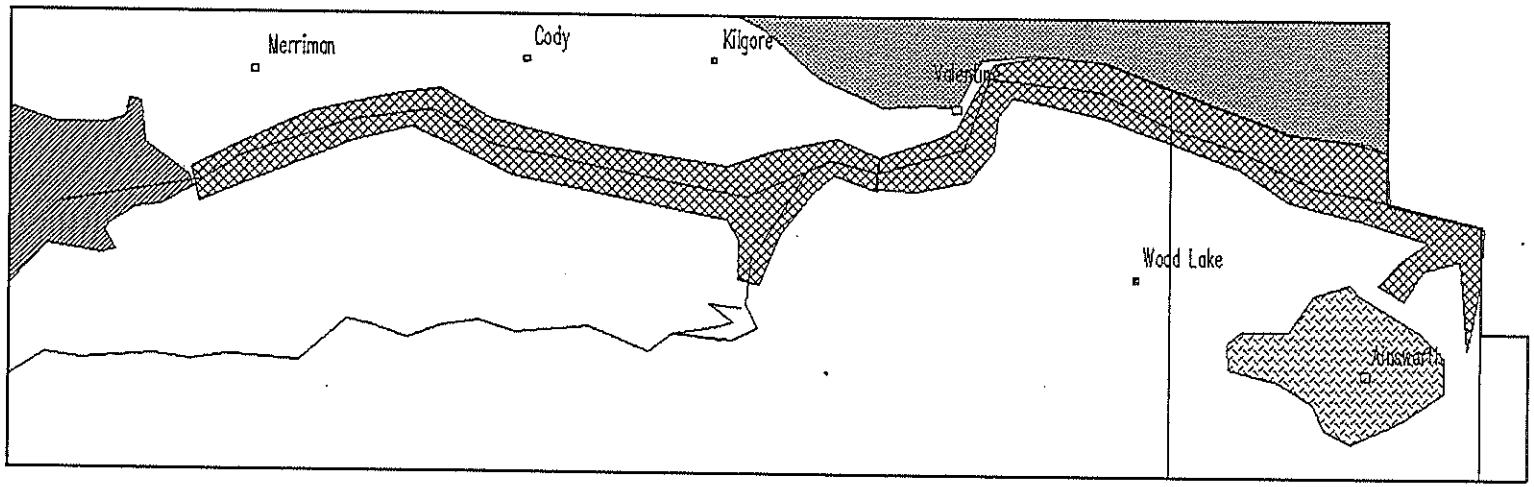


SOURCE: An Atlas of the Sandhills, University of Nebraska Conservation and Survey Division, 1989
Map Created by the Middle Niobrara NRD

APPENDIX 2

MIDDLE NIOBRARA NRD

GENERAL TOPOGRAPHIC REGIONS



SANDHILLS

DAKOTA-NEBRASKA TABLE

NIOBRARA RIVER VALLEY

AINSWORTH TABLE

NORTHERN PANHANDLE TABLELAND

SOURCE:The Goundwater Atlas of Nebraska, University of Nebraska Conservation and Survey Division, 1986

Map Created By the Middle Niorara NRD

APPENDIX 3

NEBRASKA NATURAL RESOURCES COMMISSION

Generalized Soils Map
using STATSGO data
Middle Niobrara NRD

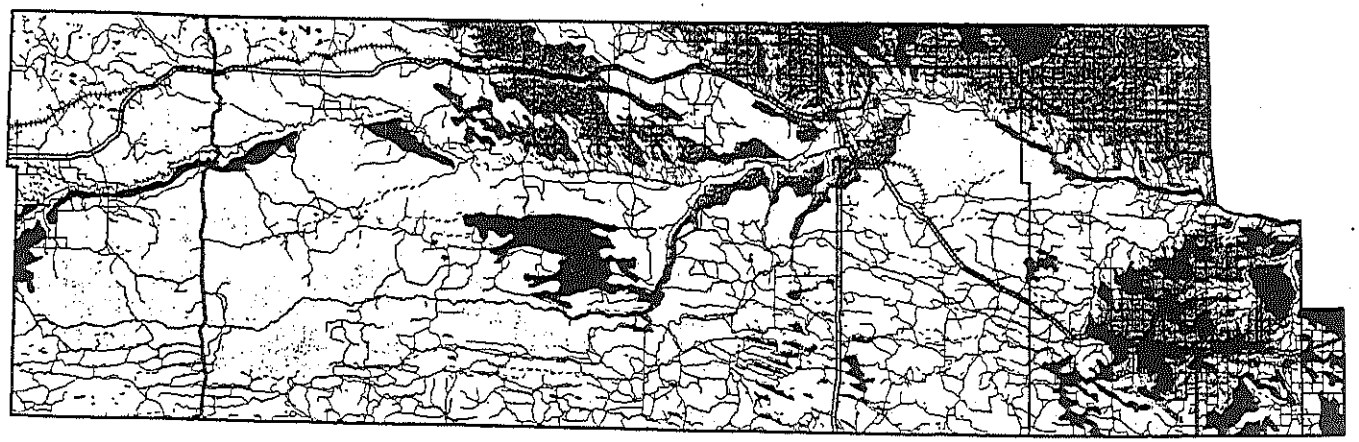
DATA BANK

Scale 1:750,000

3 0 3 6 9 12 15 Miles

Information Source:

Produced By - Nebraska Natural Resources Commission
Soils Data - USDA Soil Conservation Service, STATSGO Data Base
GIS Process - ARC/INFO
Processed - March 1993



Legend

Soils Map Units

- LAKE OR MAJOR STREAM
- VALENTINE-TASSEL-RONSON-IPAGE-DUDA
- VALENTINE-ELS-LOUP-GANNET-TYRON
- HOLT-YETAL-WANTER-ANSELMO-TASSEL
- ANSELMO-VALENTINE-KNOLLS-ELSMERE-DOGER
- ELSMERE-IPAGE-LOUP-WARLAKE-SELIA
- VALENTINE-IPAGE-ELS-ELSMERE
- VALENTINE-SIMEON-DUNDAY-O'NEILL
- VALENTINE-DUNDAY-IPAGE-LIBORY-ELSMERE
- JANSEN-O'NEILL-MEADIN-CHAPPEL-PIVOT
- INVALE-BOEL-LOUP-ALMERIA-LESHARA
- McCELVIE-RONSON-DUDA-TASSEL-MARIAVILLE
- VALENTINE-SIMEON-HERSH-DUNDAY-IPAGE
- LABU-SANSARC-BOYD-REE-RELIANCE
- O'NEILL-MEADIN-JANSEN-PIVOT-ANSELMO
- VALENTINE-ELS-IPAGE-TYRON-WARLAKE
- PIVOT-DUNDAY-McCOOK-DUNN-O'NEILL
- SATANTA-BUSHER-ALLIANCE-DUROC-DAILEY

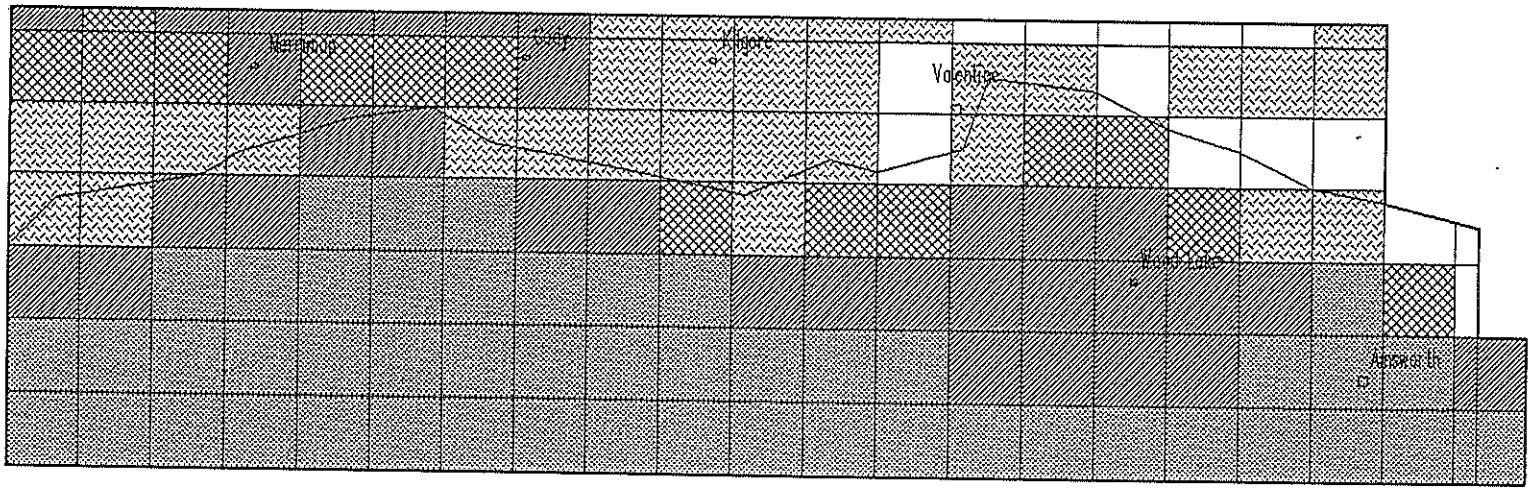
Other Attribute Information

- Interstates and Primary Highways
- U.S. and State Highways
- County and Other Roads
- Railroads
- Perennial Streams and Canals
- Intermittent Streams

APPENDIX 4

MIDDLE NIOBRARA NRD

AVERAGE SATURATED THICKNESS



LESS THAN 100 FEET

100 TO 200 FEET

200 TO 300 FEET

300 TO 400 FEET

MORE THAN 400 FEET

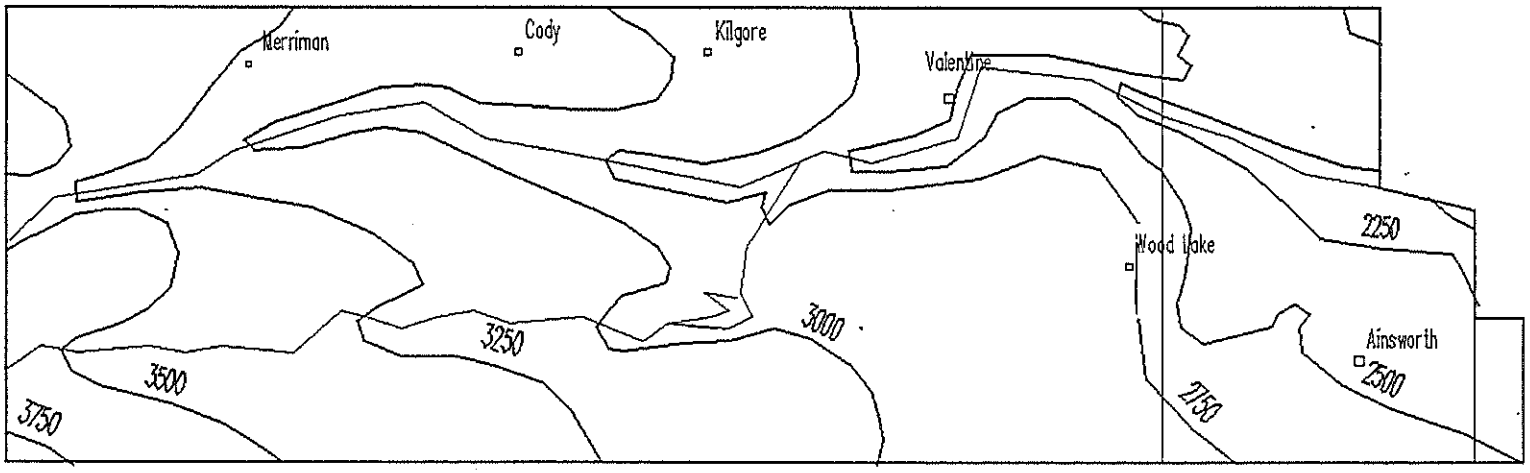
SOURCE: Groundwater Atlas Of Nebraska, University Of Nebraska Conservation And Survey Division, 1986

Map Created By The Middle Niobrara NRD

APPENDIX 5

MIDDLE NIOBRARA NRD

CONFIGURATION OF THE DISTRICT WATER TABLE



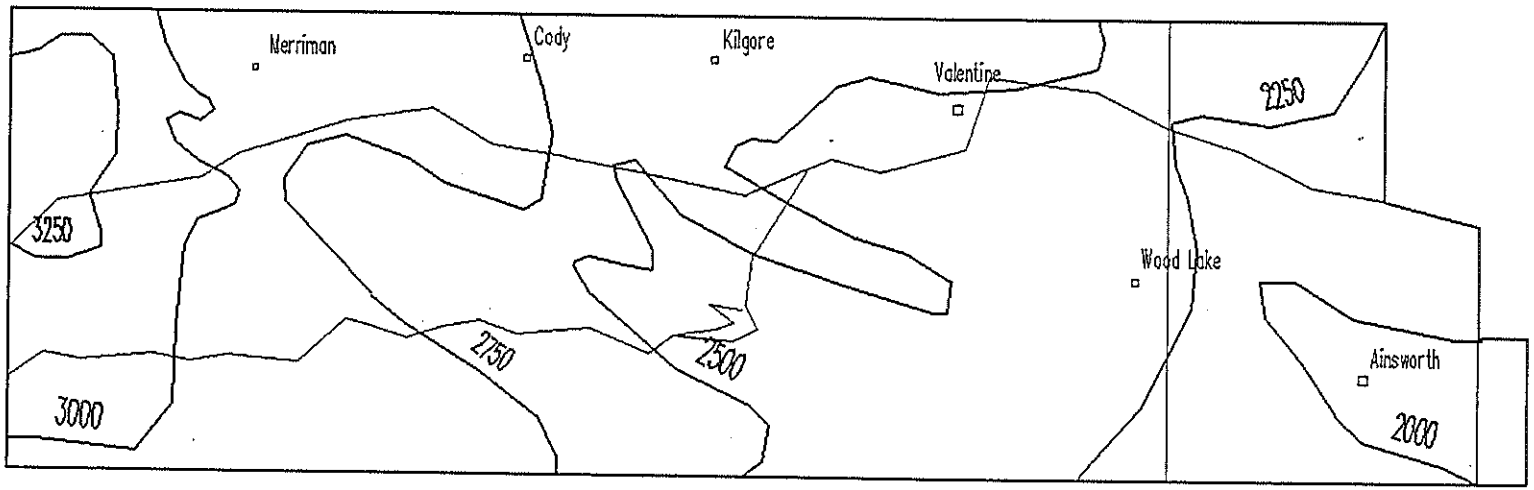
Water Table Contour Interval – 250 Feet

SOURCE: Groundwater Atlas Of Nebraska, University Of Nebraska Conservation And Survey Division, 1986
Map Created By The Middle Niobrara NRD

APPENDIX 6

MIDDLE NIOBRARA NRD

BASE OF THE PRINCIPAL GROUNDWATER RESERVOIR



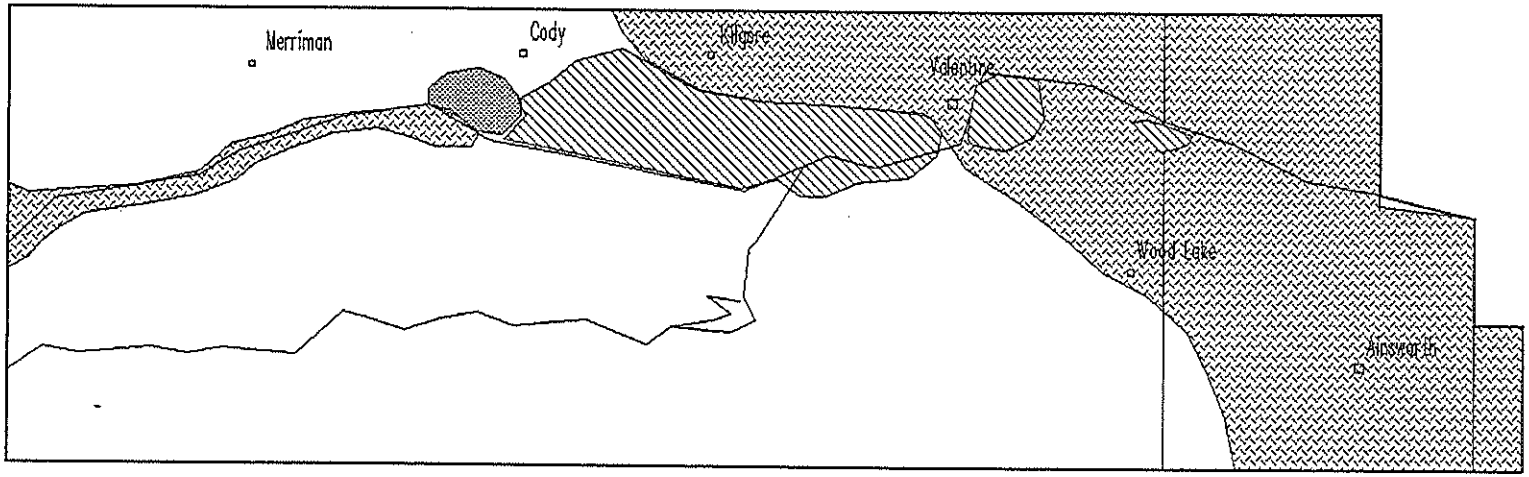
Contour Interval – 250 Feet

SOURCE: Groundwater Atlas Of Nebraska, Conservation And Survey Division, 1986
Map Created By The Middle Niobrara NRD

APPENDIX 7

MIDDLE NIOBRARA NRD

DEPTH TO REGIONAL WATER TABLE



DEPTH VARIES GREATLY WITH TOPOGRAPHY

100 TO 200 FEET

0 TO 100 FEET

GREATER THAN 200 FEET

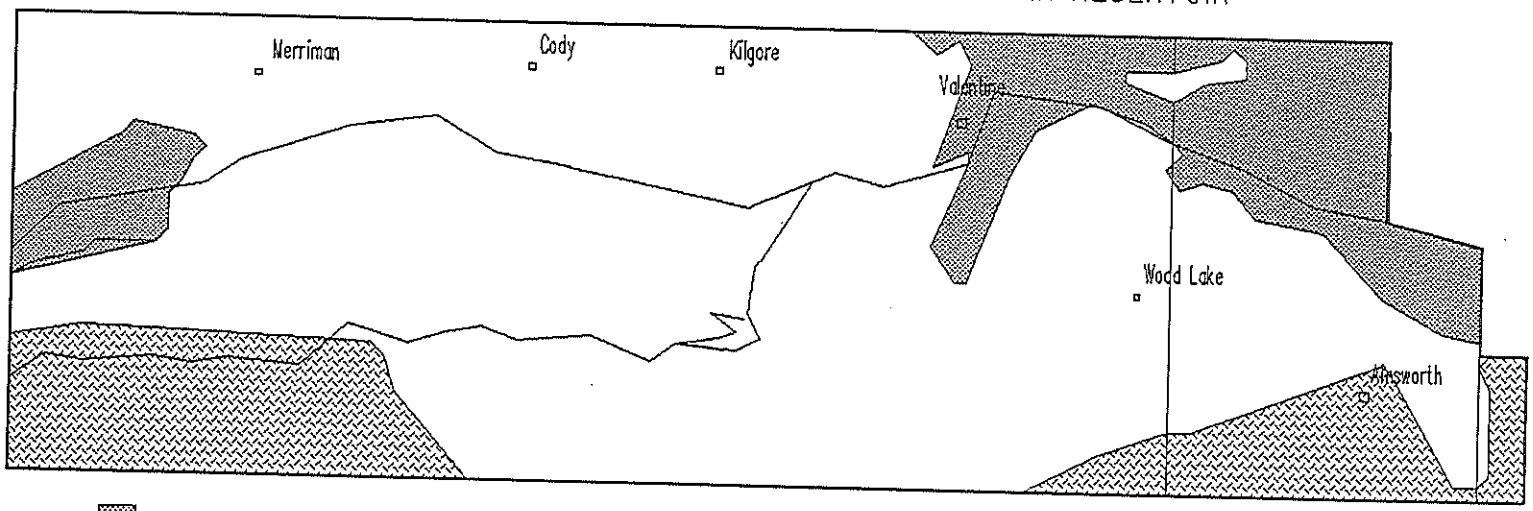
SOURCE: The Groundwater Atlas of Nebraska, University of Nebraska Conservation and Survey Division, 1986

Map Created By The Middle Niobrara NRD

APPENDIX 8

MIDDLE NIOBRARA NRD

TRANSMISSIVITY OF THE PRINCIPAL GROUNDWATER RESERVOIR



0 – 20,000 Gallons Per Day Per Foot

20,000 – 100,000 Gallons Per Day Per Foot

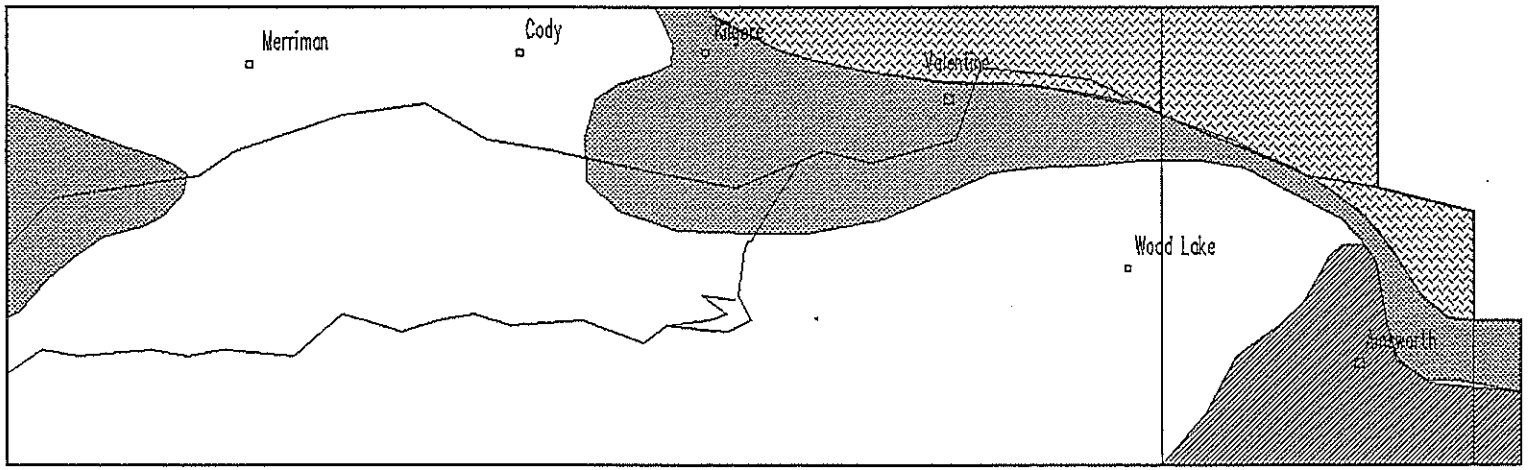
More Than 100,000 Gallons Per Day Per Foot

SOURCE: The Goundwater Atlas Of Nebraska, University Of Nebraska Conservation And Survey Division,1986
Map Created By Middle Niobrara NRD

APPENDIX 9

MIDDLE NIOBRARA NRD

AVERAGE ANNUAL RECHARGE



UNDER 2 INCHES

2 – 3.9 INCHES

4 – 4.9 INCHES

MORE THAN 5 INCHES

SOURCE: Policy Issue Study On Groundwater Water Reservoir Management, Nebraska Natural Resources Commmission, 1982

Map Created By The Middle Niobrara NRD

APPENDIX 10

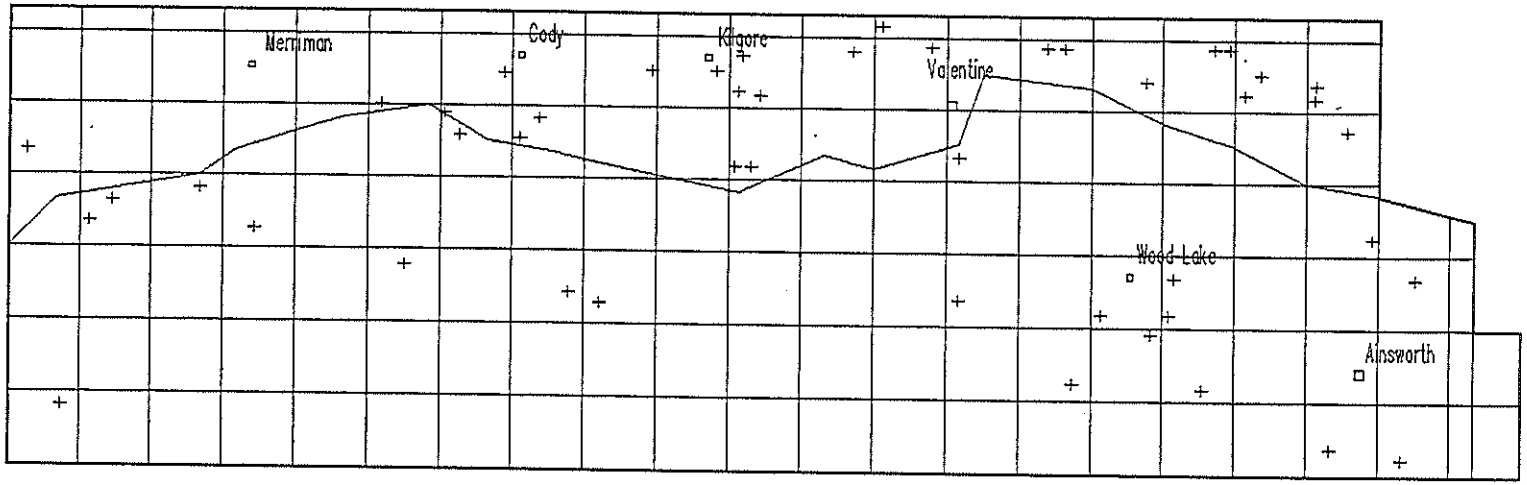
GROUNDWATER LEVELS MEASURED BY THE MIDDLE NIOBRARA NRD

APPENDIX # 11

LEGAL DESCRIPTION	COUNTY	DATE OF ORIGINAL. READING	ORIGINAL. READING	FALL 1993	CHANGE SINCE ORIGINAL READING
28N-22W 2DO	BROWN	SEP 22, 1975	13.10	6.60	6.50
29N-21W 34BO	BROWN	MAY 2, 1977	6.50	0.02	6.48
29N-22W 20BO	BROWN	MAY 14, 1976	13.80	7.50	6.30
29N-31N 24AA	CHERRY	DEC 22, 1975	3.62		2.92
29N-40W 12BDD	CHERRY	MAY 19, 1976	9.80		-0.60
30N-24W 33CDD	BROWN	JUN 2, 1975	7.80	2.50	5.30
30N-25W 12BAA	CHERRY	APR 4, 1978	6.60		0.90
30N-26W 26CD	CHERRY	MAY 1, 1975	2.20	0.09	2.11
31N-21W 5AO	BROWN	OCT 19,1977	97.80		9.40
31N-24W 31BDD	BROWN	NOV 5, 1976	19.00	16.10	2.90
31N-24W 8CC	BROWN	JUNE 30,1978	4.90	6.10	-1.20
31N-25W 32DBC	CHERRY	APR 12, 1978	5.40	5.70	-0.30
31N-27W 31DB	CHERRY	DEC 22, 1975	7.70	4.10	3.60
31N-30W 25D	CHERRY	NOV 2, 1976	21.50	15.50	6.00
31N-32W 29AB	CHERRY	NOV 23, 1976	12.05	8.60	3.45
31N-33W 22CD	CHERRY	JUN 7, 1976	7.00	4.10	2.90
31N-35W 3AD	CHERRY	JUNE 7,1976	14.37	8.50	5.87
32N-22W 26DD	BROWN	NOV 21, 1977	104.20	94.60	9.60
32N-37W 27CA	CHERRY	NOV 23, 1976	16.40	16.30	0.10
32N-38W 11AAC	CHERRY	JUNE 7,1976	83.60	82.60	1.00
32N-39W 21DBD	CHERRY	MAY 12,1975	68.50	66.50	2.00
32N-39W 30CA	CHERRY	APR 10, 1978	7.80	8.30	-0.50
33N-22W 10BCA	KEYAPAHA	NOV 4, 1975	26.00	19.00	7.00
33N-27W 29DB	CHERRY	MAY 22,1975	83.30	76.20	7.10
33N-30W 31DAB	CHERRY	JULY 11,1977	198.40	199.90	-1.50
33N-30W 32CBA	CHERRY	NOV 12,1975	204.00	206.60	-2.60
33N-33W 19DBA	CHERRY	NOV 10, 1975	157.50	154.50	3.00
33N-34W 17D	CHERRY	MAY 12, 1975	74.40	75.00	-0.60
33N-34W 7B	CHERRY	MAY 21, 1975	147.90	132.50	15.40
33N-35W 4BBD	CHERRY	MAY 21, 1975	142.50	146.50	-4.00
33N-40W 32AB	CHERRY	MAY 10, 1976	32.53	39.40	-6.87
34N-22W 30DAD	KEYAPAHA	MAY 13, 1976	33.40	18.90	14.50
34N-22W 31DO	KEYAPAHA	SEP 9, 1975	74.20	72.50	1.70
34N-23W 20DO	KEYAPAHA	NOV 4, 1975	8.20	3.70	4.50
34N-23W 31CAAB	KEYAPAHA	MAY 4, 1978	130.10	123.10	7.00
34N-24W 2DO	KEYAPAHA	NOV 4, 1975	34.20		-1.20
34N-24W 2DO	KEYAPAHA	NOV 4, 1975	41.10	29.10	12.00
34N-25W 14AC	CHERRY	DEC 3, 1975	107.20	108.50	-1.30
34N-26W 2BC	CHERRY	JUN 10,1982	132.90		-0.07
34N-26W 3ABC	CHERRY	NOV 1, 1990	105.70	107.00	-1.30
34N-28W 2CA	CHERRY	MAY 10,1976	106.80	112.90	-6.10
34N-29W 3ADB	CHERRY	MAY 5, 1976	85.20	84.00	1.20
34N-30W 30ACC	CHERRY	MAY 1, 1975	91.40	97.60	-6.20
34N-30W 33ACC	CHERRY	NOV 14, 1975	138.00		1.70
34N-30W 7BA	CHERRY	MAY 5, 1976	13.00	10.50	2.50
34N-31W 23DBD	CHERRY	MAY 21, 1975	111.00	110.50	0.50
34N-32W 24ACD	CHERRY	MAY 30, 1975	119.30		6.30
34N-34W 24DAC	CHERRY	NOV 8, 1976	87.30	84.00	3.30
35N-28W 29CCA	CHERRY	APRIL 25, 1978	115.29	107.50	7.79
AVERAGE CHANGE SINCE ORIGINAL READING					2.83

MIDDLE NIOBRARA NRD

LOCATION OF GROUNDWATER LEVEL OBSERVATION WELLS



+ OBSERVATION WELLS

Map Created By The Middle Niobrara NRD

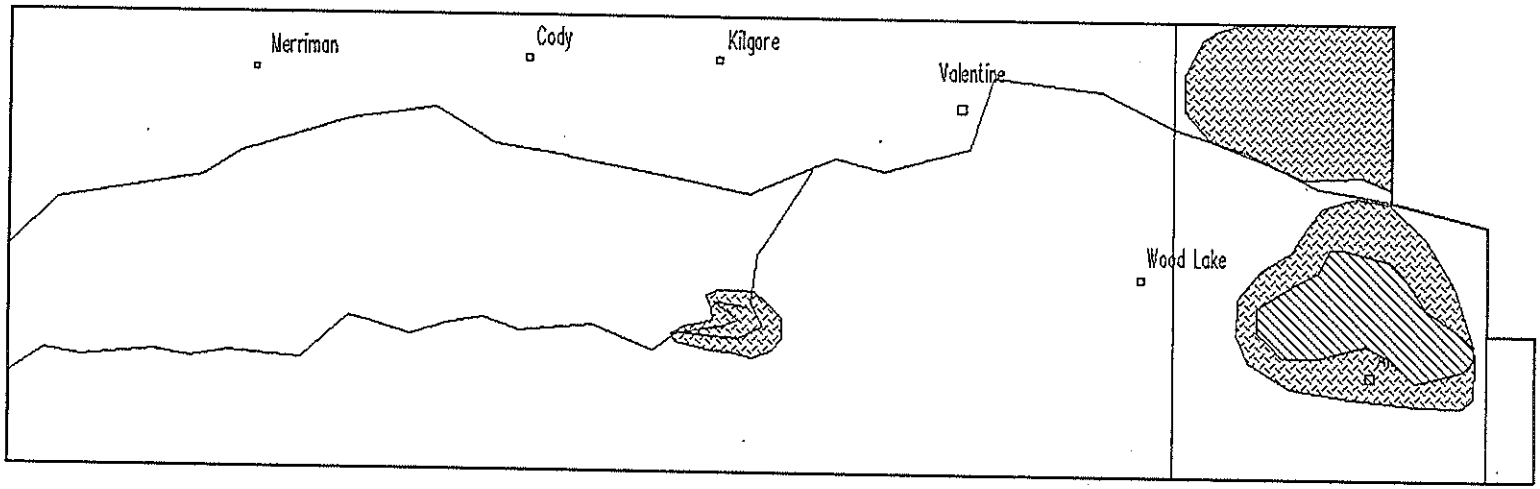
APPENDIX 12

WELLS MONITORED BY AINSWORTH IRRIGATION DISTRICT

WELL LOCATION	ORIGINAL DEPTH IN FEET	1993 DEPTH IN FEET	GAIN/LOSS IN FEET
30-20-18 ac	133.29	64.78	68.51
30-20-29 bb	121.43	119.68	1.75
30-21-12 da	147.82	132.36	15.46
30-21-14 bb	65.42	66.32	-0.90
30-21-17 bb	77.74	52.97	24.77
30-21-22 bb	60.64	28.12	32.52
30-21-23 aa	87.67	51.63	36.04
30-21-26 aa	72.16	62.08	10.08
30-21-26 bc	28.31	15.68	12.63
30-21-28 aa	9.02	5.39	3.63
30-21-28 cc	3.80	2.07	1.73
30-22-07 ab	56.27	39.67	16.60
30-22-07 dd	51.45	29.97	21.48
30-22-09 dd	15.70	2.60	13.10
30-22-10 dd	12.93	10.04	2.89
30-22-11 bb	65.52	46.28	19.24
30-22-12 bb	44.71	25.60	19.11
30-22-12 da	28.31	18.50	9.81
30-22-14 cc	42.05	38.52	3.53
30-22-19 bc	24.51	17.76	6.75
30-22-20 cb	28.49	19.11	9.38
30-22-23 aa	5.08	3.86	1.22
30-22-23 da	36.27	35.39	0.88
30-22-24 aa	44.32	37.79	6.53
30-22-25 bc	26.13	24.91	1.22
30-22-25 cc	22.80	22.93	-0.13
30-23-08 dd	44.10	30.85	13.25
30-23-14 dd	14.11	9.38	4.73
30-23-14 dd	21.93	17.34	4.59
30-23-29 ad	26.62	25.16	1.46
31-20-18 bc	125.78	115.73	10.05
31-21-07 dc	96.67	85.19	11.48
31-21-13 bb	145.61	113.47	32.14
31-21-15 bc	175.10	177.67	-2.57
31-21-19 da	139.08	131.76	7.32
31-21-28 cc	105.84	105.80	0.04
31-21-31 bb	111.10	102.40	8.70
31-21-34 da	99.29	88.87	10.42
31-22-10 aa	161.42	136.08	25.34
31-22-13 cb	115.65	85.18	30.47
31-22-15 ad	110.10	81.93	28.17
31-22-21 cb	108.50	84.74	23.76
31-22-25 cc	98.20	73.99	24.21
31-22-30 bb	121.14	92.80	28.34
31-22-34 aa	60.34	42.17	18.17
31-22-34 cc	84.70	60.49	24.21
31-23-32 dd	114.30	72.98	41.32
31-23-34 dd	95.31	52.14	43.17
31-23-36 bb	118.33	81.86	36.47
31-23-36 dd	85.52	56.56	28.96
TOTALS	**3690.58**	**2898.55**	**792.03**
AVERAGES	**73.81**	**57.97**	**15.84**

MIDDLE NIOBRARA NRD

GROUNDWATER LEVEL CHANGES

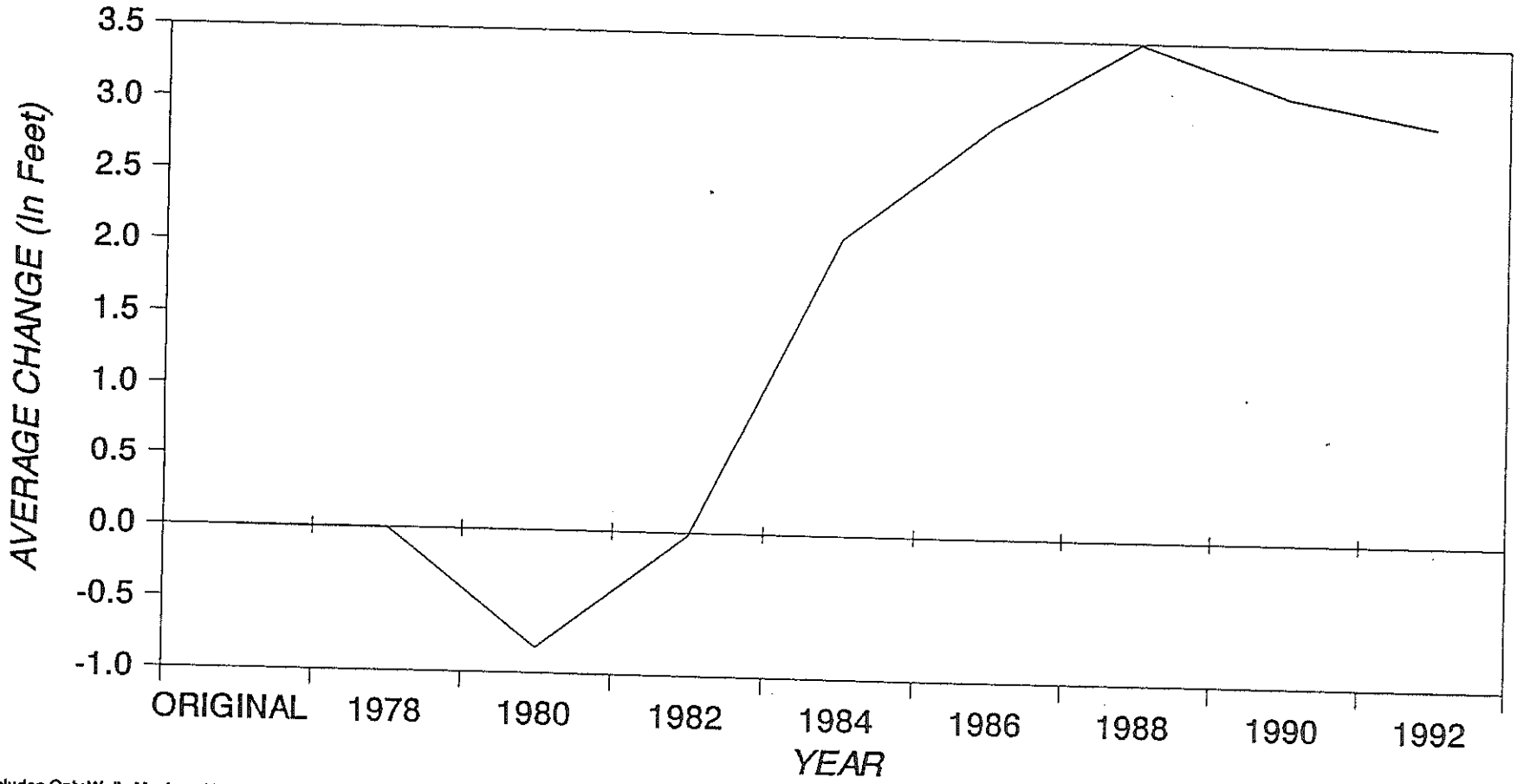


5 TO 15 FOOT INCREASE

GREATER THAN 15 FOOT INCREASE

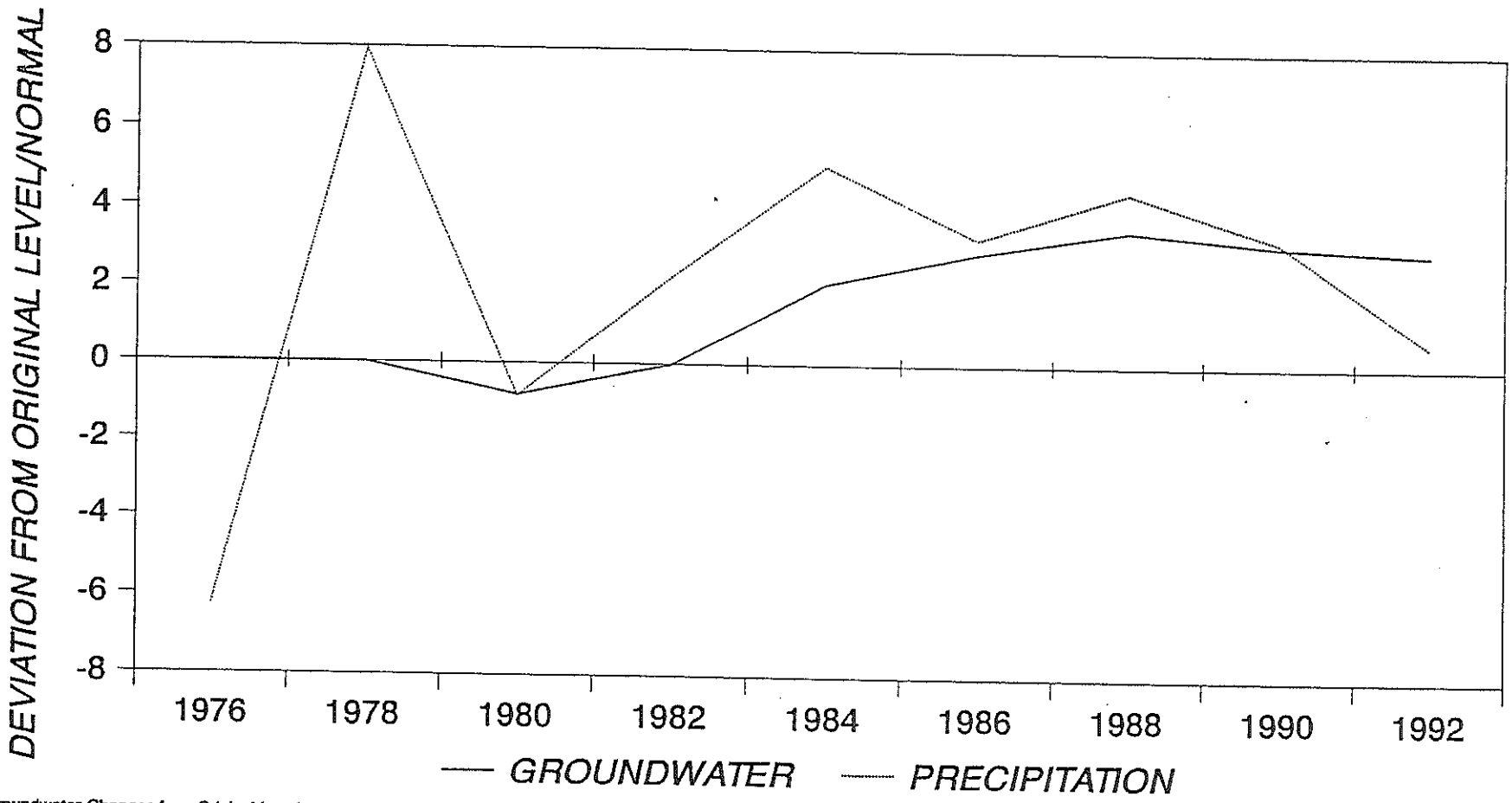
APPENDIX 14

Appendix 15 - AVERAGE BIENNIAL WATER LEVEL CHANGE FROM THE ORIGINAL READING IN DISTRICT MONITORING WELLS



Includes Only Wells Monitored by MNNRD
Original Readings Taken From 1975-1978
Readings Taken In The Fall

Appendix 16 - COMPARISON OF BIENNIAL FLUCTUATIONS IN GROUNDWATER LEVELS & PRECIPITATION IN THE NRD SINCE 1976



Groundwater Changes from Original Levels
Precipitation-Above or Below Normal
Groundwater In Feet-Precipitation Inches

NEBRASKA NATURAL RESOURCES COMMISSION
DATA BANK

REGISTERED WELLS MAP

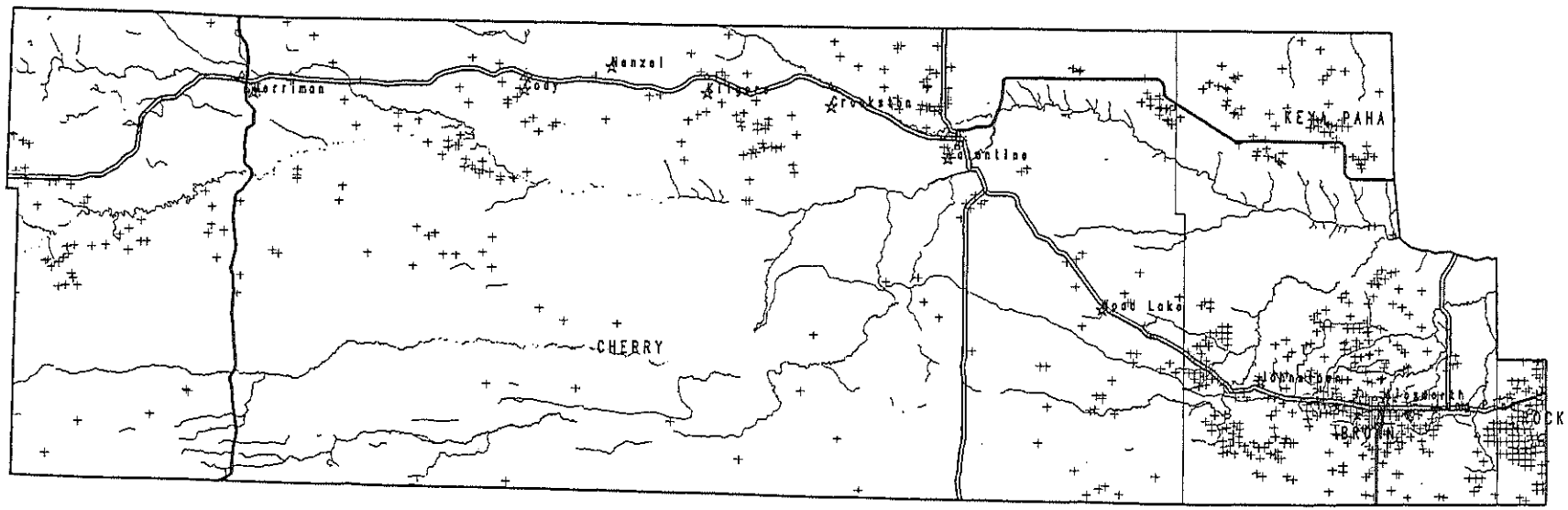
MIDDLE NIOBRARA
NATURAL RESOURCES DISTRICT

LEGEND

- Municipal Wells
- Industrial Wells
- Irrigation Wells
- Other Wells
- Interstates and Primary Highways
- U.S. and State Highways
- Perennial Streams

N

REGISTERED WELLS



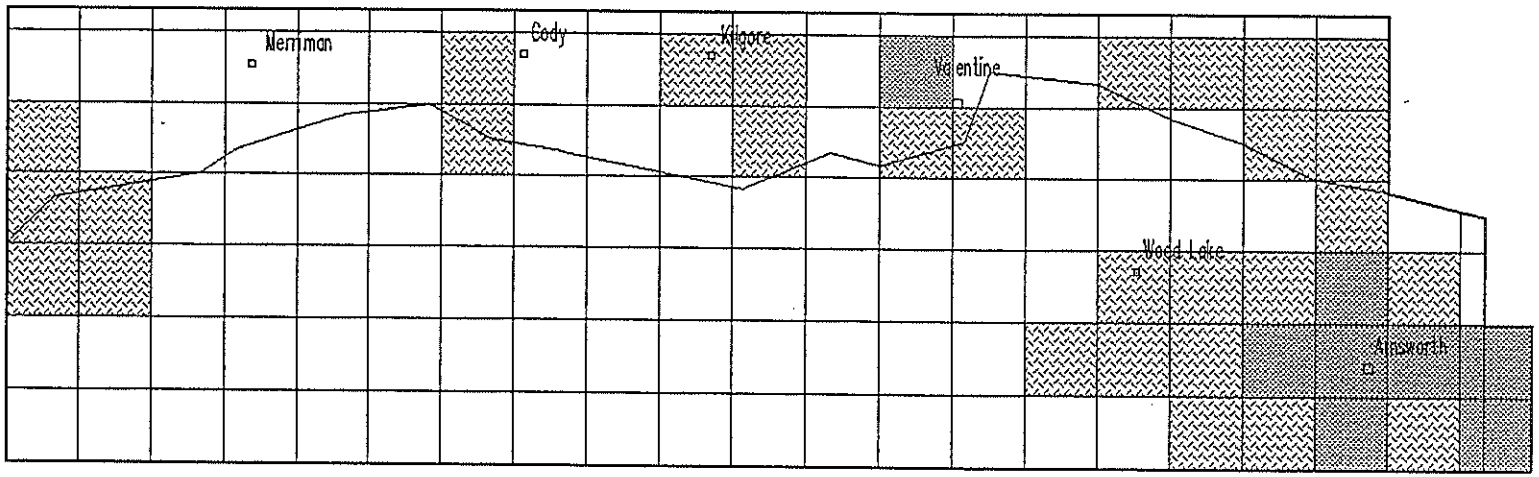
5 0 5 10 15 20 25 Miles

Information Source:
Produced By - Nebraska Natural Resources Commission
Topographic Data - TIGER Files, U.S. Bureau of the Census, 1990
Wells Data - Nebraska Department of Water Resources, Dec.1991
GIS Process - ARC/INFO
Processed - April, 1993

APPENDIX 17

MIDDLE NIOBRARA NRD

1980 WELL EQUIVALENTS



LESS THAN 5 PER TOWNSHIP 5 TO 25 PER TOWNSHIP MORE THAN 25 PER TOWNSHIP

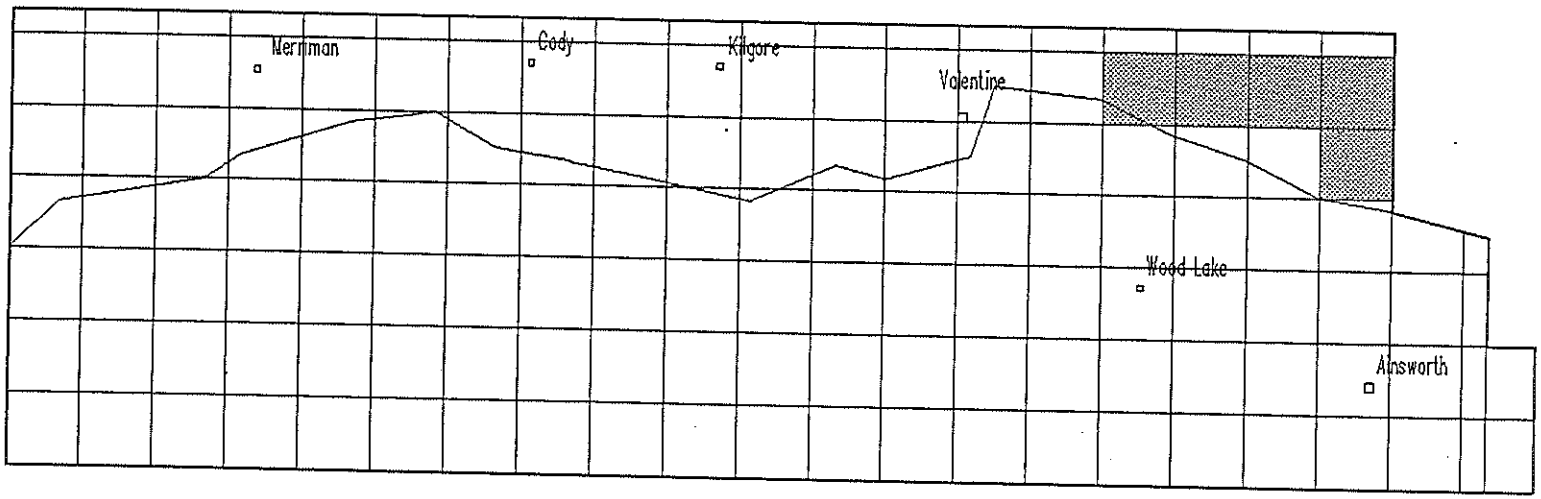
SOURCE: Policy Issue Study On Groundwater Reservoir Management, Nebraska Resources Commission, 1982

Map Created By The Middle Niobrara NRD

APPENDIX 18

MIDDLE NIOBRARA NRD

TOWNSHIPS WHERE PRESENT WITHDRAWALS EXCEED ANNUAL RECHARGE



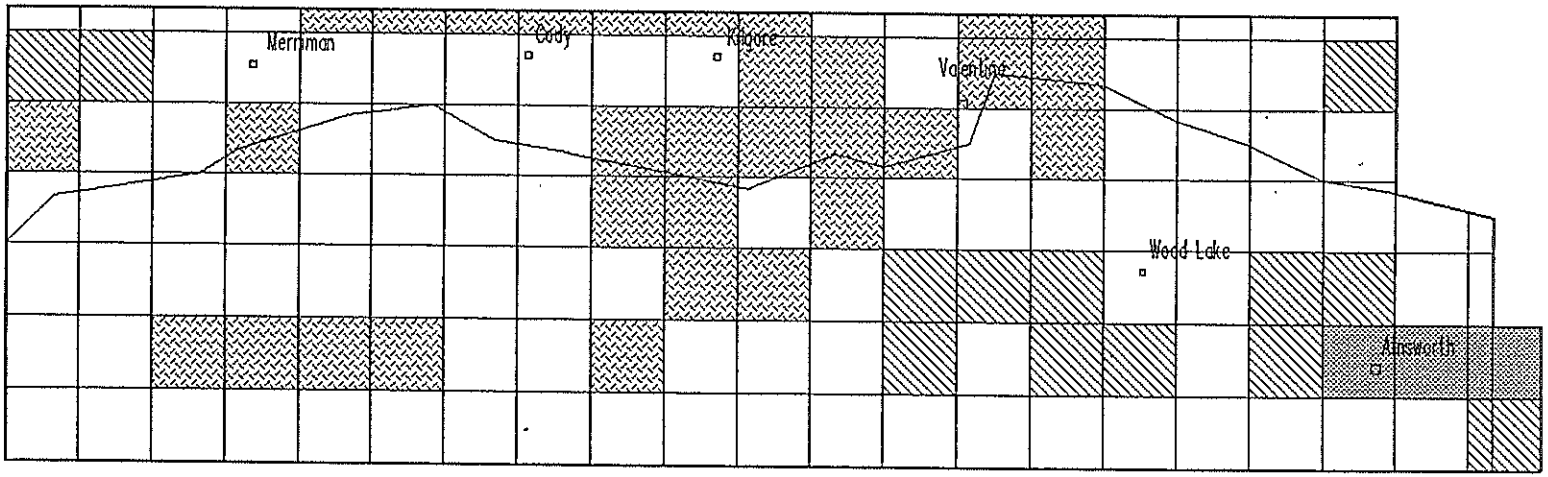
PRESENT WITHDRAWALS EXCEED ANNUAL RECHARGE

SOURCE: Policy Issue Study On Groundwater Reservoir Management, Nebraska Natural Resources Commission, 1982
Map Created By The Middle Niobrara NRD

APPENDIX 19

MIDDLE NIOBRARA NRD

MAXIMUM IRRIGATION DEVELOPMENT BASED ON SUITABLE LANDS



MORE THAN 3 WELLS PER SECTION

2 TO 3 WELLS PER SECTION

1 TO 2 WELLS PER SECTION

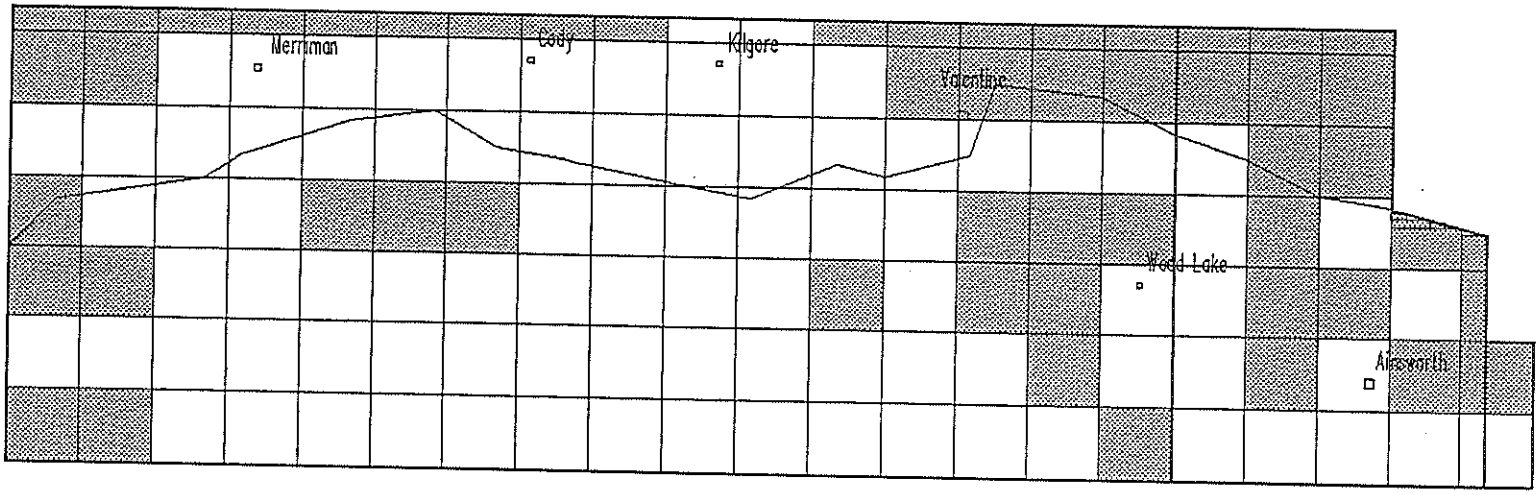
LESS THAN 1 WELL PER SECTION

SOURCE: Policy Issue Study On Groundwater Reservoir Management, Nebraska Natural Resources Commission, 1982
Map produced by the Middle Niobrara NRD

APPENDIX 20

MIDDLE NIOBRARA NRD

MAXIMUM POTENTIAL IRRIGATION WITHDRAWALS VERSES ANNUAL RECHARGE



TOWNSHIPS WHERE MAXIMUM POTENTIAL WITHDRAWALS EXCEED ANNUAL RECHARGE

TOWNSHIPS WHERE ANNUAL RECHARGE EXCEEDS MAXIMUM POTENTIAL WITHDRAWALS

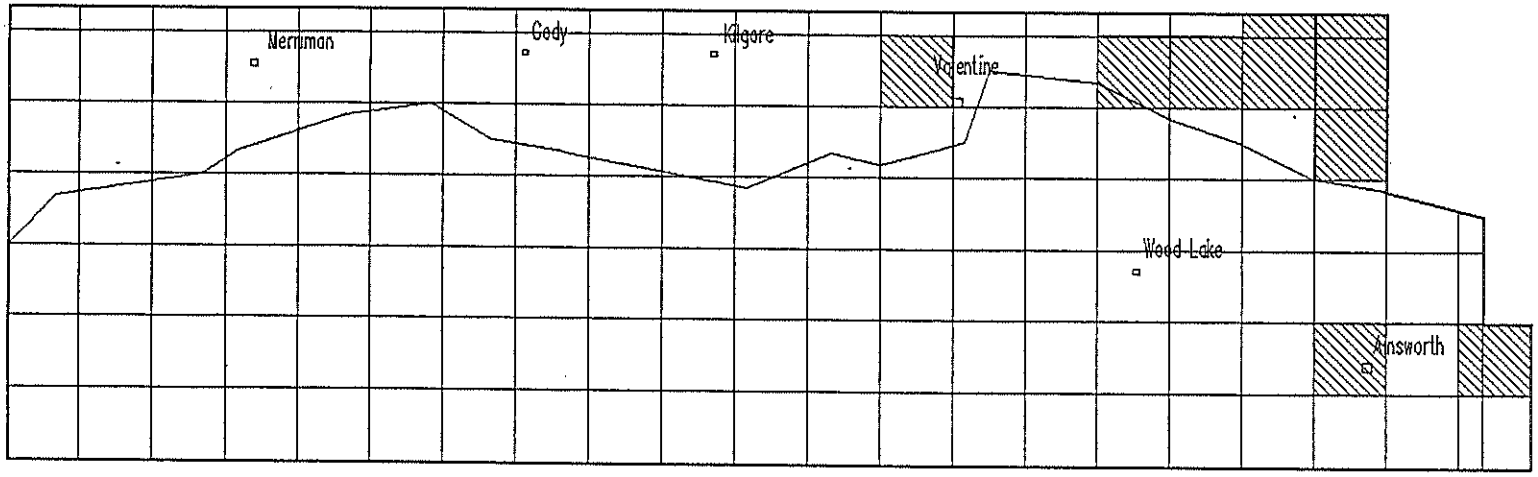
SOURCE - Policy Issue Study On Groundwater Reservoir Management, Nebraska Natural Resources Commission, 1982

Map Created By The Middle Niobrara NRD

APPENDIX 21

MIDDLE NIOBRARA NRD

TOWNSHIPS WHERE ANNUAL WITHDRAWALS EXCEED 50% OF THE NATURAL ANNUAL RECHARGE



TOWNSHIPS WHERE ANNUAL WITHDRAWALS EXCEED 50% OF THE NATURAL ANNUAL RECHARGE

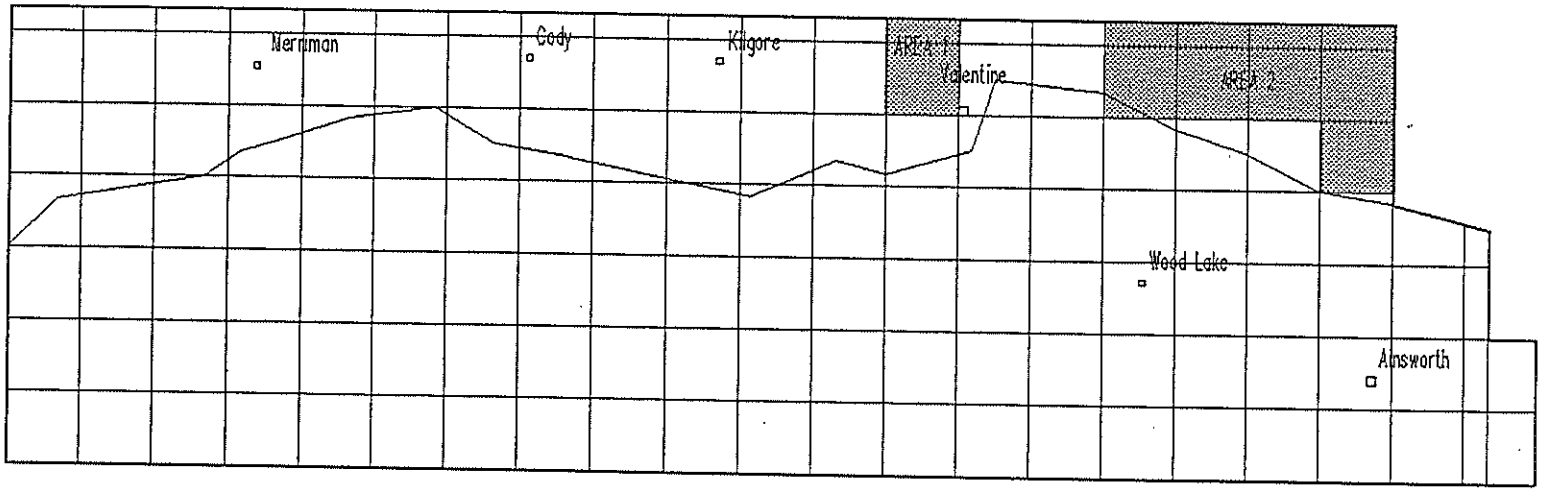
SOURCE: Policy Issue Study On Groundwater Resevoir Management, Nebraska Natural Resources Commission, 1982

Map Created By The Middle Niobrara NRD

APPENDIX 22

MIDDLE NIOBRARA NRD

LOCATION OF GROUNDWATER LEVEL WATCH AREAS



APPENDIX 23

RESULTS OF DISTRICT GROUNDWATER MONITORING APPENDIX # 24

COUNTY	LOCATION	SAMPLE DATE	ALKALINITY (ppm)	CHLORIDE (PPM)	DISSOLVED SOLIDS	TEMPER ATURE	NITRATE (PPM)	pH
CHERRY	SW 24-34-32	6/27/88	180.4	1.5	243.8	19.0	1.38	7.3
CHERRY	NE 9-34-31	6/27/88	63.8	0.5	143.2	16.0	1.81	8.5
CHERRY	SE 28-34-31	6/27/88	171.6	0.5	238.4	17.0	2.25	7.4
CHERRY	SE 31-33-30	6/27/88	178.2	1	223.8		1.44	7.7
CHERRY	N 10-33-30	6/27/88	121	0	179.4	17.0	1.38	7.5
CHERRY	SE 26-34-30	6/27/88	156.2	2.5	239.0	15.0	4.0	7.4
CHERRY	NE 14-34-25	6/28/88	180.4	1.5	257.0	19.0	3.25	7.4
CHERRY	NE 28-35-28	6/28/88	195.8	1.5	253.0	17.0	1.75	7.1
CHERRY	SW 24-33-27	6/28/88	77	5.75	152.0	14.0	2.25	7.5
CHERRY	SW 32-33-27	6/28/88	167.2	1.5	225.6	17.0	0.25	7.2
CHERRY	NE 23-34-28	6/28/88	176	6	269.8	17.0	2.88	7.1
CHERRY	NE 35-34-28	6/28/88	215.6	3.5	272.6	16.0	2.56	7.3
CHERRY	NE 01-34-28	6/28/88	193.6	4	268.4	19.0	3.75	7.1
CHERRY	SE 36-34-28	6/28/88	204.6	2.5	239.8	18.5	1.75	7.2
CHERRY	SW 35-35-29	6/28/88	176	2	242.0	17.0	2.13	7.0
CHERRY	SW 11-34-31	6/28/88	101.2	7.5	325.9	16.0	19.75	7.4
CHERRY		6/28/88	158.4	5.5	323.6	15.5	14.75	7.1
CHERRY		6/28/88	125.4	0.5	164.4	17.0	4	7.6
CHERRY	SW1/4 26-35-37	7/22/88	72.76	0.5	134.8	16.0	1.75	6.5
CHERRY	31-35-36	7/22/88	51.36	1	164.8	20.5	2.75	6.5
CHERRY	NW1/4 32-34-35	7/22/88	162.64	1.25	208.4	19.5	1.75	7.9
CHERRY	SW 08-32-34	7/22/88	74.9	0	147.6	17.0	3.25	7.0
CHERRY	SE 17-33-34	7/22/88	68.48	2	149.2	15.5	3.25	6.9
CHERRY	NE1/4 5-33-33-	7/22/88	94.16	0	152.4	16.0	2.38	7.7
CHERRY	SE 11-34-31	7/1/89					10.25	
CHERRY	NE 27-34-27	6/30/89					1.13	
CHERRY	NW 11-34-27	6/30/89					0.75	
CHERRY		6/30/89					0.31	
CHERRY	NE 30-35-25	6/30/89					1.44	
CHERRY	NE 3-34-26	6/30/89					2.69	
CHERRY	NW 20-34-27	7/1/89					1.19	
CHERRY	NW 21-32-26	7/1/89					0	
CHERRY	SE 21-32-26	7/1/89					0	
CHERRY	SE 2-32-26	7/1/89					0	
CHERRY	SE 17-31-25	7/1/89					2.88	
CHERRY	NE 31-30-25	71/89					14.5	
CHERRY	NE 30-31-27	7/1/89					0	
CHERRY	nw 1-33-28	7/1/89					0.5	
CHERRY	NW 1-33-28	7/1/89					17	
CHERRY	NW 1-33-28	7/1/89					9.34	
CHERRY		7/1/89					11.63	
CHERRY	NW 1-33-28	7/1/89					6.75	
CHERRY	NE 2-33-28	7/1/89					2.94	
CHERRY	NW 2-33-28	7/1/89					1.31	
CHERRY	SE 29-34-28	7/1/89					0.44	
CHERRY	SE 7-34-29	7/1/89					2.19	
CHERRY	SE 28-35-30	7/1/89					1.25	
CHERRY	SE 11-34-31	7/1/89					5.19	
CHERRY	SE 18-34-30	7/1/89					2.5	
CHERRY	NE 14-34-31	7/1/89					4.19	

RESULTS OF DISTRICT GROUNDWATER MONITORING APPENDIX # 24

COUNTY	LOCATION	SAMPLE DATE	ALKALINITY (ppm)	CHLORIDE (PPM)	DISSOLVED SOLIDS	TEMPER ATURE	NITRATE (PPM)	pH
CHERRY	SE 23-34-31	7/1/89					6.06	
CHERRY	NE 10-34-31	7/1/89					3.5	
CHERRY	NE 10-34-31	7/1/89					15.19	
BROWN	NW 34-30-24	8/27/88	62.93		128.2		2.25	7.0
BROWN	SE 33-23-33	8/27/88	91.14		154.6	17.0	2.94	7.7
BROWN	SE 10-31-22	8/27/88	193.13	64.09	1232.8	18.5	62	7.1
BROWN	NE 10-31-22	8/27/88	269.08	1.96	271.0	16.0	6.38	7.4
BROWN	SE 18-31-22	8/27/88	171.43	2.45	250.3	17.0	6.25	7.0
BROWN	NE 2-30-22	8/27/88	132.37		197.0	15.0	2.56	7.7
BROWN	NE 28-30-22	8/27/88	65.1		127.0		2.81	6.9
BROWN	SE 17-30-22	8/27/88	134.54	5.87	281.4	15.0	14.13	6.3
BROWN	SE 17-30-22	8/27/88	141.05	5.14	302.0	13.5	16.56	6.5
BROWN	NE 6-30-22	8/27/88	177.94	2.45	245.0	15.0	4.88	6.8
BROWN	NE 6-29-22	8/27/88	47.74	2.94	136.6	18.5	7.75	6.3
BROWN	NE 24-30-23	8/27/88	39.06	1.47	138.2	13.0	7.75	6.4
BROWN		8/27/88	49.91	0	106.6	15.3	2.75	6.4
BROWN	SE 21-31-23	8/27/88	167.09	0	216.8	18.0	3.31	7.4
BROWN	SE 8-29-23	8/27/88	28.21	0.49	97.6	14.5	3.25	6.4
BROWN	SW 4-30-24	8/27/88	34.72	1.96	130.2	14.0	5.06	6.6
BROWN	NE 34-30-22	10/7/88	66.6	2	131.2	12.5	2	6.9
BROWN	NW 23-29-22	10/7/88	35.2	1	110.8	10.5	3.63	6.7
BROWN	SE 20-30-21	10/7/88	50.6	1.5	146.4	14.5	7.38	6.5
BROWN	NW 8-29-20	10/7/88	75.48	0	140.0	12.5	1.69	8.0
BROWN	SE 30-29-20	10/7/88	37.74	1	95.6	13.5	1.94	6.6
BROWN	NW 17-30-20	10/7/88	93.24	2	178.0	13.5	5.81	7.7
BROWN	SE 34-31-21	10/7/88	255.3	3	352.8	13.5	9	6.8
BROWN	SE 9-31-21	10/7/88	166.5	0.25	232.0	15.0	4.5	7.6
BROWN	SE 32-32-21	10/7/88	133.2	0.5	215.3	15.5	5.5	7.6
BROWN	NE 5-31-20	10/7/88	106.56	2	202.0	13.0	1.8	6.4
BROWN	23-30-21	10/7/88	51.06	17.99	203.6	14.0	12.94	6.2
BROWN	NE 21-30-23	6/5/89					0.56	
BROWN	NE 5-30-23	6/5/89					0.38	
BROWN	33-30-23	6/5/89					0.38	
BROWN	SW 31-32-23	6/5/89					0.06	
BROWN	SE 26-31-23	6/5/89					8.38	
BROWN	NE 7-30-22	6/5/89					5.75	
BROWN	SE 28-31-22	6/5/89					0.38	
BROWN	SW 21-30-22	6/5/89					3.31	
BROWN	SW 15-30-22	6/5/89					12.5	
BROWN	SE 10-30-22	6/5/89					3.78	
BROWN	SE 13-30-22	6/5/89					2	
BROWN	NW 20-30-21	6/5/89					7.88	
BROWN	SW 9-30-21	6/5/89					7.88	
BROWN	NW 12-30-20	6/5/89					0.75	
BROWN	SE 22-30-20	6/5/89					5	
BROWN	SE 22-30-21	6/5/89					16.75	
BROWN	NW 34-30-21	6/5/89					8.31	
BROWN	20-30-21	6/6/89					17.32	
BROWN	SW 20-30-21	6/6/89					12.25	
BROWN	NE 30-30-21	6/6/89					5.5	

RESULTS OF DISTRICT GROUNDWATER MONITORING APPENDIX # 24

COUNTY	LOCATION	SAMPLE DATE	ALKALINITY (ppm)	CHLORIDE (PPM)	DISSOLVED SOLIDS	TEMPER ATURE	NITRATE (PPM)	pH
BROWN	NE 30-22-35	6/6/89					0	
BROWN	NW 2-29-22	6/6/89					0.31	
BROWN	SE 33-30-22	6/6/89					0.25	
BROWN	NW 31-30-22	6/6/89					0	
KEYA PAHA	SE1/4 31-34-24	4/7/89	156.36	1.41	50.0	15.5	1.19	7.2
KEYA PAHA	NW 17-33-24	4/7/89	274.05	13.2	446.2	15.0	0.25	6.8
KEYA PAHA	SW 1/4 12-32-22	4/7/89	160.37	17.44	325.4	8.5	6.13	7.2
KEYA PAHA	SW 1/4 12-32-22	4/7/89	387.73	44.32	870.2	17.5	47.5	7.1
KEYA PAHA	SE 1/4 13-33-22	4/8/89	148.19	9.43	312.2	9.5	10	6.4
KEYA PAHA	NE 9-33-22	4/8/89	131.95	10.84	352.2	9.0	18.5	6.5
KEYA PAHA	SE 1/4 27-34-23	4/8/89	111.65	6.6	287.8	7.0	12	6.5
KEYA PAHA	NE1/430-34-22	4/8/89	176.61	7.54	297.4	12.0	5.5	6.1
KEYA PAHA	NE1/4 27-34-22	4/8/89	233.45	48.56	668.2	12.0	27.75	6.5
KEYA PAHA	SW 1/4 2-34-22	4/8/89	180.67	12.73	339.2	11.0	11.25	6.4
KEYA PAHA	NE1/4 12-34-23	4/8/89	107.59	8.02	243.6	11.0	7.38	6.0
KEYA PAHA	SW 13-34-23	4/8/89		3.3	245.6	8.0	2.19	5.8
KEYA PAHA	SW1/4 24-34-24	4/8/89		8.49	337.0		14.13	
KEYA PAHA	SE1/4 17-34-24	4/8/89		2.83	255.4		3.63	
KEYA PAHA	NE4-34-24	4/8/89		0.94	236.2		0.13	
ROCK	NW15-30-20	10/7/88	177.6	0.5	346.0	12.5	21.38	7.5
ROCK	NE 13-30-20	10/7/88	31.08	6.5	307.2	11.0	24.25	6.2
ROCK	NW 2-29-20	10/7/88	77.7	15	226.8	15.0	13.75	6.4
ROCK	SW 26-20-20	10/7/88	51.06	0	113.2	14.5	1.5	6.6
ROCK	NW 9-30-20	6/6/89					12.75	
ROCK	NE 11-30-20	6/6/89					1.5	
ROCK	SE 12-30-20	6/6/89					21.56	
ROCK	SE 13-3020	6/6/89					13.75	
ROCK	NE 26-30-20	6/6/89					11.13	
ROCK	SE 27-30-20	6/6/89					16.63	
ROCK	NE 34-30-20	6/6/89					16.63	
ROCK	NE 23-29-20	6/6/89					0.31	
ROCK	14-29-29	6/6/89					2.13	
ROCK	SE 11-29-20	6/6/89					7.5	
ROCK	NW 33-30-21	6/6/89					1.38	

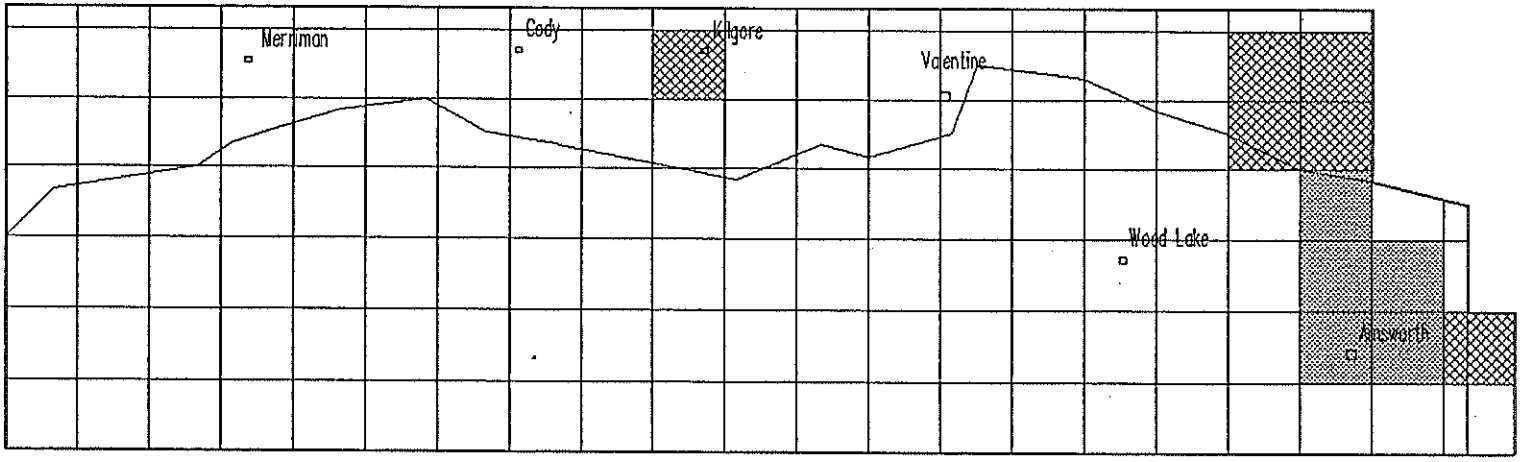
NITRATE LEVELS (ppm) IN MONITORING WELLS LOCATED IN THE LONG PINE CREEK WATERSHED

Monitoring Done by Nebraska Department of Environmental Quality

	1983	1984	1985	1986	1987	1988	1989	1990	1991
LPGW05 NW 1/4 S29-T30N-R21W	1.04	0.70	11.50						
LPGW06 NW1/4 S30 T30N R21W			1.70	7.70	6.90	9.10	8.53	4.33	
LPGW13 SE1/4 S14 T30 R22W	3.05		24.50		18.00	20.61	20.69	23.50	25.30
LPGW15 SW1/4 S25 T30N R22W	4.66	6.90	8.50	8.50	5.70	7.82	9.02	10.70	
LPGW17 NE1/4 S30 T30N R21W	1.10	1.80	1.20	1.10	1.00	7.74	1.11	1.57	
LPGW23 SE1/4 S11 T30N R21W	5.20		7.70	7.50	8.10		8.82	7.71	8.25
LPGW27 SW1/4 S1 T30N R21W	6.40		7.80	3.90	5.20	4.99	10.54	5.06	6.06
LPGW30 NW1/4 S20 T30N R21W		1.80	1.50	1.70	1.60	1.71	1.74	2.04	1.87
LPGW31 SE1/4 S25 T31N R22W		2.03	1.20	1.70	1.30	1.33	1.33	1.50	1.56
LPGW33 SE1/4 S15 T30N R21W		20.00	15.70	14.30	12.00	18.05	15.98	17.90	18.10
LPGW34 SE1/4 S15 T30N R21W		7.50	9.00		6.40	6.70		6.81	7.45
LPGW36 NW1/4 S8 T29N R20W		3.40	3.90	2.20	0.37	0.37		0.39	0.38
LPGW37 NW1/4 S17 T30N R20W		2.50	1.00	1.20	0.89	0.98			0.90
LPGW44 SW1/4 S26 T30N R22W		9.40	9.90	6.20	6.90		13.35		9.31
LPGW53 NW1/4 S30 T30N R21W				6.90	5.50	2.97	7.56	4.47	2.34
LPGW54 SE1/4 S1 T30N R21W				1.20	1.00	1.32	1.61	1.37	1.28
LPGW55 NE1/4 S14 T30N R21W				1.80	1.60	2.22	2.52	2.77	2.65
LPGW56 NE1/4 S15 T30N R21W				6.20	5.80	6.97	8.52	8.62	9.62
AVERAGES	3.58	5.60	7.51	4.81	5.19	6.19	7.95	6.58	6.79

MIDDLE NIOBRARA NRD

NITRATE LEVELS IN GROUNDWATER



ABOVE 10 PPM

5 TO 10 PPM

UNDER 5 PPM

SOURCE: District Monitoring Data
Map Created By The Middle Niobrara NRD

APPENDIX 26

APPENDIX 27 - LOCATIONS OF FEEDLOTS IN THE MIDDLE NIOBRARA NRD

BROWN COUNTY

Section 9, 29 N, 21 W	Swine
Section 7, 30 N, 21 W	Cattle
Section 9, 30 N, 21 W	Swine
Section 12, 30 N, 21 W	Sheep
Section 14, 30 N, 22 W	Cattle
Section 15, 30 N, 22 W	Cattle
Section 16, 30 N, 22 W	Cattle
Section 16, 30 N, 22 W	Cattle
Section 20, 30 N, 22 W	Swine
Section 21, 30 N, 22 W	Cattle
Section 22, 30 N, 22 W	Cattle
Section 23, 30 N, 22 W	Cattle
Section 12, 30 N, 23 W	Swine
Section 12, 30 N, 23 W	Cattle
Section 13, 30 N, 23 W	Swine
Section 13, 30 N, 23 W	Cattle
Section 14, 30 N, 23 W	Cattle
Section 21, 30 N, 23 W	Swine
Section 22, 30 N, 24 W	Cattle

CHERRY COUNTY

Section 23, 30 N, 40 W	Swine
Section 2, 33 N, 28 W	Cattle
Section 20, 33 N, 34 W	Swine
Section 24, 33 N, 34 W	Cattle, Swine
Section 11, 33 N, 36 W	Cattle
Section 11, 33 N, 36 W	Cattle
Section 33, 33 N, 40 W	Cattle
Section 23, 34 N, 28 W	Cattle, Swine
Section 26, 35 N, 28 W	Swine

ROCK COUNTY

Section 35, 30 N, 20 W	Cattle

APPENDIX 28 - LOCATIONS OF WASTE WATER TREATMENT FACILITIES IN THE MIDDLE NIOBRARA NRD

FACILITY NAME	DISCHARGE POINT
Ainsworth Waste Water Facility	Bone Creek
Long Pine Waste Water Facility	Long Pine Creek
Merriman Waste Water Facility	Dry Creek
Valentine Waster Water Facility	Minnechaduza Creek
Pavelka Enterprises, Valentine, NE	

APPENDIX 29 - LOCATIONS OF KNOWN SEPTIC FIELDS IN THE MIDDLE NIOBRARA NRD

This list is limited to known locations that contain more than 3 septic systems. Individual homesites are not included because of the difficulty collecting accurate data. There may be additional sites that have been missed.

Ainsworth - homes and businesses not hooked up to sewer system
Alkali Fish Camp - recreational development
Chaduza Acres - homes located west of Valentine
Cody - homes and businesses
Crookston - homes and businesses
Eli - homes, abandoned home sites
Ft. Niobrara Wildlife Refuge - headquarters facilities
Hidden Paradise - cabin sites along Long Pine Creek
Johnstown - homes and businesses
Kilgore - homes and businesses
Lake Minnechaduza - homes located around the lake
Long Pine - homes and businesses not hooked up to sewer system
McKelvie National Forest Headquarters
Merriman - homes and businesses not hooked up to sewer system
Merritt Reservoir - recreational development around lake
Nenzel - homes and businesses
Nordon - homes and abandoned home sites
Snake Falls - recreational development
Sparks - homes, businesses, and abandoned home sites
Valentine - homes and businesses not hooked up to sewer system
Valentine Wildlife Refuge - headquarters facilities
Wood Lake - homes and businesses

APPENDIX 30 - KNOWN LOCATIONS OF HAZARDOUS MATERIALS IN THE MIDDLE NIOBRARA NRD

Ainsworth

Chuck's Conoco - fuels and other petroleum products
Farmer's Rancher's Coop - fuel, petroleum products, ag chemicals
Irwin's Oil Co. - fuels and other petroleum products
Madison's Great Western - fuels, petroleum products, fertilizers, and ag chemicals
Masters Petroleum Co. - fuels and petroleum products
Pump and Pantry - fuels and petroleum products
U.S. West - Sulfuric Acid

Cody

Cody Oil Co. - Fuels and petroleum products

Crookston

Crookston Grain & Fertilizer - Ag chemicals
U.S. West - sulfuric Acid

Johnstown

Village Store - fuel

Kilgore

Kilgore Service Station - fuel

Long Pine

COASH - fuels, petroleum products, and ag chemicals

Merriman

Buckles Service - fuels and petroleum products

Merritt Reservoir

Merritt Trading Post - fuels

Valentine

AT&T - sulfuric acid and petroleum products
Don's Service - fuels and petroleum products
Home Oil - fuels and petroleum products
Midway Oil - fuels and petroleum products
Ron's Texeco - fuels and petroleum products
Ross Transfer - petroleum products
Sinclair Service - fuels and petroleum products
Super Pumper - fuels and petroleum products
U.S. West - sulfuric acid
West Mart Amoco - fuels and petroleum products
Weston Oil - fuels and petroleum products
4 Seasons Motors - fuels and petroleum products

Appendix 31 - LIST OF POTENTIAL GROUNDWATER CONTAMINANTS AND MAXIMUM CONTAMINANT LEVELS

MCL - Maximum Contaminant Level
MCLG - Maximum Contaminant Level Goal
All levels in milligrams per liter unless otherwise noted

Information From: SCS, Fertilizer & Pesticide Dealers, NE Dept of Health - "Regulations Governing Public Water Supply Systems", and EPA - "Drinking Water Regulations and Health Advisories, 1994"

Pesticides

High Potential Threat (Contaminants not list are considered as low threat)

Potential Contaminant	MCL	MCLG
Aciflourfen Sodium Salt (Blazer)		zero
Alachlor (Lasso)	0.002	
Atrazine	0.003	
Bentazon (Basagran)		0.02
Bromacil		
Butylate (Sutan)		
Carbofuran (Furadan)	0.04	
Chlorimuron Ethyl (Classic)		
Chlorpyrifos (Lorsban)		
Cyanazine (Bladex)		0.001
Dicamba (Banvel)		
Dimethoate (Cygon)		
Diuron (Karmex)		
EPTC (Eradicane)		
Fonofos (Dyfonate)		
Hexazinone (Velpar)		
Imazaquin Ammonium Salt		
Imazethapyr (Pursuit)		
Lindane	0.004	
Metalaxyl (Apron)		
Metolachlor (Dual)		
Metribuzin (Sencor)		
Metsulfuron-methyl (Ally)		
Pendimethalin (Prowl)		
Phorate (Thimet)		
Picloram (Tordon)	0.5	
Prameton		
Propazine (Milogard)		
Simazine (Princep)	0.004	
Terbufos (Counter)		
Tebuthiuron (Spike)		
Trifluralin (Treflan)		
Triclopyr ester (Crossbow)		
2,4,5-TB	0.01	
2,4-D	0.1	

Low Potential Threat Pesticides Commonly Used In The NRD

Potential Contaminant	MCL	MCLG
Acephate		
Benefin		
Bromoxynil		
Captan		
Carbaryl (Sevin)		
DCPA (Dacthal)		
Diazinon		
DSMA		
Glyphosphate (Roundup)	0.7	
Malathion		
Nitrapyrin (N-Serve)		
Paraquat		
Parathion		
Permethrin (Pounce)		
Propargite (Comite)		
Sethoxydim (Poast)		
Toxaphene	0.005	

Other Potential Contaminants

Contaminant	MCL
Arsenic	0.05
Benzene	0.005
Carbon Tetrachloride	0.005
Chloride	
Coliform Bacteria	Presence in sample
Floride	4.0
Lead	0.05
Mercury	0.02
Nitrates	10.0
Selenium	0.05
Sodium	500
Trichlorethelyne	0.005
Zinc	

APPENDIX 32 - KNOWN LOCATIONS OF THREATENED AND ENDANGERED SPECIES IN THE MIDDLE NIOBRARA NRD

PRAIRIE FRINGED ORCHID

Section 16 & 17-26N-27W
Section 18-30N-27W
Section 35-30N-28W
Section 12 & 28-30N-29W
Section 25-29N28W
Section 30-29N-27W
Section 2-31N-26W
Section 34-32N-26W

NORTHERN RED BELLIED DACE

Holt Creek
Cottonwood Creek
Lost Creek
Bone Creek
Fairfield Creek
South Fork Fairfield Creek
Snake River
Minnechaduza Creek
Gordon Creek
Sand Draw Creek

BLACKNOSE SHINER

Holt Creek
Gordon Creek

PEARL DACE

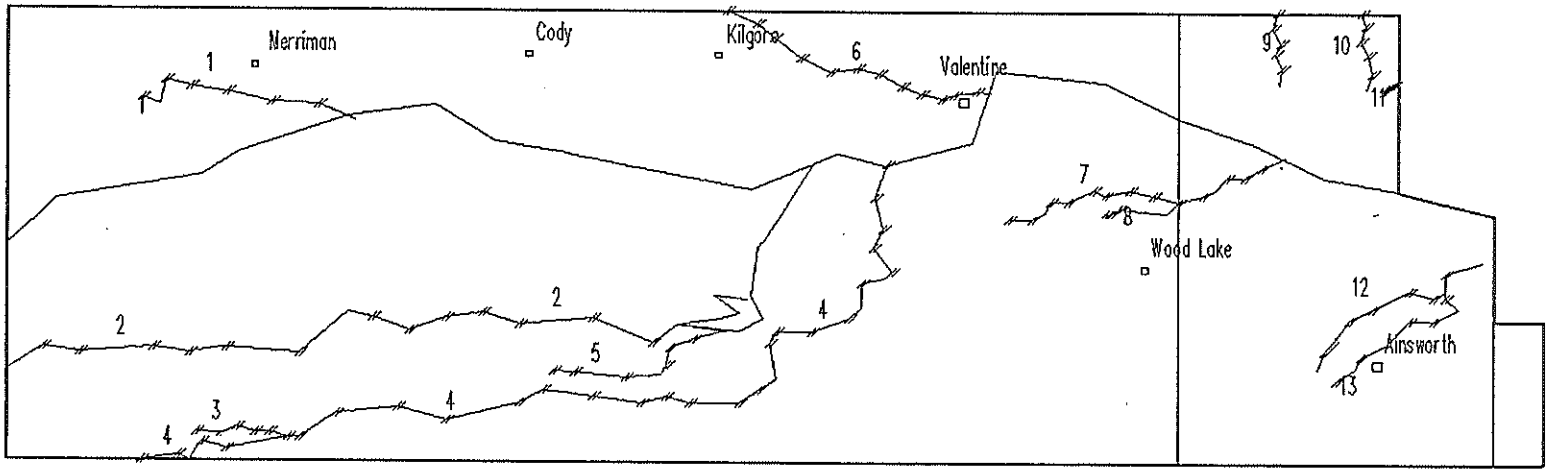
Holt Creek
Cottonwood Creek
Lost Creek
Bone Creek
Sand Draw Creek
Sandy Richards Creek
Snake River
Minnechaduza Creek
Leander Creek
Gordon Creek

FINESCALE DACE

Holt Creek
Cottonwood Creek
Bone Creek
Sand Draw Creek
Sandy Richards Creek
South Fork Fairfield Creek
Boardman Creek
Gordon Creek
Leander Creek
Minnechaduza Creek
Snake River

MIDDLE NIOBRARA NRD

STREAMS WITH POPULATIONS OF THREATENED OR ENDANGERED SPECIES OF FISH



STREAMS SUPPORTING POPULATIONS OF THREATENED OR ENDANGERED FISH

1 – Leander Creek
2 – Snake River
3 – Sandy Richards Creek
4 – Gordon Creek
5 – Boardman Creek
6 – Minnechaduza Creek
7 – Fairfield Creek
8 – South Fork Fairfield Creek
9 – Lost Creek
10 – Cottonwood Creek
11 – Holt Creek
12 – Sand Draw Creek
13 – Bone Creek

Source: Nebraska Game and Parks Commission

MAP CREATED BY: Middle Niobrara NRD

APPENDIX 33

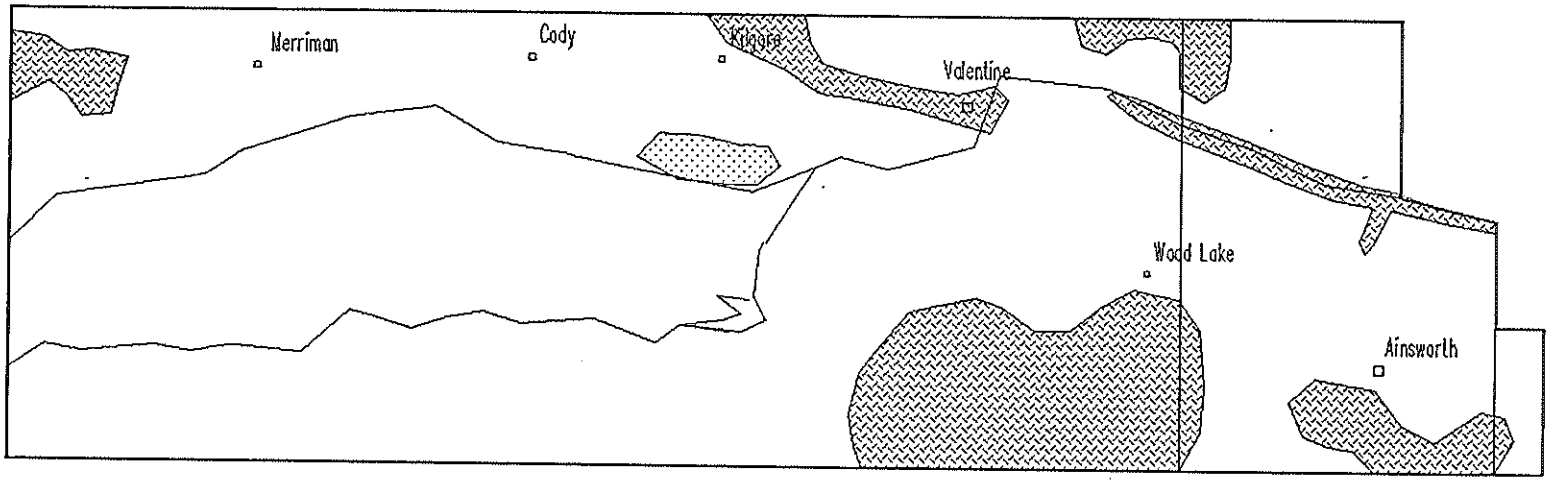
APPENDIX 34 - TIME STRATIGRAPHIC CHART OF GEOLOGICAL UNITS

ERA	PERIOD	EPOCH	GROUP	FORMATION	ENVIRONMENTS OF DEPOSITION
Cenozoic	Quaternary	Holocene		Unnamed	Eolian, alluvial
		0.01			
		Pleistocene		Unnamed	Alluvial, eolian
		1.6			
	Tertiary	Pliocene		Broadwater/ Long Pine	Alluvial, lacustrine
		5			
		Miocene	Ogallala	Ash Hollow	Alluvial
				Valentine	
				Runningwater	
			19		
			Arikaree	Upper Harrison beds	Eolian, alluvial
				Monroe Creek-Harrison	
		24		Gering	
			28		
		Oligocene	White River	Brule	Eolian, alluvial
				Chadron	Alluvial, eolian
			37		
		38	Rocks of this age not known to occur under the Sand Hills.		Soil developed on older rocks
		Eocene-Paleocene			
		65			
Mesozoic	Cretaceous	Late	Montana	Pierre Shale	Marine
			Colorado	Niobrara	
			Benton	Carlile	
				Greenhorn	
				Graneros	
		98			
		Early	Dakota		
		144			
	Jurassic			Morrison	

Note: Approximate age of boundaries given in millions of years

MIDDLE NIOBRARA NRD

POTENTIAL GROUNDWATER VULNERABILITY TO CONTAMINATION



Low Potential For Contamination

Moderate Potential For Contamination

High Potential For Contamination

SOURCE: DRASTIC Model, NE Natural Resources Commission – UNL Conservation & Survey Division, 1993

MAP CREATED BY: Middle Niobrara NRD

APPENDIX 35

APPENDIX 36

INITIAL WELL NETWORK USED FOR ESTABLISHING MANAGEMENT ZONES

ID	COUNTY		SEC	TWN	RGE	WELL TYPE
RK29-20-01	ROCK	NW	02	29	20	dom
BR29-20-02	BROWN	NW	08	29	20	dom
BR29-20-03	BROWN	NW1/4	08	29	20	dom
RK29-20-03	ROCK	SE	11	29	20	irrig
RK29-20-01	ROCK		14	29	20	irrig
RK29-20-02	ROCK	NE	23	29	20	dom
RK29-20-04	ROCK	SW	26	29	20	dom
BR29-20-05	BROWN	SE	30	29	20	dom
RK30-20-01	ROCK	NW	09	30	20	dom
RK30-20-02	ROCK	NE	11	30	20	dom
BR30-20–01	BROWN		12	30	20	dom
RK30-20-03	ROCK	SE	13	30	20	irrig
RK30-20-04	ROCK	NW	15	30	20	dom
BR30-20-02	BROWN	NW1/4	17	30	20	dom
BR30-20-03	BROWN	SE	22	30	20	dom
RK30-20-05	ROCK	NE	26	30	20	dom
BR30-20-04	BROWN	NW1/4	27	30	20	mon
RK30-20-06	ROCK	SE	27	30	20	dom
RK30-20-07	ROCK	NE	34	30	20	irrig
BR31-20-01	BROWN	NE	05	31	20	dom
BR31-20-02	BROWN	SW1/4	07	31	20	mon
BR32-20-01	BROWN	SW1/4	27	32	20	mon
BR29-21-01	BROWN	SW 1/4	06	29	21	irrig.
BR30-21-01	BROWN	SE1/4	01	30	21	dom
BR30-21-02	BROWN	SW1/4	01	30	21	dom
BR30-21-03	BROWN	SW1/4	01	30	21	mon
BR30-21-04	BROWN	SE1/4	09	30	21	mon
BR30-21-05	BROWN	SE 1/4	11	30	21	dom
BR30-21-06	BROWN	NE 1/4	14	30	21	dom
BR30-21-07	BROWN	NE1/4	14	30	21	dom
BR30-21-08	BROWN	NE1/4	15	30	21	dom
BR30-21-09	BROWN	SE 1/4	15	30	21	dom.
BR30-21-10	BROWN	SE1/4	15	30	21	dom
BR30-21-27	BROWN	NW	20	30	21	dom
BR30-21-11	BROWN	NE	20	30	21	irrig.
BR30-21-12	BROWN	NW	20	30	21	dom
BR30-21-13	BROWN	NW 1/4	20	30	21	dom
BR30-21-14	BROWN	NW 1/4	20	30	21	dom
BR30-21-25	BROWN	SE	22	30	21	dom
BR30-21-15	BROWN	NE1/4	26	30	21	mon.
BR30-21-16	BROWN	NE 1/4	28	30	21	dom
BR30-21-17	BROWN	NE1/4	29	30	21	mon
BR30-21-18	BROWN	NW 1/4	29	30	21	irrig.
BR30-21-19	BROWN	NE	30	30	21	dom
BR30-21-20	BROWN	NE 1/4	30	30	21	irrig.
BR30-21-21	BROWN	NW 1/4	30	30	21	irrig
BR30-21-22	BROWN	NW 1/4	30	30	21	dom
BR30-21-23	BROWN	NW1/4	30	30	21	dom
BR30-21-26	BROWN	NW	33	30	21	dom
BR30-21-24	BROWN	NW	34	30	21	dom
BR31-21-01	BROWN	SE	09	31	21	dom
BR31-21-02	BROWN	SE1/4	10	31	21	mon
BR29-22-01	BROWN	NW	02	29	22	dom
BR29-22-02	BROWN	SW1/4	14	29	22	mon
BR29-22-03	BROWN	NW	23	29	22	dom
BR30-22-01	BROWN	NE	02	30	22	dom
BR30-22-02	BROWN	NE	07	30	22	irrig.
BR30-22-03	BROWN	NW1/4	08	30	22	mon
BR30-22-04	BROWN	SE 1/4	14	30	22	irrig
BR30-22-05	BROWN	SW	15	30	22	dom
BR30-22-06	BROWN	SE	17	30	22	irrig.
BR30-22-07	BROWN	SW	21	30	22	dom
BR30-22-08	BROWN	SE 1/4	25	30	22	irrig.
BR30-22-09	BROWN	SW 1/4	25	30	22	irrig.
BR30-22-10	BROWN	SW 1/4	26	30	22	irrig.
BR30-22-11	BROWN	NE 1/4	30	30	22	irrig.

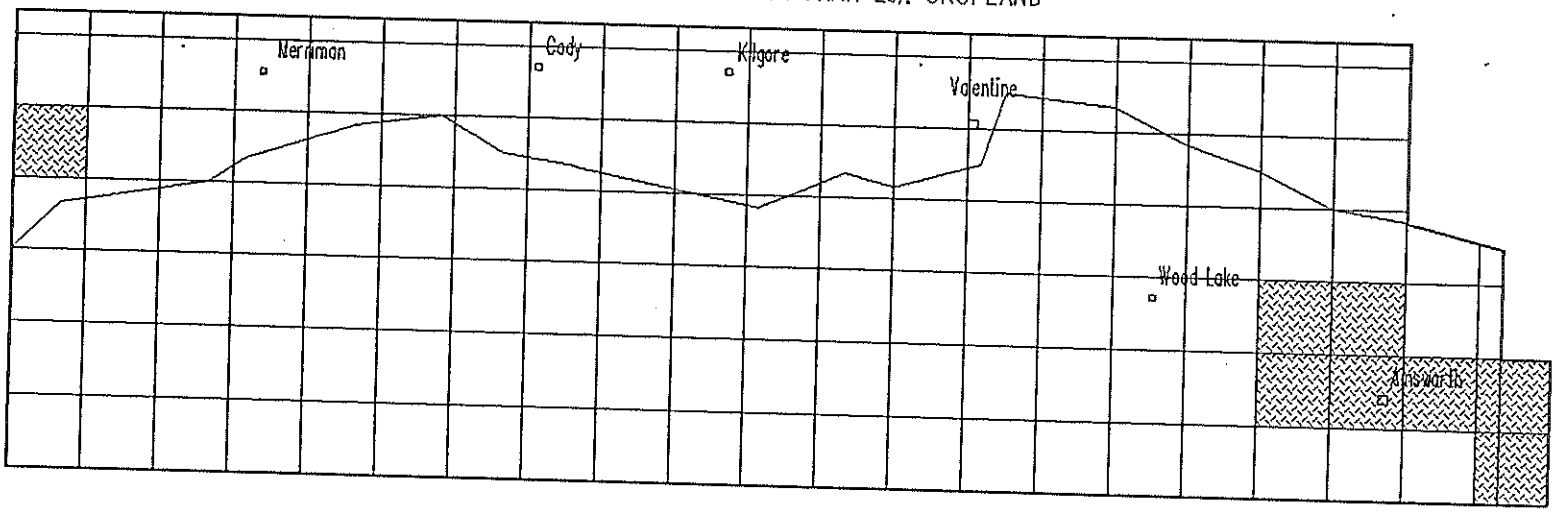
APPENDIX 36

INITIAL WELL NETWORK USED FOR ESTABLISHING MANAGEMENT ZONES

ID	COUNTY		SEC	TWN	RGE	WELL TYPE
BR30-22-12	BROWN	NW	31	30	22	dom
BR31-22-01	BROWN	NE	01	31	22	irrig.
BR31-22-02	BROWN	SE	10	31	22	dom
BR31-22-08	BROWN	NE	10	31	22	dom
BR31-22-04	BROWN	SE	18	31	22	dom
BR31-22-07	BROWN	NW1/4	22	31	22	irrig.
BR31-22-05	BROWN	SE 1/4	25	31	22	dom
BR31-22-06	BROWN	NE1/4	29	31	22	irrig.
BR31-22-03	BROWN	NW1/4	29	31	22	irrig.
BR31-22-09	BROWN	NW	35	31	22	mon
KP32-22-01	KEYA PAHA	SW 1/4	12	32	22	dom
KP32-22-02	KEYA PAHA	SW 1/4	12	32	22	dom
KP33-22-02	KEYA PAHA	NE	09	33	22	dom
KP33-22-01	KEYA PAHA	SE 1/4	13	33	22	dom
KP33-22-03	KEYA PAHA	SW1/4	16	33	22	dom
KP34-22-01	KEYA PAHA	SW 1/	02	34	22	dom
KP34-22-02	KEYA PAHA	NE1/4	30	34	22	dom
BR30-23-01	BROWN	NE	05	30	23	dom
BR30-23-02	BROWN	NW 1/4	13	30	23	irrig.
BR30-23-03	BROWN	NE	24	30	23	dom
BR31-23-01	BROWN	SE 1/4	12	31	23	irrig.
BR31-23-02	BROWN	SE	26	31	23	dom
BR33-23-01	BROWN	SE	33	33	23	dom
KP34-23-01	KEYA PAHA	NE1/4	12	34	23	dom
KP34-23-02	KEYA PAHA	SW	13	34	23	dom
BR30-24-01	BROWN	SW	04	30	24	dom
BR30-24-02	BROWN	NW	34	30	24	dom
KP33-24-01	KEYA PAHA	NW	17	33	24	dom
KP34-24-01	KEYA PAHA	NE	04	34	24	dom
KP34-24-02	KEYA PAHA	SE1/4	17	34	24	dom
KP34-24-03	KEYA PAHA	SE1/4	31	34	24	dom
CH31-25-01	CHERRY	SE	17	31	25	dom
CH34-25-01	CHERRY	NE	14	34	25	irrig
CH35-25-01	CHERRY	NE	30	35	25	dom
CH32-26-01	CHERRY	SE	02	32	26	dom
CH32-26-02	CHERRY	NW	21	32	26	dom
CH32-26-03	CHERRY	SE	21	32	26	lvstk
CH34-26-01	CHERRY	NE	03	34	26	irrig
CH31-27-01	CHERRY	NE	30	31	27	dom
CH33-27-01	CHERRY	SW	24	33	27	lvstk
CH33-27-02	CHERRY	SW	32	33	27	irrig
CH34-27-01	CHERRY	NE	27	34	27	dom
CH33-28-01	CHERRY	NW	01	33	28	dom
CH33-28-02	CHERRY	NW	01	33	28	dom
CH33-28-03	CHERRY	NE	02	33	28	lvst
CH33-28-04	CHERRY	NW	02	33	28	dom
CH34-28-01	CHERRY	NE	01	34	28	dom
CH34-28-02	CHERRY	SE	29	34	28	dom
CH34-28-03	CHERRY	NE	35	34	28	dom
CH34-28-04	CHERRY	SE	36	34	28	dom
CH35-28-01	CHERRY	NE	28	35	28	dom
CH34-29-01	CHERRY	SE	07	34	29	dom
CH35-29-01	CHERRY	SW	35	35	29	dom
CH33-30-01	CHERRY	N	10	33	30	irrig
CH33-30-02	CHERRY	SE	31	33	30	irrig
CH34-30-01	CHERRY	SE	18	34	30	dom
CH34-30-02	CHERRY	SE	26	34	30	irrig
CH34-31-01	CHERRY	NE	10	34	31	dom
CH34-31-02	CHERRY	SE	11	34	31	irrig
CH34-31-03	CHERRY	SW	11	34	31	dom
CH34-31-04	CHERRY	SE	23	34	31	dom
CH34-31-05	CHERRY	SE	28	34	31	irrig
CH34-32-01	CHERRY	SW	24	34	32	irrig
CH33-33-01	CHERRY	NE1/4	05	33	33	irrig
CH32-34-01	CHERRY	SW	08	32	34	irrig
CH33-34-01	CHERRY	SE	17	33	34	irrig

MIDDLE NIOBRARA NRD

TOWNSHIPS WITH GREATER THAN 20% CROPLAND

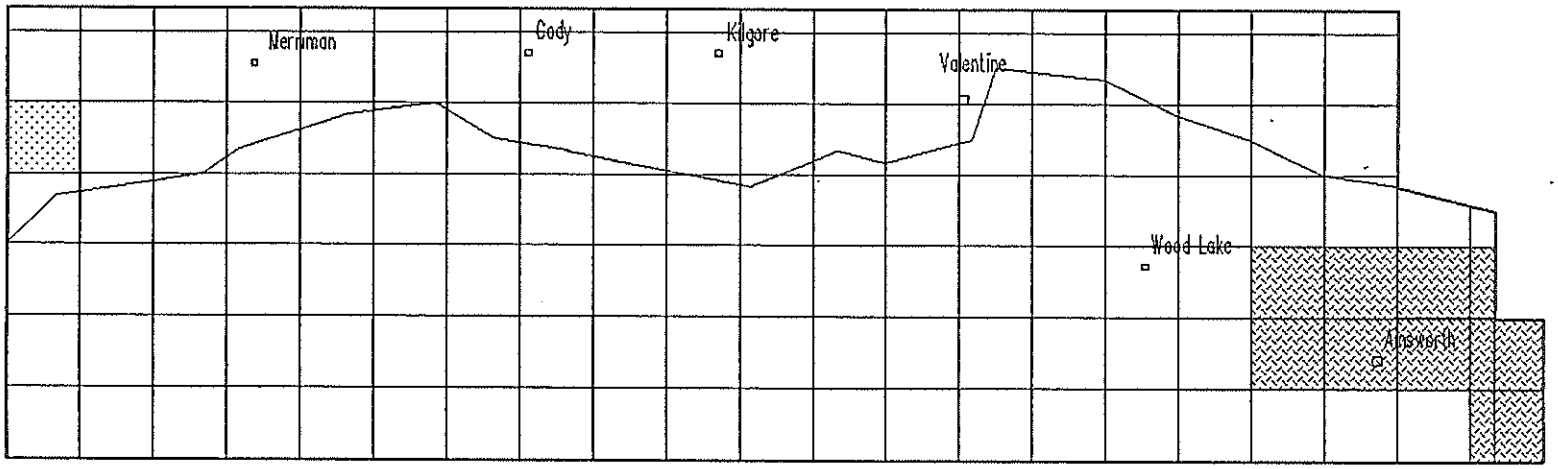


Townships With Greater Than 20% Cropland

APPENDIX 37

MIDDLE NIOBRARA NRD

PROPOSED QUALITY MANAGEMENT ZONES



Management Zone 1

Management Zone 2

Management Zone 3

APPENDIX 38