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INTRODUCTION

1.1 GENERAL BACKGROUND

The Upper Niobrara-White Natural Resources District (NRD) recognizes that ground water is one of the state's most valuable resources and ground water management is essential to the public interest. Retaining primary responsibility for ground water management at the local NRD level is also important.

This revision of the Ground Water Management Plan is in response to LB 51, enacted by the Nebraska Legislature in 1991, requiring NRDs to amend their ground water management plans to identify levels and sources of ground water contaminants within the area. The NRDs also have responsibility for establishing ground water quality goals, long-term solutions necessary for maintaining water quality, and procedures to reduce the possibility for additional or ongoing contamination of ground water.

The Upper Niobrara-White NRD Board of Directors determined that the best approach to meeting the requirements of LB 51 would be a complete update and revision of the NRD's Ground Water Management Plan. Integration of all the material into one document would provide the reviewing agencies, the NRD staff, and the citizens of the NRD with a more usable reference. The NRD contracted with Jacobson Helgoth Consultants, Inc., a Nebraska-based environmental consulting firm, to assist the NRD staff with the revision.

This revised Ground Water Management Plan has been prepared by compiling the available technical information. The technical data contained in the original (1985) Ground Water Management Plan had been collected and summarized by Hoskins-Western-Sonderegger, Inc. During the preparation of this plan, Jacobson Helgoth Consultants, Inc. (JHC) incorporated new environmental information into the plan in order to meet the requirements for amended Ground Water Management Plans as set forth by the State of Nebraska Natural Resources Department. The policies and programs contained in this plan have been approved by the NRD Board of Directors so that the plan will serve as a working document and management tool. Revision of the plan, based on bi-annual reviews, will be performed by the Board of Directors as necessary to attain the desired goals and objectives.

Public participation has been provided by the District Ground Water Management Planning Committee and by the Board of Directors' meetings. Future public input will be solicited from the residents in the NRD during public meetings or during the day-to-day operations of the NRD staff. The NRD Board of Directors may consider plan revisions based on this input during the scheduled reviews of the plan.

The Upper Niobrara-White Natural Resource District has taken a number of steps to implement the objectives contained in the initial (1985) Ground Water Management Plan. Primary programs initiated by the District include:

- Ground Water Level Monitoring Program
- Ground Water Quality Monitoring Program
- Irrigation Scheduling Program
- Irrigation Runoff Control Program
- Educational Program for agriculture emphasizing Best Management Practices
- Educational Programs for students and teachers
- Inspection Program of chemigation systems
- Soil Conservation Program emphasizing tree planting
- Sediment and Soil Erosion Control Program

The details and results of these programs are included in the body of this amended Ground Water Management Plan.

1.2 REGULATORY BACKGROUND

Concerns about declining ground water levels resulted in the Nebraska Legislature passing the Ground Water Management Act of 1975. This legislation provided a means by which ground water depletion could be controlled and regulated to avoid irreparable damage to aquifers. In 1982 the State of Nebraska revised the Ground Water Management Act, later called the Ground Water

Management and Protection Act, to allow the creation of Ground Water Management Areas. The 23 Nebraska Natural Resource Districts were required by a 1984 revision to this act to develop a Ground Water Management Plan that would inventory the ground water resources of each District.

Prior to 1984, the focus of Nebraska ground water legislation was strictly water depletion. The 1986 update of the Act further defined the role of the NRDs and provided a means by which nonpoint source ground water contamination could be addressed. In 1991, legislation was passed, requiring the NRDs to address water quality issues in more detail in their Ground Water Management Plans. The State of Nebraska has given the primary responsibility for administering nonpoint source regulations to the NRDs. The responsibility for administering point source regulations is divided among several state agencies, primarily the Department of Environmental Quality and the Department of Health.

SECTION 2.0

PHYSICAL SETTING AND HYDROGEOLOGY

2.1 General Physical Setting

2.1.1 Drainage and Topography

The State of Nebraska has been separated into eight (8) regions of similar physical features by the staff of the Conservation and Survey Division. All eight (8) of these regions are represented within the boundaries of the Upper Niobrara-White NRD. These are the Plains Region, the Dissected Plains Region, the Valleys Region, the Sand Hills Region, the Rolling Hills Region, The Bluffs and Escarpments Region, the Valley Side Slopes Region, and Large Reservoirs. The distribution of these regions is shown on Figure 2-1.

Five major drainage areas shape the topography of the District. These include the Hat Creek and White River basins in the northwest part of the District; the Niobrara Valley through the center of the District; the Snake Creek drainage area in Box Butte County; and the Sand Hill area of southern Sheridan County.

Streams in the District range from intermittent to perennial. The perennial streams have surface flows all year long in contrast to intermittent streams that are dry for some part of the year. The flow in perennial streams, after the spring runoff period, is primarily due to ground water discharge. The White River and Hat Creek are perennial streams that carry runoff from the District northward into South Dakota. Hat Creek drains northern Sioux County. The White River drains east-central Sioux County and northern Dawes County.

The Niobrara Valley of southern Sioux County, southern Dawes County and northern Sheridan County is drained by the Niobrara River and its tributaries. The Niobrara River is a perennial stream flowing eastward from Wyoming. Runoff water and ground water discharge provide year-round base flow. The Snake Creek, Hemingford and Box Butte Creek systems drain most of Box Butte County toward the southeast. A number of these intermittent streams disappear into the Sand Hills at the southeast corner of Box Butte County.

For planning purposes, the District can be divided into five (5) distinct topographic areas: the Sand Hills, the Box Butte and Niobrara Valleys, the Pine Ridge, the White River Valley and the Sioux Tablelands. The topography of the District is varied, consisting of escarpments, plains, rolling hills, valleys, and tablelands. Each topographic region has its unique characteristics with regard to ground water, soils, runoff, land use, natural vegetation, and population. Figure 2-1 illustrates the varied topography encountered district-wide.

The Sand Hill areas are found in southern Sheridan County, in a small area of west-central Sioux County, and along the southern edge of Box Butte County. The Sand Hills consist of rolling sand dunes stabilized by thin grass cover. The dunes have blocked development of any integrated drainage systems so that the area now consists of a series of enclosed drainage basins.

The Hat Creek-White River drainage systems have eroded a deep basin which is bounded by the Pine Ridge escarpment along the southern edge. The footslopes along the base of the escarpment contain several areas of Badlands topography.

The Pine Ridge area includes the Pine Ridge Escarpment and a portion of the northern Niobrara Valley. The feature called the ridge line is actually along the crest of the escarpment.

The majority of Box Butte County is tableland, which is characterized by generally flat surfaces with a few topographically high erosional remnants, such as Box Butte, for which the county is named. Other areas of tableland are located north of the Niobrara River in Dawes and Sheridan County.

Sioux County, from Harrison to the Box Butte County border south of the Niobrara River, is rolling uplands similar to much of the High Plains Region. It is referred to as the Sioux Uplands.

Flat areas along streams include floodplains and terraces. Terraces are extensively developed along the major streams in the District. Mirage Flats is an example of a large terrace which was developed along the Niobrara River in Sheridan County.

2.1.2 Ground Water Reservoirs

The principal aquifer units comprising the ground water reservoir in the Upper Niobrara-White Natural Resource District consist of the Arikaree group and several younger units, of which the sediments of the Ogallala Group are the most intensively developed. There are several other, less important units (in terms of thickness, areal extent, and use) such as the saturated unconsolidated sands of the Sand Hills area overlying the Ogallala Group sediments, and the Box Butte and Running Water units overlying the Arikaree. These units are also considered part of the "principal aquifer". Figure 2-2 is a geologic map showing the areal distribution of the various geologic units. A table showing the depositional sequence and relative age of each unit, its thickness, and an indication of its hydraulic characteristics (aquifer, aquiclude, aquitard) is also included on Figure 2-2. In trying to visualize the areal distribution of the various aquifer units, keep in mind that the Arikaree and Ogallala units underlie a large portion of the District, except in the northwest and north central portions of the NRD where erosion has removed them and exposed the older units. The distribution of the Arikaree and Ogallala rocks are shown on Figure 2-3.

Figures 2-4, 2-5, and 2-6 are taken from the Box Butte County Report (Souders, Smith and Swinehart, 1980) to demonstrate the type of variation encountered in the subsurface distribution, thickness and number of units present beneath a given location. In large areas of Box Butte County the Arikaree unit is overlain by the Sheep Creek and Upper Harrison units. These units are composed of fine-grained silts and clays that serve as confining layers (aquitards) to the Arikaree sediments and may inhibit recharge from precipitation. A complicating factor, when trying to envision lateral and vertical distribution of NRD's aquifer units, is that the units overlying the Arikaree are not neatly stacked, one upon the other. Instead, many units fill deep channels which were cut into older units. An example is the erosional thinning of the upper Harrison unit between Snake Creek and Hemingford Creek (Figure 2-6 cross-section CC) which is infilled with Ogallala group sediments. Therefore, the thickness of any unit may change in any direction and most units have restrictive lateral extent. Basically, the Arikaree unit is thickest and most extensive toward the west and the Ogallala thickens and is most extensive toward the east.

> The principal regional ground water reservoir is thin to absent in the White River-Hat Creek Basin in northern Sioux and Dawes Counties, where the Tertiary formations have been removed by erosion. This causes a water shortage in that area. A few wells are developed in the fractured Brule formation. These locally yield sufficient water to supply stock and domestic purposes. The Chadron sand also supplies some stock and domestic wells. At a few specific sites, where fracture systems intersect faults, this formation contributes up to 600 gallons per minute from springs. For the most part, the area north of the White River relies on an extensive system of ground water supplied pipelines and dams to supply potable or livestock water.

The distribution of registered irrigation wells in the NRD is illustrated on Figure 2-7. Development of irrigated agriculture corresponds primarily with soil suitability, reasonable depths-to-water and good well yield. This figure provides a look at the area distribution of ground water reservoir that is most suitable for irrigation development.

There are sizeable areas in southern Sioux and Sheridan Counties where aquifer thickness is great and transmissivity is sufficiently high enough to yield water for irrigation, but the depth-to-water is great. Soils are poor or topography is unsuitable for irrigation development in parts of these areas. These areas are capable of yielding large amounts of water over an extended period of time, but would probably need an economic use with greater return on investment than irrigation to support their development.

2.1.3 Aquifer Properties

The elevation of the base of the principal aquifer is presented in Figure 2-8, with the generalized depth to the base of the aquifer (from land surface) shown in Figure 2-9. The aquifer thickness map (Figure 2-10) was compiled by subtracting the values on the configuration of the base of the aquifer map (Figure 2-8) from the values taken from the configuration of the water table map (Figure 2-11). Aquifer thickness varies widely over the NRD. Aquifer thickness ranges from zero to 100 feet in localized areas along the Pine Ridge, to over 800 feet in southern Sheridan County. Aquifer thickness in the heavily developed areas in Box Butte County and the Mirage Flats area in Sheridan County range from 200 to 400+ feet thick. The aquifer rocks in this area are primarily Ogallala Group sediments combined with some Arikaree sediments. The thick saturated materials in southern Sheridan County are primarily Ogallala Group rocks. Some overlying Sand Hill deposits are also included in the total thickness. The thick aquifer mapped in central Sioux County is primarily the Arikaree unit. District-wide, there is a significant thickness of aquifer materials with the exception of those areas where the principal tertiary-aged aquifer is thin or absent. The concentration

of irrigation wells cannot be explained by availability of saturated material alone, because the areas with the greatest thickness of aquifer materials are also the most sparsely developed.

Another factor that serves to explain the existing ground water development pattern and potential for additional development of the principal aquifer is transmissivity. Transmissivity represents an aquifer's ability to flow water and is usually expressed in terms of thousands of gallons/day/square foot. To visualize what this value means, imagine a one square-foot window in the side of an aquifer for one day. If the one-foot wide window were lengthened to stretch from the top of the aquifer to the bottom, the amount of water that would flow out of this window in one day would be called the transmissivity (gallons of water yielded per square foot of formation per day). Estimated transmissivities for the principal aquifer are shown on Figure 2-12. District-wide, transmissivities range from zero to 10,000 gal/ft./day along the Pine Ridge, to more than 100,000 gal/ft./day in southern Sheridan County.

Transmissivity does not translate directly to well yield. Well yield, usually expressed in gallons per minute, is the ultimate measure of how much water can be taken from an aquifer. The table on Figure 2-12 illustrates the relationship between transmissivity, saturated thickness and estimated well yield. For example, a fully penetrating well that would yield 500 gal/minute in an area where the aquifer is 50 feet thick, would require a transmissivity greater than 50,000 gal/ft./day. Whereas the same 500 gal/minute well in an area where the aquifer is 200 feet thick could be obtained if transmissivity of the formation was between 10,000 to 20,000 gal/day/ft. The transmissivity and saturated thickness maps can be used, in conjunction with the table, to estimate expected well yields for any given area in the District. One should always keep in mind that these values are provided for the purpose of description and estimation only.

Transmissivity is a material-dependent parameter that is highly influenced by the grain size, distribution, consolidation, cementation,

and confinement of the aquifer sediments. Transmissivity is therefore a fairly site-specific value.

Precise estimation of well yield for any particular point would require site-specific data. Figure 2-13 provides a generalized look at estimated well yield, based on a composite of the saturated thickness and transmissivity maps. The highly developed area in Box Butte County is estimated to be capable of yielding anywhere from 500 to 5,000 gallons/minute (more than sufficient for center pivot irrigation). The highly developed area in north-central Sheridan County supports wells ranging in yield from 500 to 1000+ gallons/minute.

Two areas that appear to support exceptionally high-capacity wells (in the range of 1,000 to 5,000 gallons/minute) lie in southern Sheridan and central Sioux Counties. Obviously, the limiting factor to the development of southern Sheridan County for irrigation is its highly variable topography and sandy soils. Central Sioux County, however, is a gently rolling upland with sandy-loamy soils that, if properly developed and managed, could potentially support irrigation. Why then is there a scarcity of wells developed in this area? The answer appears to be in soil suitability, depth-to-water and economics of pumping lift for irrigation use, as well as traditional land use practices in this area.

Across the NRD, ground water in storage has been estimated to range from less than 20 feet to more than 100 feet. Estimated ground water in storage for the state is shown on Figure 2-14. The actual amount of water in storage is dependent upon the saturated aquifer thickness and type of material in which the water is stored. A column of fairly coarse-grained material and a column of fairly fine-grained material may hold the same volume of water, but the water in the fine-grained column may not be economically recoverable for irrigation or other uses because of its slow drainage into a well. In addition, water quality is important to consider when evaluating ground water in storage. All water in storage is not potable or useable for irrigation. Water quality can change dramatically with depth and the mineral components of the aquifer. Figure 2-14 only provides an areal perspective on ground water in storage. However, there is a significant need for determining just how much of that water is of useable quality. The storage map shows the areas in southern and central Sioux Counties that contain the greatest amount of water, but as mentioned earlier, they are two of the least developed areas. South-central Box Butte County, southern Dawes, and north-central Box Butte County and north-central Sheridan Counties also contain a significant amount of water in storage. These areas support the bulk of irrigation development in the NRD, primarily because of water availability, soil suitability, water quality, and reasonable depths-to-water.

The configuration of the water table, with directional flow arrows, is presented in Figure 2-11. The principal uses of this map are to identify possible recharge and discharge areas, as well as to provide a look at depth-to-water (subtract the water

level elevation the from ground-surface elevation) and saturated thickness (subtract the base-of-the-aquifer values from the water levels). Some general conclusions can be drawn from the configuration of the contours on this map. There are several discharge areas indicated by the flow arrows and contour bends. The Niobrara River serves as a ground water drain. The river appears to be a gaining stream from about central Sioux County until it leaves the NRD in northern Sheridan County (as indicated by flow arrows pointing toward the river from the higher areas). The White River system and Hat Creek basin also serve as drains for ground water. The stretch of the White River near Crawford flows perennially as a result of ground water inflow. Snake Creek, in southern Box Butte County, is also indicated as a discharge area, although evaporation keeps up rather well with what discharge there is, as it is an intermittent stream.

The flow arrows pointing directly to Alliance are a reflection, not only of the regional slope of the water table, but are also influenced by the intensity of pumpage for irrigation. Ground water pumping is also considered a "discharge" from the flow system, and the severity of the bend in the 3,900 foot contour around Alliance is a direct result of the discharge by wells in the area.

The water level surface prior to development and the 1975 ground water surface for Box Butte County are depicted on Figure 2-15. The effects of well development are most apparent from this figure. The movement of the contours from 1938 to 1975 is a direct result of ground water withdrawals reducing the water levels. The arrows also indicate that some underflow may be gained from Wyoming, along the west end of the District, and also from the area south of Alliance. The Sand Hills area in the extreme southeast portion of the NRD appears to serve as a recharge area, with flow arrows emanating from it. However, the lack of an adequate data base precludes confident interpretation of how this area relates to the Alliance area, the Niobrara River, or even to the numerous wetland areas located within. Figure 2-16 is a generalized depth-to-water map prepared from the elevation configuration map. Figure 2-17 is a plot of the USGS-NRD-CSD cooperative water level observation well network. This network, coupled with water level data from test holes, drillers' logs of irrigation wells, and water level measurements taken by the NRD, served as the base of data for construction of the water-table map.

A comparison of Figure 2-7 to Figure 2-16 shows that the density of well development is greatest around Alliance, where depth-to-water is less than 100 feet. The Mirage Flats area is also most heavily developed where water levels occur at less than 50 feet below land surface. Wells in central Box Butte County, also highly developed, generally have to penetrate between 100 and 200 feet to reach water. Figure 2-2 shows that in this area, the Arikaree aquifer unit is overlain by the Sheep Creek and Upper Harrison confining units (aquitards). However, the soils are of sufficient quality and water is of sufficient availability and quality to make irrigation development feasible.

The other two areas of the NRD, containing extensive water supplies with estimated high yield, are quite variable in terms of depth-to-water. Southern Sheridan County contains numerous wetland areas that appear to be surface expressions of the water table or perched aquifers. In some areas depth-to-water may be as much as 300 feet, depending upon the topography and surface elevation of the measurement. In central Sioux County, an area apparently capable of supporting high-capacity wells, depths-to-water generally range from 100 to 300 feet. Considering the well depth that would be required to obtain a suitable supply to a center pivot system, the pumping lift and associated energy costs might be prohibitive.

2.1.4 Precipitation and Evaporation

Precipitation amounts and variations are crucial to ground water management. This is because precipitation provides the base supply of water for crops, and serves as a source of water for ground water recharge. In an agricultural area the amount of precipitation received in any given year generally determines the amount of demand placed on other water supplies.

In the Upper Niobrara-White NRD, average annual precipitation ranges from 14.9 inches in southern Sioux County to 18.38 inches in eastern Sheridan County. The general distribution of precipitation over the NRD is illustrated on Figure 2-18. The precipitation is represented by graphs of the average annual variation recorded for selected stations. The precipitation patterns shown are fairly typical of the Great Plains Region, with the greatest amounts received in the months of May, June and July, averaging around 2 to 3 inches per month. Figure 2-19 shows the type of annual variability that can be expected in the NRD area by depicting the variation in annual precipitation for the Alliance weather station. In very few years does the actual precipitation approximate the long-term average. Actual precipitation is often either well below or well above the average, with annual extremes ranging from less than 10 inches to more than 30 inches.

The Upper Niobrara-White NRD is characterized as an area subject to high evaporation rates. Based on pan evaporation data collected by the National Weather Service at Alliance, the average evaporation for the growing season of May to September is about 43 inches (based upon 30 years of record). Evaporation from a free-water surface would be about 70 percent of that, or about 30 inches. Table 2-1 shows the distribution of evaporation rates over the growing season. From the data presented, it is apparent that on the average, evaporation from a lake, pond or heavily irrigated field exceeds precipitation by about 30 inches per year. About 18 inches of this occurs during the growing season. Therefore supplemental water from either a surface or ground water source is be needed to meet agricultural production needs.

TABLE 2-1

PAN EVAPORATION

Month	Number of years used to average	Average pan evaporation
May	33	7.60
June	34	8.46
July	34	10.54
August	34	9.48
Sept.	34	7.03
	Total, May through September	43.10

2.1.5 Ground Water Recharge

Recharge to the ground water reservoir occurs in several ways: a) underflow from surrounding ground water reservoirs, b) precipitation, c) seepage from streams, canals, surface impoundments, and lakes, d) infiltration from irrigated lands. Souders, Smith, and Swinehart (1980) provide a very detailed estimate of recharge for Box Butte County. They estimated that 44,000 acre-feet per year moves into the county and 21,000 acre-feet moves out of the county by underflow. They estimated that 130,000 to 150,000 acre-feet per year is recharged by infiltration of precipitation. Based on this, it can be seen that precipitation is the largest contributor to ground water recharge in Box Butte County.

The percentage of the total precipitation that eventually makes it to the ground water reservoir is dependent upon such factors as these: the timing, duration, and intensity of rainfall; the freezing, thawing, wetting, and drying of the soil column; land slope; vertical permeability and texture of the soil; and the vertical permeability of the subsoil strata in the unsaturated zone. The presence of low-permeability layers or zones between the surface soils and the water table also inhibit downward migration of recharge water.

One geological factor that influences recharge rates in Box Butte County is the fact that some of the hydrologic units occur at or near the surface. Figure 2-20 demonstrates this by showing fairly low recharge rates over the Box Butte unit, which is comprised of a clayey silt that swells when wet. The greatest recharge appears to occur on the Arikaree Group sediments where soils are quite sandy and the permeable sandstone facies of the Arikaree is exposed. Souders (and others) conclude that "the hydrologic units at or near the land surface, and probably the soils as well, influence average annual recharge more significantly than the total amount of annual precipitation".

Recharge from stream seepage and surface impoundments in Box Butte County is likely negligible. The Niobrara River is a gaining stream that receives ground water discharge. It probably seldom serves as a source of ground water recharge since water table flow gradients slope toward the River. Snake Creek, entering Box Butte County from the west, may provide some recharge, as may Kilpatrick Lake, a privately owned reservoir on Snake Creek. Figure 2-21 also depicts Hemingford Creek and Berea Creek to be losing streams that may contribute to the ground water reservoir. Infiltration recharge from irrigated lands could be about 10,000 acre-feet. It was estimated to be something less than 10 percent of the water applied on about 10,000 acres (Souders, et al; 1980, p. 125).

Very little exists in the way of recharge calculations for the remainder of the District; however, the principal factors controlling recharge are influenced primarily by the hydrologic unit at or near the surface, and secondly by soil type. Recharge in the Sand Hills area of southern Sheridan County is most certainly greater than what one would expect in the White River-Hat Creek Basins, which are underlain by Pierre shale and Brule formations near the surface.

Based on data from the water level monitoring program, there have not been any significant rises or declines in water levels over the District, except those areas mapped on Figure 2-22. With the exception of the Box Butte and Mirage Flats areas, the hydrologic system seems to be in dynamic equilibrium. Recharge appears to be equaling discharge over most of the area.

In the Mirage Flats area, surface water from the Irrigation District canal system was providing recharge to the ground water reservoir for years. However, the area has become one of the best examples of conjunctive use in the State of Nebraska following the installation of wells that intercept and use the infiltrating water.

Further investigation is needed along with more detailed information to prepare meaningful recharge estimates for the entire NRD. Generalized estimates based on soils and topography were not considered sufficient for the area because of the controlling factor of geologic units at or near the surface.

2.1.6 Recharge/Discharge Study

Due to the lack of a common aquifer across the District, water budget calculations are difficult to prepare. HWS, as part of the District's 1985 Plan, prepared simplified water budgets for some selected irrigated areas within the District (See Figure 2-23). The basic assumption in their calculations was the areas in question received 1.5 inches of water recharge to the aquifer each year from precipitation infiltration. The predicted decline in the water table was determined by comparing the water withdrawn by wells for irrigation with the water that is predicted to recharge the aquifer. The results of their calculations are shown in Table 2-2.

TABLE 2-2

1985 WATER BUDGET STUDY FOR IRRIGATED AREAS IN DISTRICT

Study Area	Area Irrigated (acres)	Ground Water Use (acre/feet)	Predicted Decline (feet/year)	Actual Decline since 1969 (feet/year)
Box Butte	368,640	106,768	0.83	0.87 to 1.21
Tableland	323,840	32,424	0.29	0.0
Mirage Flats	34,560	6,048	0.50	(6.0)* to 0.75
Southeast Dawes	107,520	6,155	0.16	0.0

Note: (6.0) indicates a increase in water level

For the Tableland and Southeast Dawes areas, the lack of predicted decline must be due to ground water underflow from outside these study areas which offsets the water withdrawn by pumping. In the Box Butte study area, the declines up to 1985 were variable across the area, but in general are exceeding recharge. Recent studies by the Nebraska Conservation and Survey Division (1991) indicate the declines between 1975 and 1990 for Box Butte County range from 0.0 to 2.5 feet/year, but average about 1.0 feet per year.

The Mirage Flats area has experienced both increases and declines in the local water table. During the period 1953-1975, recharge from surface water irrigation canals caused an increase in the water table of up to six feet. By 1973, irrigation wells had begun to intercept the recharge from the canals and the water levels began declining. The declines continued until 1992, when water levels began rising again.

2.2 Soils

2.2.1 Soil Descriptions

The major soil types within the District are summarized on Figure 2-24. Topography and parent materials strongly influenced the development of the soils in the region. Loamy soils have developed on the flat areas of loess, alluvium, and weathered siltstone. The loam soils produce the principal agricultural areas in Box Butte, southern Dawes and central Sheridan Counties. The steep areas of exposed bedrock, such as found in parts of the Pine Ridge, are typified by thin soil cover.

The Sand Hills soils are characterized as thin, fragile soils developed on the sand dunes. These soils are always in danger of blowing away if the vegetative cover is destroyed. For the most part, they are highly permeable and allow rapid downward migration of water.

The Box Butte and Sheridan tablelands (including Mirage Flats) are covered by loamy soils developed from eolian silt (loess) and siltstone. These areas support the majority of intensely irrigated agricultural irrigation development.

The Pine Ridge and Sioux uplands are characterized by silty and sandy soils developed from siltstone and sandstone parent materials. These soils support rangeland with some limited irrigation development.

The Pierre Plains, in northern Sioux and Dawes County, are covered by heavy clay soil developed from the Pierre Shale. This is an important rangeland and dryland farming area. Pump irrigation is rare because no suitable aquifer is present.

The Pine Ridge Escarpment is covered with natural pine forest cover. Soils are thin and easily eroded on the steep west and south facing slopes. Areas of bare rock outcrop are common, and many areas of badlands occur in this zone. These exist as exposed silt and clay because erosion continues to remove all topsoil and vegetation.

North facing slopes have deeper soils and the most productive forest. The footslopes along the base of the Pine Ridge Escarpment contain silty and sandy soils derived from siltstone, claystone, and sandstone. Many areas of badlands occur in this zone. These areas exist as exposed silt and clay because erosion continues to remove all topsoil and vegetation. The footslope areas generally support only rangeland.

The flood plains and low terraces of the streams are covered by alluvial soils which are generally loamy. These areas are suitable for irrigation where water is available, either from wells or surface systems.

Soils have a major influence on surface water infiltration and ground water recharge. The physical properties of soils have a significant effect on the rates at which surface waters can reach ground water aquifers. Table 2-3 is a summary of the seven major soil associations found across the district and some of their distinctive properties, source materials and most common usage.

2.2.2 Soil Vulnerability

The physical properties of soils have a significant effect on the amount of contaminant and the rate at which it may be transmitted to the aquifer. Soils that are vulnerable to rapidly transmitting contaminants to underlying aquifers are those with high permeabilities and low organic carbon contents, positioned on gentle slopes. Coarse, sandy soil will transmit both water and dissolved contaminants much more quickly than a clay-rich soil. Table 2-3 includes some

of the physical properties of soils important in assessing potential vulnerability to contaminant pollution.

The Nebraska Department of Environmental quality and the Center for Advanced Land Management Information Technologies at the University of Nebraska-Lincoln has developed a system of indicating the potential vulnerability of ground water to contamination using the DRASTIC method developed by the USEPA (Aller, et.al, 1987). The Natural Resources Commission has provided information from this data base to the NRD. DRASTIC is a system of mathematically ranking seven different parameters to determine a numerical value of potential risk. The higher the DRASTIC number, the higher the potential risk. The seven parameters used in DRASTIC include: D = depth-to-ground water; R = recharge; A = aquifer type; S = soil type; T = topography; I = impact of the vadose zone; and C = aquifer conductivity. Each parameter is weighted as to its role in vulnerability and then all the values are summed to produce an index number. Depth-to-water and vadose zone impact factors are weighted the highest and topography has the lowest weight. Several regional studies (Lorber, et al, 1989) have indicated that vulnerability index numbers across the United States can vary from 69 to 245. DRASTIC numbers less than 100 indicate low vulnerability, between 100 and 140 is considered medium vulnerability and over 140 is considered high vulnerability.

The Nebraska DRASTIC study of the Upper Niobrara-White NRD is included as Figure 2-25. The DRASTIC map indicates that the lowest vulnerability areas are located in north-central Box Butte County, a large area north of Rushville in Sheridan County, a township-sized area southeast of Crawford in Dawes County, and a large area immediately south of the South Dakota border adjacent to the Sioux and Dawes County lines. The most vulnerable areas include most of southern Sheridan County (Sand Hills), the Sand Hills immediately east of Alliance and along the southern margin of Box Butte County and a small Sand Hills area in northeastern-most Sheridan County. The terrace areas immediately adjacent to the Niobrara River that cross the entire district are considered high vulnerability to potential pollution. Another significant high vulnerability area is between Chadron and Crawford in Dawes County. This area lies on the northern slope of the Pine Ridge and extends to the White River. The entire northern slope of the Pine Ridge across Sioux and Dawes Counties has moderate to high vulnerability to potential contamination by pollutants.

The three large areas of irrigated agriculture within the district have significantly different DRASTIC vulnerability indices. Box Butte County soils range from low to moderate vulnerability. As previously mentioned, the agricultural region between Chadron and Crawford in Dawes County has high potential vulnerability. The Niobrara River valley in southern Dawes and north-central Sheridan Counties is highly variable in vulnerability, ranging from low to high. The Mirage Flats area has moderate vulnerability.

2.3 Identified Needs and Data Deficiencies

Further information is needed to prepare more meaningful recharge estimates for the entire NRD so that a better water budget model can be created for the District. Additional soil information may be needed in the high vulnerability areas if special study areas are deemed necessary.

SECTION 3.0

WATER QUALITY INVENTORY

3.1 General Comments

The usefulness of water for human or agricultural needs depends on its quality. Water quality is determined by the quantity of dissolved chemicals, gases and suspended materials in water. Water quality is affected by natural contamination as well as by the influences of man. Rainwater that falls on the surface and percolates through the soil horizons often dissolves natural minerals and substances. Rainwater that reaches the water table can be further contaminated by the various natural geologic materials that it travels through. Natural ground waters, because of their chemical history, vary considerably in their quality. Human activity, either through chemical spills, improper water disposal, widespread use of fertilizers and pesticides, or leaking tanks, has allowed contaminants to reach the water table making the water unfit for any use.

The U.S. Environmental Protection Agency through the Safe Drinking Water Act has set maximum chemical concentrations for community and non-community water systems. For municipal or private systems serving at least 25 people, 60 or more days per year, the concentrations are either maximum contaminant levels (MCLs) that are enforceable by law or are non-enforceable health advisory levels (HALs). Some common MCLs are 0.005 mg/l (5 ppb) for benzene, a common constituent of gasoline, and 10 mg/l (10 ppm) for Nitrate (N). The USEPA also has set secondary maximum contaminant levels (SMCLs) for factors that effect the taste or smell of water. Common SMCLs are Iron, Chloride, Sulfate and Total Dissolved Solids (TDS). Private wells currently do not have to meet these water quality standards.

3.2 Measurement of Water Quality

Water naturally contains a number of different dissolved inorganic constituents such as Calcium, Magnesium, Sodium, Potassium, Chloride, Sulfate, Carbonate and Bicarbonate. Minor constituents of water include Iron, Manganese, Fluoride, Nitrate and Strontium. Trace elements such as Arsenic, Lead, Cadmium or Chromium may have significant impacts on water quality if they are present in only a few micrograms per liter.

Total Dissolved Solids, or the total amount of solids in milligrams per liter that remain when water is evaporated to dryness, is a measure of the total solid material dissolved in the water. A maximum of 500 ppm is recommended by the Nebraska Department of Health for drinking water supplies. High TDS will usually result in taste and odor problems. Generally, the lowest TDS occurs in the geologically youngest water in areas of active recharge such as the Sand Hills. The highest TDS may occur in sluggish flow systems such as confined aquifers, fine-grained materials, and aquifers containing very soluble material such as carbonates, sulfides, or sulfates. High TDS occurs primarily because the water is in contact with the material longer and so there is more time for minerals to be dissolved or to exchange chemical constituents with the ground water. Total dissolved solids concentrations can vary from very fresh waters with TDS of 100 mg/l or less to deep brines with TDS of over 100,000 mg/l.

Alkalinity is a measure of the ability of the water to neutralize acid. Carbonate and Bicarbonate contribute to this characteristic. Alkaline salts are injurious to crops when they accumulate on the soil. Hardness is due to Calcium and Magnesium and inhibits the generation of soap suds. Water containing less than 50 ppm of these elements is considered to be soft. Water with a hardness of 150 to 200 ppm is not objectionable for most purposes. Sulfate in ground water can cause an objectionable taste and excessive amounts act as a laxative. The recommended limit for dissolved Sulfate is 250 ppm.

Nitrates (N), a term used to express Nitrogen, are mapped because they are of increasing concern in Nebraska ground water quality issues. Concentrations over the recommended maximum of 10 ppm have been linked to methemoslabinemia or "Blue-Baby Syndrome" in infants. The connection between high incidences of cancer in areas of Nebraska known to have elevated ground water nitrate levels is being studied. The long-term affect of nitrates on adults is not known because elevated nitrates have only been recognized widely in ground water during the last 20 years. This period roughly corresponds to the large-scale application of nitrate fertilizer. Localized occurrences of nitrates have been known for years where point source pollution took place from septic systems, feed lots, and breakdown of humus.

Other important constituents of ground water that have significant impacts on water quality include trace metals, bacteria, pesticides, volatile organic compounds and radioactive materials.

3.3 District Ground Water Quality

The water quality information for the District was prepared using data from the following sources: 1) Nebraska Department of Health, 2) USGS Data Bank, 3) USGS Water Supply Paper 2245 (1984), 4) Conservation and Survey Resource Atlas No. 3 (1978), 5) Conservation & Survey Map "Ground Water Nitrate Nitrogen Concentrations, Alliance Quadrangle" (1980), 6) Water Institute of the University of Nebraska (1993), and 7) the Upper Niobrara-White NRD Water Quality Monitoring Program (1991 and 1992).

3.3.1 Regional Water Quality

Table 3-1 contains data from selected wells from across the District, with selected quality characteristics. The water quality information for these wells was derived from data from the Health Department data and from the USGS WATSTORE data bank. Locations of the wells that were sampled are shown on Figure 3-1. Hardness, sulfate, total dissolved solids, alkalinity, and nitrates were chosen as the dissolved constituents best typifying water quality within different parts of the District. All of these constituents are reported in "parts per million" (ppm).

The distribution of minerals in solution (TDS) within the ground water of the District is not easily mapped. Engberg and Spalding (1978) and Engberg (1984) mapped hardness, sulfate, alkalinity, total hardness, and other parameters. The maps do not generally agree. Table 3-1 can be summarized to gain an approximation of the distribution. Total solids are highest in the northern part of the District where water is moving slowly through the Chadron and Brule formations, and lowest in the Sand Hills areas where transmissivity is high. Deeper formations may have higher TDS, but for most wells analyzed, water from several elevations was mixed so it is difficult to evaluate the TDS of the deeper aquifers from present data. Sulfates are more prevalent in the north and in the Alliance city wells, where it may be originating in the deeper formations. Total hardness is greatest in water samples from the north. North of the White River the high TDS prevents the use of ground water for stock watering.

The Alliance wells are also higher in TDS reflecting the possible influence of the deeper formations. Alkalinity is not mappable because of the insufficient number of samples. The alkali lakes in southern Sheridan

County and some of the alkali spots along Snake Creek near Alliance are examples of buildup of alkali by evaporative discharge of ground water.

Several studies have addressed Nitrate (N) contamination in the District area. The 1980 nitrate map published by the Conservation and Survey Division was prepared by analyzing 558 water samples that were taken in 1979. Figure 3-1 (nitrate map) shows the locations of 40 of the analyzed wells that contain more than 10 ppm Nitrate (N).

The high Nitrate (N) wells in southern Sheridan and southwest Sioux Counties are mostly stockwells situated in the Sand Hills. The probable Nitrate (N) source is cattle manure near the well casings (contamination from a point source). The observed high Nitrate (N) concentrations in Box Butte County, especially near Alliance and near Hemingford, are located in irrigated and highly fertilized areas. This may suggest a non-point source origin for the Nitrate (N). The same situation appears in northern Sheridan County. The Nitrate (N) contamination observed in northern Sioux and Dawes Counties probably results from mixed non-point and point sources. However, further investigation will be needed to identify the sources.

The most common non-point Nitrate (N) source is from excessive fertilizer applied to crops. Any Nitrate (N) that is carried over, which is not used by the plants, can be stored only so long before it is leached downward beyond the root zone. In silty and sandy soils, applied fertilizer often passes beyond the root zone before the plant can use the Nitrate (N). Therefore, this leached Nitrate (N) is the prime non-point source. This was targeted for management initiatives by the NRD in the 1985 Ground Water Management Plan and will be targeted in future programs and policies.

3.3.2 Municipal Water Quality

Water analysis for heavy metals by the Nebraska Department of Health of 35 public water supplies in the District indicates that none of the water samples tested exceeded the maximum contaminant levels (MCLs) established by the USEPA. The water samples were analyzed between 1985 and 1991. Table 3-2 contains a summary of the heavy metal water analyses (values in mg/l).

A study of Selenium in the ground water of the State of Nebraska by the Nebraska Conservation and Survey Division (1973) indicated that Selenium concentrations in wells across the four counties comprising the NRD ranged from 0.005 to 0.020 mg/l. The Selenium values are below the USEPA MCLs.

TABLE 3-2

HEAVY METALS IN MUNICIPAL WATER SUPPLIES

Metal	Sampled Range	Average* (milligrams/liter)	MCL (milligrams/liter)
Arsenic	ND to 0.01	0.006	0.050
Barium	ND to 0.40	0.154	2.0
Cadmium	Not Detected	<0.001	0.005
Chromium	ND to 0.004	0.0025	0.1
Lead	ND to 0.002	0.0013	0.015**
Selenium	Not Detected	<0.005	0.050
Silver	Not Detected	<0.001	0.050
Mercury	Not Detected	<0.001	0.002
Nitrate	0.5 to 6.9	2.1	10.0
Fluoride	0.4 to 1.13	0.616	4.0

* **Average of values above detection limit**

** **Lead limit is not a MCL but an action trigger**

3.3.3 Radioactive Materials in Ground Water

To determine potential ground water contamination by radioactive materials, Spalding (1991) measured total gross Alpha particle activity as an inexpensive screening method to determine Alpha contribution from waters suspected of being impacted by radioactive isotopes of the uranium series elements. The results of this sampling for rural domestic wells in the District are listed in Table 3-3.

Because of the potential for human organ damage or possibly cancer, the USEPA standard for Alpha concentration is a MCL of 15 picocuries per liter (pCi/l). The Spalding data indicates that the mean values for Alpha

are below the MCL for all four counties, but a number of individual wells exceed the standard.

An in-situ leaching operation for the recovery of uranium is being operated by a mining company in Dawes County, four miles southeast of Crawford. The Alpha values for Dawes County fall within the range of concentrations indicated in the other three counties. No concentrations of abnormally high values have been observed.

Additional information needs to be obtained to determine the exact locations of the domestic wells exceeding the gross alpha level MCL standard in order to inform owners of those wells of potential health advisories concerning radioactivity. Additional information about the specific depths and aquifer source for these wells exceeding the MCL needs to be addressed.

TABLE 3-3

GROSS ALPHA LEVEL IN PICOCURIES PER LITER (pCi/L)

County	Number of Sampled Wells	Mean Value	Minimum Value	Maximum Value
Box Butte	28	7.9	2.2	19.5
Dawes	19	8.7	2.8	21.2
Sheridan	20	7.0	0.0	17.5
Sioux	12	7.7	3.0	21.1

3.3.4 Bacterial Contamination

The presence of coliform bacteria in water derived from ground water is an indication that surface contamination from human or animal wastes derived from septic tanks or barnyards is finding its way into the water well. Usually soils have the capacity to filter out bacteria and the presence of coliform bacteria indicates the well does not have an adequate sanitary seal to prevent this type of contamination. Poor well construction and close proximity of the well to either or both septic tanks and animal barnyards are often the cause of this contamination. Spalding's 1991 survey of rural domestic wells in Nebraska tested for coliform bacteria in the four counties of the District. The Upper Niobrara-White NRD water

quality monitoring study also tested for the presence of bacteria. The USEPA water quality standards indicate that the presence of one bacterial colony per 100 milliliters of water indicates the water supply is contaminated. The results of the Spalding and District bacteria sampling is shown in Table 3-4. The studies analyzed and reported their data differently. Spalding's study counted bacterial colonies, where as the District sponsored study just looked for the presence of bacteria.

TABLE 3-4

RURAL DOMESTIC WELLS BACTERIAL LEVELS
(Number of colonies/100 ml)

County	Number of Wells Sampled	Mean Number of Colonies	Minimum Number of Colonies	Maximum Number of Colonies
Box Butte	28	0.14	0.0	3
Dawes	19	0.21	0.0	1
Sheridan	20	3.35	0.0	51
Sioux	12	0.17	0.0	2

(Data from Spalding, 1991)

UPPER NIOBRARA-WHITE WATER QUALITY BACTERIA STUDY
(Domestic wells with detectable coliform bacteria)

County	Wells Sampled	Wells with Detectable Bacteria	Percentage
Box Butte	49	7	14%
Dawes	49	16	24%
Sheridan*	60	11	18%
Sioux	45	26	58%

*** Sheridan County wells exclusive of Mirage Flats**
(Data from Knapp, 1991)

The Spalding and NRD coliform bacteria studies indicates that this contamination is a serious problem for some domestic wells within the District. Landowners with wells exceeding the MCL for bacteria need to be informed about this contamination and encouraged to either eliminate

potential contaminant sources, relocate their wells or have their existing wells rehabilitated to eliminate surface water contamination of their ground water.

3.4 District Ground Water Quality Program

The Upper Niobrara-White NRD Ground Water Quality Monitoring Program began in June, 1987 and is currently ongoing. The program began by accumulation and review of existing and available water quality data from state agencies as well as incorporation of the District's knowledge of the area's ground water quality. The primary goal of the monitoring program was to identify non-point Nitrate (N) contamination within the District. To date, the District has sampled a total of 428 domestic and irrigation wells for Nitrate (N) concentrations. Currently a network of 175 domestic wells and 100 irrigation wells located in Sheridan and Box Butte Counties are being sampled in the District's ongoing ground water quality program. The term Nitrate (N) is used to mean total Nitrogen which includes both the combined Nitrate and Nitrite compounds.

The District has undertaken three separate studies of ground water quality since 1987. During the period 1987-1990 a water quality survey of the entire District was undertaken. The Mirage Flats Irrigation District in Sheridan County was selected for detailed ground water analysis due to high Nitrate (N) concentrations found in the earlier district-wide survey. A small area near the Chadron Municipal Landfill was also sampled due to suspected high Nitrate (N) concentrations. Knapp Consulting Services performed the sampling and water analyses. The following is a summary of the Knapp Consulting reports on the three water quality studies. (Also see Tables 2-2, 3-1, 3-2 and 3-3) The locations and relative concentrations of individual wells that have been sampled for Nitrate (N) are indicated on the County maps enclosed in Appendix A.

3.4.1 District Program Sampling Procedures

District personnel contact landowners for permission to sample their wells. The personal contact approach is producing extremely positive results in getting landowner permission for sampling. Landowners are also encouraged to bring water samples to the Natural Resource District office for analysis.

Domestic water supply samples were collected whenever possible at a spigot close to the wellhead. Irrigation and stock well samples were taken

at the wellhead. Wells were allowed to purge for five minutes prior to sampling. Locations of corrals, septic tanks, or other possible sources of contamination were observed and recorded. The initial survey samples were analyzed for specific conductance, alkalinity, Chloride, total dissolved solids, temperature, pH and Nitrate-Nitrite (N). Areas with increased levels of Nitrate (N) were then sampled on a more intensive basis to better delineate the aerial extent and magnitude of Nitrate (N) contamination. Domestic wells were also sampled for the presence of coliform bacteria.

Alkalinity measurements were made in the field and samples selected for Nitrate (N) analysis were preserved in the field with sulfuric acid to produce a pH of less than 2.0. Samples were placed on ice immediately upon collection and maintained at 4° C. prior to analysis. Coliform bacteria determinations were performed within 24 hours of sample collection. Specific conductance was determined by Wheatstone bridge, alkalinity by titration with hydrochloric acid to a pH of 4.5, Chloride by mercury nitrate titration, total dissolved solids by drying at 180° C., pH by meter in the field, Nitrate-Nitrite (N) by manual Cadmium reduction, and coliform bacteria by membrane filtration. Testing protocols were conducted according to accepted methods for examinations of water and wastewater.

3.4.2 Summary of 1987-1990 Survey

Sioux County: Forty-five wells were sampled across the county. The number of wells sampled in the northern part of the county is limited due to the lack of ground water wells, as most domestic users are served generally by water pipeline. An area of domestic wells near Harrison was sampled due to high Nitrate (N) concentrations indicated by previous information. The municipal well in Harrison has averaged 5.4 ppm (N) since 1984 with minor fluctuations. Of the wells sampled in Sioux County, 79 percent exhibited Nitrate (N) levels of less than 3.0 ppm (See Table 3-8 for a summary of the survey).

Dawes County: Sixty-six wells were sampled in Dawes County. No noticeable clustering of elevated Nitrate (N) levels was found except for a small housing development east of Chadron. The area east of Chadron is discussed in more detail in Section 3.4.4 of this report. In general, the Nitrate (N) levels are low, with 74 percent of the wells showing less than

3.0 ppm. Wells in the northern one-third of the County are sparsely located and most landowners are served by pipeline (See Table 3-6 for a summary of the study).

Box Butte County: A total of 120 wells, both domestic and irrigation, were sampled across the County. Of the wells sampled 22 percent of the irrigation wells and 17 percent of the domestic wells had less than 3.0 ppm Nitrate (N). Box Butte County has both sandy soils and intense agricultural development. Typically, older domestic wells are completed at depths less than 100 feet and irrigation wells produce water from depths ranging from 200 to 300 feet. Of

TABLE 3-5

RESULTS OF GROUND WATER QUALITY MONITORING PROGRAM FOR BOX BUTTE COUNTY 1988-1990

Total Wells Sampled: One Hundred Twenty (120)

Well Type	Number	Percentage of Total
Irrigation	46	38%
Domestic	74	62%

Ground Water Depth:

Irrigation Wells	Range: 200' to 345', Average 269'
Domestic Wells	Range: 20' to 380', Average 179'

Average Nitrate (N) Levels: (Range 0.0 mg/l to 45.25 mg/l)

Irrigation Wells	4.62 mg/l
Domestic Wells	6.71 mg/l

Summary of Nitrate (N) Concentrations:

Range	Irrigation		Domestic	
Less than 3.0 mg/l	10	22%	13	17%
3.0 to 4.9 mg/l	28	61%	34	47%
5.0 to 6.9 mg/l	7	15%	13	17%
7.0 to 9.9 mg/l	0	0%	6	8%
Exceeding 10.0 mg/l	1	2%	8	11%

Number of Wells Exceeding Total Coliform Bacteria Standard for Drinking Water

Number of Wells Sampled	**49**
Wells Exceeding Standard	**7**
Percentage of Total Sampled	**14%**

TABLE 3-6

RESULTS OF GROUND WATER QUALITY MONITORING PROGRAM FOR DAWES COUNTY, OCTOBER, 1988

Total Number of Wells Sampled (Domestic & Stock): Sixty Six (66)

Average Ground Water Depths and Nitrate (N) Levels			
White River Drainage		**"Table Area"**	
Average Ground Water Depth	**Average Nitrate (N) Level**	**Average Ground Water Depth**	**Average Nitrate (N) Level**
45 feet	**5.33 mg/l**	**223 Feet**	**1.80 mg/l**

Summary of Nitrate (N) Concentrations		
	Number of Wells	**Percent**
Less than 3.0 mg/l	**49**	**74**
3.0 to 4.9 mg/l	**7**	**11**
5.0 to 6.9 mg/l	**2**	**3**
7.0 to 9.9 mg/l	**2**	**3**
Greater than 10.0 mg/l	**6**	**9**
Number of Wells Exceeding Total Coliform Bacteria Standard	**16**	**24**

TABLE 3-7

RESULTS OF GROUND WATER QUALITY MONITORING PROGRAM FOR SHERIDAN COUNTY (Exclusive of Mirage Flats) 1988

Summary of Nitrate (N) Concentrations (Domestic Wells) (Range: 0.0 mg/l to 45.25 mg/l)		
	Number of Wells	**Percent**
Less than 3.0 mg/l	**65**	**68**
3.0 to 4.9 mg/l	**10**	**11**
5.0 to 6.9 mg/l	**4**	**4**
7.0 to 9.9 mg/l	**1**	**1**
Greater than 10.0 mg/l	**15**	**16**
Total Wells Sampled	**95**	

Number of Wells Exceeding Total Coliform Bacteria		
Standard for Drinking Water	**Number Sampled**	**60**
	Number Exceeding Standard	**11**
	Percent	**18%**
Ground Water Depths	**Range: 20' to 150' (Average: 68')**	

TABLE 3-8

RESULTS OF GROUND WATER QUALITY MONITORING PROGRAM FOR SIOUX COUNTY, SEPTEMBER, 1988

Number of Wells Sampled		
Irrigation	2	4%
Domestic	43	96%

Ground Water Depth	
Irrigation	Average: 50'
Domestic	Range: 15' to 350', Average 130'

Average Nitrate (N) Levels	
Irrigation	5.38 mg/l
Domestic	5.55 mg/l

Summary of Nitrate (N) Concentrations		
	Number of Wells	Percent
Less than 3.0 mg/l	14	31%
3.0	12	27%
5.0 to 6.9 mg/l	10	22%
7.0 to 9.9 mg/l	3	7%
Greater than 10.0 mg/l	6	13%
Number of Wells Exceeding Total Coliform Bacteria Standard	26	58%

concern is the higher percentage of domestic wells with higher Nitrate (N) concentrations than the irrigation wells. Is the higher Nitrate (N) concentrations in the domestic wells due to local contamination sources (farmyards and septic tanks) or is this a reflection of contamination that has not reached the deeper irrigation aquifers? Two areas of elevated Nitrate (N) were indicated by this survey: one east of Hemingford and one immediately east and northeast of Alliance (See Table 3-5 for summary of the study).

Sheridan County: Ninety-five domestic wells outside of the Mirage Flats Irrigation District were sampled. The Mirage Flats District sampling program will be discussed in more detail in a following section. With the exception of Mirage Flats, most of Sheridan County has high quality ground water. Sixty-eight percent of the sampled wells have less than 3.0 ppm Nitrate (N) concentrations. In the Sand Hills region some wells are impacted by alkali. The two areas of concern regarding Nitrate (N) are the Mirage Flats area and a small localized area northeast of Gordon, which is an area of center pivot irrigation development. It is interesting to note that in the Sand Hills area most of the farm and ranch domestic wells are located in extremely sandy soils with very shallow ground water levels. Typically these wells exhibit less than 3.0 ppm Nitrate (N). One would expect these wells would exhibit higher total Nitrate (N) concentrations due to the close proximity of farm and ranch activities and domestic water wells (See Table 3-7 for summary of the study) .

3.4.3 Mirage Flats Irrigation District

The Mirage Flats Irrigation District is located about 10 miles south of Hay Springs in Sheridan County and covers portions of Townships 29 and 30 North and Ranges 46 and 47 West. The Irrigation District covers approximately 23 square miles. Mirage Flats is an area of intensive agricultural production on porous soils. Irrigation water used in the District comes from both surface water via a canal from Box Butte Reservoir and from ground water wells. Domestic water is supplied almost exclusively from ground water. Domestic well owners report static water levels in their wells to be generally at 30 to 50 feet. The domestic wells are generally drilled from 80 to 100 feet deep. Irrigation wells are generally completed from depths ranging from 200 to 300 feet.

A network of 54 domestic wells were sampled annually between 1988 and 1992. Wells were sampled within the Irrigation District and adjoining areas. The total area of study was approximately 60 square miles. Forty-eight irrigation wells were sampled in 1989 and 42 in 1991. The results of the 1991 and 1992 sampling (44 wells) indicates that the Nitrate (N) concentration in eight of the domestic wells (18 percent) exceeded the Primary Drinking Water Standard of 10 ppm and additional 18 of the wells exceeded 5.0 ppm Nitrate (N). Of the 42 irrigation wells sampled in 1991, five (12%) exceeded 10 ppm and another seven wells exceeded 5.0 ppm. Tables 3-9 and 3-10 summarize the testing of domestic wells in 1992 and irrigation wells in 1991. The Trend column in Tables 3-9 and 3-10 refers to average changes in Nitrate (N) concentrations since 1989.

TABLE 3-9

MIRAGE FLATS DOMESTIC WELLS (1992):

Location	Number of Wells	Average NO_3 (N) ppm	NO_3 (N) Range ppm	Trend
T29N, R46W	24	9.1	0.8 - 32.0	Steady/Up
T29N, R45W	16	12.9	1.7 - 17.2	Steady
T30N, R46W	10	5.4	2.3 - 12.1	Steady/Down
T30N, R45W	4	4.2	2.1 - 4.9	Steady

TABLE 3-10

MIRAGE FLATS IRRIGATION WELLS (1991):

Location	Number of Wells	Average NO_3 (N) PPM	NO_3 (N) RANGE PPM	Trend
T29N, R46W	22	4.9	1.4 - 12.4	Mixed
T29N, R45W	15	4.2	2.2 - 5.4	Steady
T30N, R 46 W	5	2.0	1.2 - 3.4	Steady

The Nitrate (N) concentrations for the last sampling of domestic wells at Mirage Flats are shown on Figure 3-2. The domestic well Nitrate (N) testing indicates a scattering of low to high concentrations across the

Irrigation District, with the highest concentrations located in the northeast quarter of T29N, R46W and in the western quarter of T29N-R45W. The Nitrate (N) concentrations for the deeper irrigation wells are illustrated on Figure 3-3 and indicate the highest (N) concentrations are located in Sections 3, 4 and 10 of T29N-R46W.

Figures 3-4 and 3-5 show the trends in Nitrate (N) concentrations for the Mirage Flats domestic wells sampled between 1988 and 1992 and the irrigation wells sampled in 1989 and 1991. These two figures show diverse patterns of increase, decrease and minimal change. In the northeastern quarter of T29N-R46W, a majority of domestic and irrigation wells show increasing trends. In the west-central portion of T29N-R45W, the domestic wells show steady Nitrate (N) concentrations, while the irrigation wells in the same area exhibit an increasing trend in concentrations. Figure 3-6 illustrates some selected domestic wells that were sampled periodically during these surveys. The wells in T30N-R46W show decreasing Nitrate (N) concentrations with time. The well in the NW NW of Section 35 shows a dramatic decrease in Nitrate (N) from extremely high levels over 40 mg/l to less than 10 mg/l over a three year period. The Nitrate (N) concentrations for the four domestic wells in Section 10 of T29N-R46W show how variable Nitrate (N) concentrations can be within a limited area.

With considerable variation in Nitrate (N) concentrations within the Irrigation District, it is difficult to determine if the increases in concentration are due to non-point source fertilizer application or from point sources such as septic tanks and nearby barnyards or in the case of irrigation wells, chemical spills near the well itself. The District needs a comprehensive study of each of the sample wells in the area of highest concentration to better delineate the source of the Nitrate (N). Additional studies need to be done in the case of the Nitrate (N) decreasing wells to determine if the landowner has changed his surface practices adjacent to these wells.

3.4.4 Chadron Municipal Landfill Area

A small housing development with private wells and septic tanks at each residence is located in a low-lying area immediately east of the City of Chadron and southeast of the municipal landfill. Residents were concerned that elevated Nitrate (N) levels in the domestic wells were

caused by leachate from the landfill. In 1987, 22 wells in the housing development were sampled along with 10 wells along Little Bordeaux Creek that drains an area to the northeast of the landfill.
Nitrate (N) levels in the domestic wells averaged 6.8 ppm and ranged from 5.3 to 9.6 ppm. Nitrate (N) levels in the monitoring wells at the landfill range from 0.25 to 3.88 ppm and average 1.66 ppm. The close proximity of the domestic wells and septic tanks at the housing development is strongly suspected as the source of the observed Nitrate (N) levels in these wells.

With the exception of one well adjacent to a cattle operation on Little Bordeaux Creek, the Nitrate (N) levels in the 10 domestic wells in this area ranged from zero to 3.25 ppm and averaged 0.8 ppm. The one well close to the cattle feeding operation exhibited 19.5 ppm Nitrate (N).

3.5 Pesticides

The use of agricultural pesticides and herbicides and their effects on ground water quality have not been studied in adequate detail in the District. The USEPA established MCLs for most pesticides and herbicides are in the few parts per billion range. The cost of these analyses to detect chemicals at this level has made regional ground water quality studies for these chemicals economically prohibitive for the District.

A study of the pesticide Atrazine by Exner and Spalding (1990) indicated that for 10 wells sampled in Box Butte County, only one well had detectable quantities. A well in southernmost Box Butte County had an indicated Atrazine content of between 0.5 and 1.0 parts per billion. The USEPA MCL for Atrazine is 3 ppb. Wells were not sampled for pesticides in Sheridan, Dawes or Sioux Counties.

As part of the Mirage Flats water quality study, a triazine immunoassay scan was used to detect the presence of the pesticides atrazine, simazine and propazine was conducted on samples collected in July, 1989. Out of the 18 wells sampled for triazine, four wells indicated detectable traces of triazine. The wells with detectable triazine were all domestic wells.

Additional studies are needed to determine if pesticides and herbicides pose a threat to regional ground water quality within the District.

3.6 Suitability Characteristics

The USEPA is responsible for establishing drinking water regulations and preparing health advisories with respect to municipal water quality. In Nebraska, the Department of Health is responsible for compliance to USEPA standards. The USEPA has established Maximum Contaminant Levels for 199 organic compounds, 38 inorganic compounds, 6 radioactive, as well as standards for 15 other substances and water quality factors. Maximum concentration standards for seven microbiological contaminants are also mandated by the USEPA.

Nebraska Title 117 defines suitability of Class A agricultural surface water. Surface water criteria are useful for a general comparison with ground water quality that are for the same intended use. Class A agricultural surface water should not exceed the following criteria:

- Conductivity not to exceed 2000 umhos/cm
- Nitrate-nitrite (N) not to exceed 100 mg/l
- Selenium not to exceed 0.02 mg/l

With the exception of the domestic wells with either high Nitrate (N), high radioactive levels or the presence of bacteria as previously indicated, most of the ground water in the southern part of the District meets Federal and State suitability standards for surface waters. The exceptions are some of the higher TDS waters found in the northwestern portion of the District. In general, agricultural usage ground water in the southern two-thirds of the District meets State agricultural suitability standards for surface waters.

3.7 Identified Needs and Data Deficiencies

The exact locations of the domestic wells sampled by Spalding in 1991 where the Gross Alpha Level exceeded the standard (MCL) for radioactivity. Additional information about the specific depths and aquifer source for these wells exceeding the MCL needs to be collected. The District needs to establish a program to inform owners of those wells with potential health threats due to radioactivity in the ground water.

Additional information is needed with regard to the Box Butte County wells where domestic wells exhibit higher Nitrate (N) concentrations than the irrigation wells in the same area. The purpose would be to determine if the

higher Nitrate (N) concentrations in the domestic wells are due to local contamination sources (farmyards and septic tanks) or are a reflection of non-point source contamination that has not reached the deeper irrigation aquifers.

The Mirage Flats ground water studies need to be continued to better delineate the differences between point and non-point Nitrate (N) contamination and determine if a special designation is needed for this area.
Pesticide and herbicide sampling of ground water in the higher agrichemical use areas of Box Butte, Sheridan and Dawes Counties is needed to determine if water quality is being degraded by the presence of these chemicals.

SECTION 4.0

LAND USE

4.1 Land Use Studies

Land use information for the Upper Niobrara-White NRD was derived primarily from the data bases of the Nebraska Natural Resources Commission and the Soil Conservation Service data bases. The Nebraska Department of Agriculture Statistics Service provided the source of agricultural land use information.

General land use information for the entire District is shown on Figure 4-1 and is based on 1975 Conservation and Survey Division information. Table 4-1 summarizes the information shown on Figure 4-1. Over 85 percent of the District acreage is used for rangeland and dry cropland. This usage has little impact on ground water. Irrigated cropland, which has the highest impact on ground water usage, makes up only 4 percent of the District area. Urban areas, which include predominantly residential, commercial and industrial usage, cover only 15.5 square miles of the four county area or less than 0.2 percent of the District.

TABLE 4-1

DISTRICT LAND USE
(Based on 1975 Data)

Land Use	Acres	Percentage
Rangeland	2,713,290	60.6
Irrigated Agriculture	178,314	4.0
Dry Agriculture	1,126,050	25.2
Barren (Badlands)	47,480	1.0
Wetlands	44,500	0.9
Forrest	355,970	8.0
Urban	9,920	0.2
	Total: 4,475,520 acres	

The Upper Niobrara-White District acquired detailed land use information on Box Butte County in 1993 as part of a detailed study of that county. The information is based on the 1987 Nebraska Resources Census information and 1990 U.S. Census information. A summary of this data is shown in Table 4-2. In Box Butte County, irrigated cropland accounts for only 17 percent of the area. As can be seen from the District-wide information, 64 percent of the District's irrigated cropland lies in Box Butte County. Almost 78 percent of the County's area is used for rangeland and dry cropland.

TABLE 4-2

BOX BUTTE COUNTY - LAND USE

Land Use	Acreage	Percentage
Dry Cropland	226,240	33.2
Irrigated Cropland	135,560	19.9
Pasture	19,040	2.8
Rangeland	284,440	41.7
Rural Non-crop Use	10,800	1.6
Urban	4,160	0.6
Water	1,760	0.3
	Total Acres: 681,600	

Table 4-3 illustrates the trend in irrigated acreage across the District. The total cropland under irrigation has been relatively stable across the four county area, but there is a small but steady annual decrease in total irrigated acreage. Between 1987 and 1991, the total acreage under irrigation has decreased five percent. If the trend in decreased irrigated acreage continues, ground water usage should also decrease.

Table 4-4 shows the various crops that are irrigated across the District. Corn, beans and alfalfa make up the bulk of the irrigated cropland. The crop water use data from Table 6-6 indicates that alfalfa uses the largest volume of water per season (43 inches) followed by corn (27 inches). In other words, the alfalfa crops use almost twice the volume of water as the corn crop per acre.

TABLE 4-3

UPPER NIOBRARA-WHITE NRD TOTAL IRRIGATED ACREAGE

County	1987	1988	1989	1990	1991
Box Butte	141,000	136,000	136,000	134,000	134,000
Dawes	19,000	19,000	19,000	20,000	19,000
Sheridan	74,000	74,000	71,000	68,000	67,000
Sioux*	50,000	47,000	46,000	49,000	49,000
Total Acreage	284,000	276,000	272,000	271,000	269,000

Note: Sioux County acreage for entire county.
Source: 1991/92 Nebraska Agricultural Statistics

TABLE 4-4

IRRIGATED CROPLAND - ACREAGE PLANTED IN 1991

County	Corn	Wheat	Alfalfa	Sugar Beets	Beans
Box Butte	46,900	11,100	7,400	24,000	30,000
Dawes	2,000	1,700	9,000	0	2,700
Sheridan	24,600	3,300	17,600	0	13,500
Sioux*	12,200	300	12,400	3,300	5,300
Totals	85,700	16,400	46,400	27,300	51,500

Note: Sioux County acreage is for entire county.
Source: 1991/92 Nebraska Agricultural Statistics

The rural nature of land use in the four-county NRD area is illustrated by Table 4-5 showing housing density, derived from the latest U.S. Census Information. Rural housing in Box Butte County averages one house per square mile. Sioux County, which has the sparsest population, averages a third of a house per square mile.

TABLE 4-5

HOUSING DENSITY

County	Area-Square Miles	Rural Houses	Area / House (square miles)
Box Butte	**1065**	**1023**	**1.04**
Dawes	**1389**	**973**	**1.43**
Sheridan	**2484**	**1389**	**1.79**
Sioux	**2055**	**677**	**3.04**

Note: Information based on 1990 U.S. Census Information

4.2 Surface Water - Rivers and Lakes

The principal surface drainage ways in the district are Hat Creek, White River, White Clay Creek, and the Niobrara River. The White River supplies water to Lake Whitney and the Whitney Irrigation District in Dawes County. Diversions from the Niobrara River supply surface water from Box Butte reservoir for irrigation in the Mirage Flats Irrigation District in central Sheridan County. Both of these rivers are gaining streams in the District, principally from ground water. A detailed investigation of stream-aquifer relationships is needed to determine their precise interrelationships to understand the impact that ground water withdrawals will have adjacent to or in the vicinity of the river systems.

Appendix B contains a copy of a Stream Water Supply Paper taken from the "Policy Issue Study on Supplemental Water Supplies," dated January 1984. This paper provides and excellent summary of the use and water yield of the primary river systems in the Upper Niobrara-White Natural Resources District.

4.3 Surface Water - Wetlands

Copies of recent wetland delineation maps prepared by the Army Corps of Engineers and by the SCS are available in the local SCS offices. These maps are useful for locating natural and manmade wetlands. They also can be used for local water table delineations and potential impact studies of ground water changes on wildlife and endangered species. Table 4-6 is a summary of the number of wetlands sites and their total acreage within the District.

TABLE 4-6

DISTRICT WETLANDS INVENTORY

County	Number of Sites	Acres
Box Butte	741	2859
Dawes	237	3155
Sheridan	299	1467
Sioux	17	664
NRD Totals	1294	8145

The NRD contains numerous Sand Hills lakes and areas of shallow depth-to-water. Figure 4-2 illustrates the relative density and distribution of the Box Butte - Sheridan County lakes in relation to the rest of the Sand Hills region. Box Butte County contains nine Sand Hills lakes located on the extreme eastern edge of the county. The waters in these lakes have poor fishing potential, are shallow, medium to moderately alkaline, and total about 2,116 hectares. There are also several intermittent, slightly alkaline, marsh-type lakes located directly south of Alliance.

Sheridan County contains the largest number of lakes in the south half and extreme northeast corner of the County. There are about 521 lakes, of which only 215 are permanent bodies of water of more than four hectares. The 521 natural lakes have a total area of 6,622 hectares. Sheridan County has more permanent Sand Hills lakes than any other Nebraska county. However, about 80 percent of the lakes are strongly alkaline with a pH of 9.3. The remainder of the lakes range from slightly to moderately alkaline. Around 92 percent of the lakes are non-supportive of fishes, three percent are borderline, and five percent supportive. For the most part, the connection between the Sand Hills lakes and the regional water table needs more definition. In some areas the lakes represent perched water conditions, whereas in others the lakes appear to be surface expression of the water table. Additional definition is needed in order to predict the impacts of development on these environmentally sensitive areas.

4.4 Identified Needs and Data Deficiencies

As part of the ongoing development and expansion of the NRD's environmental quality data base, the following additional information will be needed.

- Updated land use information similar to the data acquired by the District for Box Butte County is needed for Sioux, Sheridan and Dawes Counties. A data base of irrigated acreage, including acreage and crop type is needed for future water use planning.

Section 9 of this plan details some of the types of land use studies and determinations that may targeted for consideration by the NRD Board of Directors.

SECTION 5.0

CONTAMINANT SOURCE INVENTORY

5.1 General

Ground water becomes contaminated when contaminated surface water and other pollutants seep into the earth and into aquifers. Major sources of ground water contamination include:

- Hazardous waste sites
- Landfills
- Surface impoundments
- Storage tanks
- Septic tanks
- Agricultural uses of fertilizers and pesticides
- Highway de-icing
- Accidental and intentional chemical spills

The U. S. Environmental Protection Agency and the Nebraska Department of Environmental Quality (NDEQ) have developed an extensive list of potential contaminant sources. This list includes all types of ground water contaminant sources which are known to have resulted in contaminated ground water somewhere in Nebraska.

The sources of contaminants are generally divided into two types: point sources and non-point sources.

Point sources are discrete locations where contaminants come in contact with the soil and can be easily documented. Examples are surface spills, leaking underground tanks, manure piles, leaking pipes, storage lagoons, septic tanks, feedlots, barnyards or corrals, landfills, road salt storage areas, and discrete spills such as improper disposal of pesticides. Many of the contaminants that are released from point sources are petroleum products. Point sources are discussed in Section 5.4 of this Ground Water Management Plan.

Non-point sources do not have a specific location of contamination but involve contamination of larger areas. Examples are overfertilization of crops, crop dusting or pesticide applications, road salting, the residential use of lawn fertilizer, and similar area-wide distributions of chemicals. Chemigation

applications are considered under the heading of potential non-point contaminant sources. Non-point sources tend to be area specific. Non-point sources are discussed in Section 5.3.

The NDOH conducted a Vulnerability Assessment Survey for each public water supply well in the State of Nebraska. This survey involved locating potential contaminant sources likely to give rise to one or more of 12 EPA-prioritized volatile organic contaminants. The potential sources within 1,500 feet of each wellhead were plotted on a map. Copies of the NDOH Vulnerability Assessment Survey for the public water supply wells in the Upper Niobrara-White NRD have been included in the NRD files.

5.2 Types of Contamination

The common sources of ground water contamination are chemicals or other hazardous substances that are introduced into the environment at the surface of the land. Rainfall or irrigation water dissolves these substances and transports them through the soil and vadose (unsaturated) horizons above the water table to the zone of saturation which is called the aquifer. The three major types of chemical contaminants that pose threats to ground water quality include:

- Water soluble compounds (liquids or solids) and the slightly soluble portions of generally non-soluble compounds. Water soluble contaminants include: road salt, fertilizer, pesticides, landfill leachate, sewage system and septic tank outflow.

- Light non-aqueous phase (non-soluble in water) liquids = "floaters" = LNAPLs (a type of free product). "Floaters" include: gasoline, diesel fuel, fuel oil.

- Dense non-aqueous phase (non-soluble in water) liquids = "sinkers" = DNAPLs (a type of free product). "Sinkers" include: carbon tetrachloride, degreasing solvents.

5.3 Non-Point Source Inventory (Potential or Known)

5.3.1 Residential

In the Upper Niobrara-White NRD, the combined residential, commercial and industrial areas cover about 15.5 square miles of the four-county area

or less than 0.2 percent of the total District area. Based on known practices and the small aerial extent of residential development, the NRD feels the impact of residential non-point sources on ground water quality is minimal.

5.3.2 Agrichemical and Chemigation

Agriculture uses large quantities of nitrogen fertilizers to enhance the growth of crops. Chemical pesticides and herbicides are used to control insect pests and weeds, respectively. The amounts and types of these substances applied to individual crops vary considerably with soil types and the experience of the farmer.

Nitrogen in the form of soluble nitrates can be introduced to the soil in the form of commercial fertilizer or manure. Excess nitrate not used by the crops can be leached into the soil below the root zone and ultimately reach ground water. Pesticides and herbicides that are not broken down chemically by their intended use can also reach the water table.

Chemigation is the process of applying a chemical to a crop by mixing it with water and distributing it through an irrigation system. Chemigation allows the close control of how much fertilizer or pesticide the crop receives. The potential exists for ground water contamination through leakage down irrigation wells or soil infiltration because of surface spills or over application of chemicals. The chemigation systems must be kept in proper working order to minimize ground water contamination. State law requires farmers who want to chemigate to have a permit and a state chemical applicator's certification. The Natural Resource Districts have the responsibility for inspecting chemigation systems and issuing permits.

Starting in 1989, the Upper Niobrara-White NRD initiated a system of chemigation inspection to comply with Nebraska DEQ Title 195 Chemigation Rules and Regulations. District personnel inspect each chemigation system before a permit is issued, check valves, drains and other devices designed to keep chemicals from entering the irrigation well. In addition, chemigation systems are put on a schedule for periodic inspections to insure the system is working properly and to stop the use of those systems that are not in compliance. The following tables (Tables 5-1, 5-2, and 5-3) summarize the chemigation activities with the District over the past five years.

TABLE 5-1

CHEMIGATION ACTIVITY IN UPPER NIOBRARA-WHITE NRD

Permits	1989	1990	1991	1992	1993
Total	362	426	477	580	617
Renewals	43	314	384	453	554
New	119	110	93	127	63
Inspections	282	195	333	317	338
Revoked	0	2	0	1	4

TABLE 5-2

NITROGEN FERTILIZER APPLICATION VIA CHEMIGATION

Nitrogen	1989	1990	1991	1992	1993
Total Lbs. Applied	2,784,000	2,171,226	2,210,402	2,722,381	4,876,307
Total Acres	27,898	31,531	36,628	38,473	71,823
Lbs/Acre	99.8	68.9	60.4	70.8	67.9

TABLE 5-3

PESTICIDE, HERBICIDE & OTHER CHEMICAL APPLICATION VIA CHEMIGATION

	1989	1990	1991	1992	1993
Number of Chemicals	11	15	16	17	19
Total Acres	6,608	7,576	14,723	19,708	18,293
Total Gals.	17,931	2,653	3,579	3,924	19,693
Total Lbs.	32	0	523	701	1430

The District maintains a complete set of records of inspections, repairs needed, revoked permits, specific chemicals applied, and how many acres received applications.

The number of chemigation permits has risen by 70 percent since 1989. The District has been able to inspect over 50 percent of the applicators. The most significant statistic indicated by these tables is the dramatic increase in both total pounds of nitrogen applied and the total application acres between 1992 and 1993. Even though the acreage subject to chemigation has increased, the application rates have been relatively constant over the past four years. The almost 72,000 acres under chemigation in 1993 represent almost 40 percent of the total irrigated acreage in the District. The increased use of chemigation will allow the District to monitor and potentially regulate agricultural chemical usage over a larger portion of the District's area.
Of significant concern is the dramatic increase in the volume of pesticides applied by chemigation between 1992 and 1993. The increased use of pesticides and herbicides in vulnerable ground water areas could have significant impacts on future ground water quality in the District.

5.3.3 Erosion/Sediment Control Programs

In order to preserve soil cover and prevent erosion, the NRD has an active program of tree planting and erosion control. The details of these programs are included in Section 9.4 of this report.

5.3.4 Park/Recreation Agrichemical Applications

The majority of park and recreation areas within the NRD are retained in a natural setting. The amount of developed and maintained park and recreation sites, such as golf courses, camp grounds and picnic areas, within the NRD is limited. Application of pesticides, herbicides, and fertilizers at these sites is not considered to be a significant source of potential contaminants.

5.3.5 Agricultural Activities (Non-point Sources)

For some counties in the NRD there is only one supplier for agrichemicals. The amounts of agrichemicals sold within the NRD were not listed in the published Agrichemical Usage and Sales Data compilations to avoid the

publication of possibly proprietary sales information. For 1993 the total fertilizer sales within the NRD were 38,038 tons.

5.4 Point Source Inventory (Known or Potential)

In the Upper Niobrara-White NRD, residential, commercial and industrial areas where most of the point sources are located, cover about 15.5 square miles of the four county area or less than 0.2 percent of the total District area.

The Upper Niobrara-White NRD has initiated the development of an environmental quality data base to include the inventorying of known or potential point source contamination sources. Information was obtained from the Nebraska Department of Health (NDOH), Nebraska Department of Environmental Quality (NDEQ), Nebraska State Fire Marshal (NSFM), and the United States Environmental Protection Agency (USEPA). Even though the Natural Resource District does not have jurisdiction over point source contaminants, it is important to be able to recognize the locations of point source contamination and its potential to degrade the overall water quality in the District.

Included in the point source data base is information for the four county NRD area covering the following potential contaminant sources and other related information:

- Designated Wellhead Protection Areas
- Municipal and Private Wastewater Treatment Plants
- NPDES Permit Holders
- Landfills
- Point-Source Agricultural Activities and Feedlots
- Registered UST and AST Inventories
- Registered RCRA Facilities
- Known contaminant releases
- NDOH Vulnerability Maps
- Abandoned or Out-of-Service Well Inventory

5.4.1 Wellhead Protection and Municipal Water Supplies

Figure 5-1 Shows the relationship of some major point sources to areas of high soil vulnerability in the District.

Table 5-4 summarizes the vulnerability of public water supply wells within the District, which wells have NDEQ approved Wellhead Protection Areas, the number of vulnerable wells and wells with detected or potential pollution sources. Information was supplied by the Nebraska Department of Health and is current to February, 1994.

TABLE 5-4

VULNERABILITY OF PUBLIC WATER SUPPLY WELLS

Area	No. of Wells	WHPA Delineated	Vulnerable Wells	Reasons
Alliance	9	yes	5	VOC detected & nearby potential sources
Box Butte Co.	4	no	2	Nearby potential sources
Chadron	5	yes	0	
Dawes Co.	2	no	0	
Whitney	3	no	0	
Gordon	7	no	1	VOC detected & nearby potential sources
Harrison	2	no	0	
Hay Springs	3	no	0	
Hemingford	5	yes	1	VOC detected
NE Boys Ranch	4	no	0	
Pine Ridge CC	2	no	0	
Rushville	3	no	0	
Sheridan Co.	2	no	1	Nearby potential source
Sioux Co.	1	no	0	
Terrace Water	1	no	0	
Transcisco	1	no	0	

5.4.2 NPDES Permits

The following list (Table 5-5) of National Pollution Discharge Elimination System Permits includes Waste Water Treatment Plants (WWTP) and other facilities required to have a discharge permit.

TABLE 5-5

LIST OF NPDES PERMITS

County	City	Facility	Treatment Type
Box Butte	Alliance	Dayco Products	Exempt
Box Butte	Alliance	Alliance WWTP	Lagoon System
Box Butte	Alliance	Alliance CO-OP	N/A
Box Butte	Hemingford	Hemingford ?	Exempt
Dawes	Chadron	Chadron State Park	Exempt- Complete Retention
Dawes	Chadron	Pine Ridge C C	Exempt-Activated Sludge
Dawes	Chadron	C&NW Railroad	Oil Separation
Dawes	Chadron	Chadron State College	N/A
Dawes	Crawford	NE Game & Parks	Exempt
Dawes	Crawford	Crawford WWTP	Trickling Filter
Sheridan	Gordon	Gordon WWTP	Lagoon System
Sheridan	Hay Springs	Hay Springs WWTP	Complete Retention
Sheridan	Rushville	Rushville WWTP	Trickling Filter

5.4.3 Community Solid Waste Disposal Sites

The Upper Niobrara-White NRD has compiled a listing of the solid waste disposal sites in the District as part of the environmental quality data base. A summary of these sites, which are subdivided into groups of Unlicensed Community Solid Waste Disposal Sites, Licensed Landfills, and Proposed Landfills and presented in the following Tables. The ongoing program of

data base improvement will include expansion and updating of the NRD files on these sites.

TABLE 5-6

UNLICENSED COMMUNITY SOLID WASTE DISPOSAL SITES

County	Community	Status*
Dawes	Crawford	Closed 10/93
Dawes	Fort Robinson	Closed 10/93
Dawes	Whitney	Closed 10/93
Sheridan	Hay Springs	Closed 10/93
Sheridan	Clinton	Closed 10/93
Sioux	Harrison	Closed 10/93

*** Closed status refers to landfills no longer accepting waste rather than closure under USEPA Title D requirements.**

TABLE 5-7

LICENSED LANDFILLS

County	Community	Status*
Box Butte	Alliance Disposal Area	Open
Box Butte	Hemingford Disposal Area	Closed 10/93
Dawes	Chadron Disposal Area	Closed 4/94

*** Closed status refers to landfills no longer accepting waste rather than closure under USEPA Title D requirements.**

TABLE 5-8

PROPOSED LANDFILLS

County	Community	Status
Dawes	Solid Waste Authority of Northwestern Nebraska (Site North of Chadron)	Planning to open in early 1995

5.4.4 Feedlots

The environmental quality data base being assembled by the NRD includes information on agricultural facilities, such as feedlots, which require permits. These facilities are considered to be potential point sources for ground water contamination. Table 5-9 summarizes this information.

TABLE 5-9

FEEDLOTS AND AGRICULTURAL FACILITIES REQUIRING PERMITS

County	Facility	Location	Controls Required
Box Butte	Dinklage Feedlot	19-24N-48W	Yes
Box Butte	Jespar Jensen	27-26N-50W	No
Box Butte	Flying U Cattle	18-27N-49W	No
Box Butte	Gardner/Kinghorn	05-24N-50W	Yes
Dawes	Crawford Livestock	03-31N-52W	Yes
Dawes	Wasserburger	25-32N-52W	No
Sheridan	City of Hay Springs	10-31N-46W	No
Sheridan	Ruse Farms	24-32N-42W	Yes
Sheridan	Marlys Essex	23-33N-42W	Yes
Sheridan	Gerald Denton	07-34N-45W	No
Sheridan	Hay Springs Pork	12-31N-46W	Yes

Note: The City of Hay Springs has a permit for a demonstration site for composting of yard waste.

5.4.5 CERCLA Sites

Some significant existing point-source contamination areas impacting ground water quality include five sites on the Comprehensive Emergency Response Compensation and Liability Act (CERCLA) listings of known or suspected, uncontrolled or abandoned waste sites that are currently under investigation. Table 5-10 lists these facilities.

TABLE 5-10

CERCLA LISTED UNCONTROLLED OR ABANDONED WASTE SITES

County	City	Event
Box Butte	Alliance	Hoffman Drums
Box Butte	Alliance	Municipal Landfill
Box Butte	Alliance	VOC Ground Water Contamination
Box Butte	Hemingford	VOC Ground Water Contamination
Sheridan	Gordon	VOC Ground Water Contamination

5.4.6 Leaking Underground Storage Tanks

A number of underground storage tank releases have been reported within the District. The following is a listing of the communities involved and the number of leaking tanks. Detailed information listings supplied by NDEQ are in the NRD files, and are summarized in Table 5-11. Copies of selected reports and correspondence contained in the specific LUST/ER Section Project files will be acquired from the NDEQ Public Information Office for future inclusion in the NRD files.

TABLE 5-11

DOCUMENTED LEAKING UNDERGROUND STORAGE TANK SITES

County	City	Number of LUST Sites
Box Butte	Alliance	15
Box Butte	Hemingford	2
Dawes	Chadron	18
Dawes	Crawford	3
Sheridan	Gordon	4
Sheridan	Hay Springs	3
Sheridan	Rushville	1
Sheridan	Whiteclay	8
Sioux	Harrison	2

5.4.7 Septic Tanks

One of the point sources for contamination that needs to be considered during ground water planning is septic tank density. Septic tanks, used by approximately 20 million American households, handle an estimated 3.5 billion gallons of liquid waste per day. Septic systems discharge high volumes of water soluble waste into ground water. Improper disposal of household chemical products through septic tank systems contributes a variety of potential contaminants. Chemical solvents used to clean septic tanks also can contribute to contamination of ground water. Localized occurrences of nitrates and bacteria have frequently been traced back to septic tank systems. In areas of high septic tank density, the impact on ground water may be marked. Table 5-12 shows the estimates of septic tank density in the Upper Niobrara-White NRD counties.

TABLE 5-12

NRD ESTIMATED SEPTIC TANK DENSITY

County	Area-Square Miles	Rural Houses	Area / House (square miles)
Box Butte	1065	1023	1.04
Dawes	1389	973	1.43
Sheridan	2484	1389	1.79
Sioux	2055	677	3.04

Note: Information based on 1990 U.S. Census Information

Assuming each rural house has a septic tank system, the density of septic tanks varies from almost one per square mile in Box Butte County to one third per square mile in Sioux County. This density would indicate on a regional basis, the impact of septic systems on contaminating ground water is not as significant as non-point agricultural applications of fertilizer and pesticides. Septic systems' contamination of ground water is a matter of local concern when domestic water supply wells are in close proximity to septic systems in areas of high permeability soils and shallow depths to ground water. The housing area east of Chadron is a case in point where septic systems in close proximity to domestic wells have had an impact on local ground water quality. In situations where high Nitrate (N) concentrations are found in domestic wells, coliform bacteria counts need to be made to determine if septic systems or other nearby agricultural activities are responsible for the observed water contamination.

As part of Spalding's 1991 survey of rural wells in Nebraska, information was collected concerning potential point-source pollution sites adjacent to the domestic wells sampled. Included in Tables 5-13 and 5-14 is separation-distance information for septic tanks and barnyards to the water wells that were sampled during Spalding's survey.

TABLE 5-13

DISTANCE FROM DOMESTIC WELLS TO SEPTIC TANKS (feet)

County	Number of Sampled Wells	Mean Distance	Minimum Distance	Maximum Distance
Box Butte	27	103	10	250
Dawes	16	258	50	1100
Sheridan	19	120	40	500
Sioux	12	289	25	1300

(Modified after Spalding 1991)

TABLE 5-14

DISTANCE FROM DOMESTIC WELLS TO BARNYARDS (feet)

County	Number of Sampled Wells	Mean Distance	Minimum Distance	Maximum Distance
Box Butte	18	184	30	675
Dawes	15	142	10	350
Sheridan	13	247	20	1300
Sioux	11	181	5	1000

(Modified after Spalding 1991)

5.4.8 Abandoned Water Wells

Nebraska Department of Health Title 178 NAC 12 Water Well Standards requires that abandoned water wells and test holes be properly plugged to assure that either potential contaminants from the surface or another aquifer will result in water quality degradation or cross aquifer contamination. The Upper White-Niobrara NRD has not had the budget available to address this issue. The recent passage (April, 1994) of LB 981 has further defined the decommissioning process for water wells. This legislation also establishes a state cost-sharing program to help the NRDs financially in decommissioning illegal water wells.

5.5 Identified Needs And Data Deficiencies

As part of the ongoing development and expansion of the NRD's environmental quality data base several types of information will be needed.

- Exact location of existing and former solid waste disposal facilities.
- Detailed information on septic tank density, especially in areas with concentrations of rural residences.
- Specific information on known releases from documented LUST sites.
- Information on historic spills and releases of potentially contaminating materials.
- Information on the amounts and types of agrichemicals sold within the NRD.

The following types of studies are targeted for consideration by the NRD Board of Directors:

- The specific relationship of water wells with reported nitrate contamination to septic tanks and livestock facilities.
- An inventory of abandoned or out-of-service wells.
- An inventory of existing ground water monitoring wells.

SECTION 6.0

WATER USAGE AND DEMAND

6.1 Domestic Uses

6.1.1 Current Local/Regional Regulatory Framework and Programs

Local public water supply use is regulated through local municipalities. Many of the municipalities have instigated water metering or other types of usage controls. Alliance and Chadron have had water meters in operation for several years. Hemmingford has just started using meters.

6.1.2 Current Population and Water Usage Summary

With the exception of Box Butte County, the population trends for the four county District area since 1960 are showing a gradual decline in population. Table 6-1 shows the U.S. Census population information for the District since 1960. The population of the four counties has declined from 32,848 people in 1960 to 30,450 people in 1990. Box Butte County experienced a 36 percent growth in population between 1970 and 1980, primarily due to industrial growth in the Alliance area. The agricultural-based populations of Sheridan, Dawes and Sioux Counties have shown a significant decline between 1980 and 1990. Sioux County has lost almost 40 percent of its population in the last 30 years.

TABLE 6-1

U. S. CENSUS BUREAU INFORMATION - TOTAL POPULATION BY COUNTY

County	1960	1970	1980	1990
Box Butte	11,688	10,094	13,696	13,130
Dawes	9,536	9,693	9,609	9,021
Sheridan	9,049	7,285	7,544	6,750
Sioux *	2,575	2,034	1,845	1,549

*** Sioux County information is for the entire county.**

Table 6-2 shows the comparison of urban versus rural population densities for the District and the comparison of urban versus rural housing. A little more than one half of the entire population of the District is in urban areas

in Box Butte and Dawes Counties. With the exception of Sioux County, there are more urban housing units than rural houses in the District. A majority of the urban population is connected to municipal water systems. However, many of the urban areas, with homes on the fringes of the communities, are still supplied with domestic wells, either for all their water or as a supplemental source.

TABLE 6-2

1990 CENSUS INFORMATION - URBAN VS, RURAL COMPARISONS BY COUNTY

	Population		Housing Units	
County	**Urban**	**Rural**	**Urban**	**Rural**
Box Butte	**10,718**	**2,412**	**4,511**	**1,023**
Dawes	**6,751**	**2,270**	**2,936**	**973**
Sheridan	**3,656**	**3,094**	**1,822**	**1,389**
Sioux *	**291**	**1,258**	**192**	**677**

*** Sioux County information for entire county.**

Table 6-3 shows changes in the number of farms in the NRD counties between 1987 and 1991. The data shows an ongoing decrease in the number of farms. This decrease is projected to continue for the rest of the 1990s.

TABLE 6-3

UPPER NIOBRARA-WHITE NRD NUMBER OF FARMS

County	1987	1988	1989	1990	1991
Box Butte	**530**	**525**	**515**	**515**	**505**
Dawes	**445**	**445**	**435**	**435**	**430**
Sheridan	**700**	**700**	**695**	**695**	**680**
Sioux*	**360**	**355**	**345**	**345**	**335**
Totals	**2,035**	**2,025**	**1,990**	**1,990**	**1,950**

Note: Sioux County farms are for entire county.
Source: 1991/92 Nebraska Agricultural Statistics

Table 6-4 shows the public water supplies for the urban areas within the District and the annual water use. Even though the information is from 1981, the relatively stable population information should be reflected in similar water usage today. The City of Crawford derives its municipal water from surface water sources and the City of Chadron also uses a significant quantity of surface water.

TABLE 6-4

DISTRICT PUBLIC GROUND WATER SUPPLIES, 1981

County	Water System	Water Use (in Acre Feet)
Box Butte	Hemingford	344
	Alliance	2903
Dawes	Chadron	467 (753 from SW*)
	Crawford	0 (344 from SW)
	Dawes RWD #1	37
	Whitney	16
Sheridan	Gordon	512
	Hay Springs	193
	Rushville	225
Sioux	Harrison	101
	TOTAL	4,687

***SW = Surface Water**

Rural domestic water use from ground water sources is difficult to quantify, but assuming 5,000 domestic wells in the District and water consumptions of 100 to 400 gallons per day per household, ground water withdrawals are estimated to be in the range of 500 to 2,000 acre feet per year.

6.2 Agricultural Uses

Most of the agricultural water used in the Upper Niobrara-White NRD is derived from ground water. Two principal exceptions to this are the Whitney and Mirage Flats Irrigation Districts, which derive a significant portion of their supplies from the White River and Niobrara River, respectively.

Ground water development in the District exhibited a pattern of rather gradual growth until the early 1970s when development sky-rocketed with the advent of the center pivot irrigation system. Figure 6-1 depicts the increase in registered wells over the 50 years between 1940 and 1990. As of January, 1992 there are 1857 registered wells in the four county area. Ninety-eight percent of the registered wells are used for irrigation. Most of the irrigation development is concentrated in Box Butte, southern Dawes, and northern Sheridan Counties (Figure 2-7).

Previously, the NRD funded water use investigations in Box Butte and Sheridan Counties and in Southern Dawes County between 1981 and 1983.

The inventory in Box Butte County (Lawton and Teahon, 1984) documented irrigated acreage and water application rates by crop and system types. The inventory in Dawes and Sheridan Counties documented irrigated acres by system type. The water use studies indicated the water requirements of various crops differed greatly.

An average application rate was used for all crop types of 10.5 inches/acre for gravity systems, based on the average data derived from the 1981 and 1982 Box Butte County studies. This information was used to generate the irrigation water use estimates shown in Table 6-5.

TABLE 6-5

ESTIMATED AGRICULTURAL GROUND WATER USE

		IRRIGATION			Estimated Water Use		
		Irrigated Acres			(in acre feet)		
County	Year of Est.	Pivot	Other	Total	Pivot	Other	Total
Box Butte	1982	88,188	32,502	120,690	77,164	43,336	120,500
Sheridan	1982	38,770	12,713	51,483	33,924	16,951	50,875
Southern Dawes	1982	4,991	1,929	6,920	4,367	2,572	6,979
TOTAL (acres)				179,093			178,314

Note: Data unavailable for Sioux County, as use is minimal - only 59 registered irrigation wells in NRD.

Sub-irrigation water uses have not been quantified for the purposes of this document because of the lack of sufficient data. However, Figure 6-2 shows that a fair amount of sub-irrigated vegetation has been mapped in the region, primarily in the shallow water tables of the rivers and Sand Hills lakes.

Estimates of average weekly use of water for crops are presented in Table 6-6. The data was obtained from the UNL Panhandle Agricultural Experiment Station. It is important to keep in mind that these values are averages. In a dry year, requirements will be greater and in a wet year, they will be less. A killing frost will effectively stop crop water use for the remainder of the season. However, the values are presented here primarily to provide comparative values to weigh against precipitation values, and to illustrate discrepancies between the crop water requirements and timing of precipitation.

The values given in Table 6-6 represent averages and their accuracy for a particular week are not guaranteed. They should be considered to be guide lines. Crop use can vary by variety, plan population and weather. Allowance should be made for losses in irrigation efficiency.

Local information indicates that the total water use for alfalfa and pasture will probably be less than given in Table 6-6 due to harvesting and grazing. Alfalfa will be approximately 36 inches per year and pasture around 32 inches per year.

In summary, the crop water needs are greatest during the months of July and August, exceeding average precipitation amounts by as much as 6 inches for some crop types. For irrigated crops, this means that, on the average additional water is needed by the crop during July, August, and often September, and irrigation must supply the additional water.

Prior to the development of irrigation, much of the land in the NRD was rangeland, hay or planted wheat (all very low-water using agriculture). A map of general land use in 1975 (Figure 4-1) shows that a significant portion of the NRD is still considered rangeland. Comparison of the land use map to the registered irrigation well map (Figure 2-7) shows a close correlation between well distribution and agriculture in Box Butte, southern Dawes, and Sheridan Counties. Some of the remaining agriculture can be explained by surface water irrigation along the Niobrara and White Rivers, but also includes dryland farming, primarily wheat and hay.

TABLE 6-6

AVERAGE EXPECTED WESTERN NEBRASKA CROP WATER USE (in/year)

Week	Date	Alfalfa	Corn	Beans	Small Spring Grains	Sugar Beets	Small Winter Grains	Pasture	Potatoes
1	4/15-22	0.5	---	---	0.25	0.2	0.6	0.5	---
2	4/22-28	0.8	---	---	0.3	0.3	0.85	0.75	---
3	4/29-5	1.1	0.25	---	0.35	0.35	1.05	1.0	---
4	5/6-12	1.45	0.35	---	0.55	0.4	1.25	1.3	---
5	5/13-19	1.8	0.4	---	0.8	0.5	1.3	1.55	0.3
6	5/20-26	1.85	0.5	---	1.1	0.6	1.95	1.6	0.4
7	5/27-2	1.9	0.65	0.2	1.3	0.75	2.0	1.7	0.45
8	6/3-9	2.0	0.85	0.2	1.45	0.9	1.95	1.7	0.55
9	6/10-16	2.0	1.05	0.3	1.7	1.05	1.75	1.75	0.7
10	6/17-23	2.05	1.3	0.5	2.15	1.2	1.5	1.8	0.85
11	6/24-30	2.1	1.5	0.8	2.1	1.35	1.15	1.8	1.05
12	7/1-7	2.1	1.7	1.25	1.95	1.5	0.75	1.85	1.30
13	7/8-14	2.1	1.85	1.7	1.7	1.65	0.5	1.85	1.5
14	7/15-21	2.1	2.0	1.9	1.4	1.75	0.1	1.85	1.65
15	7/22-28	2.1	2.0	2.05	0.95	1.85	---	1.85	1.8
16	7/29-4	2.05	2.05	1.9	0.55	1.9	---	1.8	1.85
17	8/5-11	2.0	2.0	1.65	0.1	1.85	---	1.75	1.8
18	8/12-18	1.9	1.85	1.35	---	1.75	---	1.65	1.75
19	8/19-25	1.8	1.65	0.95	---	1.7	---	1.60	1.65
20	8/26-1	1.7	1.45	0.55	---	1.6	---	1.5	1.55
21	9/2-8	1.6	1.2	0.2	---	1.5	---	1.4	1.45
22	9/9-15	1.45	0.95	0.1	---	1.35	---	1.3	1.35
23	9/16-22	1.35	10.75	---	---	1.2	---	1.15	1.25
24	9/23-29	1.2	0.55	---	---	1.0	0.3	1.05	---
25	9/30-6	1.05	0.4	---	---	0.85	0.4	0.95	---
26	10/7-13	1.0	---	---	---	0.65	0.5	0.85	---
	TOTAL	43.05	27.25	15.6	18.7	29.7	17.9	37.85	23.20

6.3 Industrial Water Use

Industrial ground water use in the District is minimal as compared to agricultural and domestic uses. There are few industries that have developed their own wells for water supply. Table 6-7 illustrates the water usage for two industries in the District. A portion of the municipal water in the Alliance area is for commercial and industrial use.

TABLE 6-7

SELF-SUPPLIED INDUSTRY, 1982

County	Industry Type	Water Use (in Acre Feet)
Box Butte	Railcar Maintenance	0.30
Sheridan	Rendering and Packing	33.00
	TOTAL	33.30

The District does not foresee any significant industrial development in the near future that would require any large water supplies.

6.4 Fish and Wildlife

Recreation is an important source of income for the four county area, especially in the Pine Ridge area. Game fish and wildlife are important tourist draws for the economy of the District. The NRD also recognizes that any ground water management activities, including those in this GWMP, may have some impact (positive or negative) on the threatened and endangered species listed in Table 6-8 below. It is important that surface water supplies be maintained to assure that rivers, lakes and wetlands have sufficient water to support fish and wildlife. The NRD recognizes that general protection of ground water quantity and quality has many benefits including protecting the habitats of threatened and endangered species, including those listed below.

The Upper Niobrara-White NRD four county area has a number of endangered or threatened species or their environments that could be impacted by declines in ground water levels. Information received from the Nebraska Game and Parks

Commission and the U. S. Fish and Wildlife Service indicates the following areas have threatened or endangered species.

The threatened species that would be impacted by declining ground water levels, water quality and availability include all of the Dace fish species, the Western Prairie Fringed Orchid and the Whooping Crane. Table 6-8 summarizes the endangered or threatened species and their location within the NRD.

The threatened fish species are found in small, cool prairie streams with low turbidity. Lowered ground water levels in the Niobrara and Pine Creek areas could result in flow loss due to decreased ground water discharge to these streams and threaten the existence of these fish. Increased turbidity due to increased suspended material resulting from agricultural or grazing practices is also a threat to these species. Ground water levels adjacent to these streams need to be monitored to determine if the environment necessary for these species of fish is being degraded. Anti-erosion and fencing practices in areas adjacent to these streams would need to be addressed to reduce turbidity, if this becomes a problem.

TABLE 6-8

THREATENED OR ENDANGERED SPECIES

County	Stream or Area	Species
Dawes/Sioux	Niobrara River (Wyoming border to Hwy 183 in Dawes County)	Northern Redbelly Dace Pearl Dace Finescale Dace
Sheridan	Pine Creek	Northern Redbelly Dace
Box Butte	East & West of Alliance, & Southeast near Morrill County Line	Blowout Penstemon
Sheridan	Sand Hills	Western Prairie Fringed Orchid
Dawes/ Sioux/Sheridan	Wetlands & Lakes	Whooping Crane
Four Counties	Winter Roosting	Bald Eagles
Four Counties	Migration Routes	Peregrine Falcon
Four Counties	Prairie Dog Colonies (potential habitat)	Black Footed Ferret

The Whooping Crane needs wetlands and lakes for both migration and nesting. Ground water levels in wetlands areas, where whooping cranes have potential habitat, should be monitored and maintained to preserve these habitants.

The Western Prairie Fringed Orchid has not been observed in the four county area of the Upper Niobrara-White NRD. The potential habitats for the orchid are the tallgrass wet meadows and mesic tallgrass prairies which occur in the Sand Hills portion of Sheridan County. A decline in regional ground water levels could directly impact vegetation in these areas and could potentially destroy the potential orchid environment. Overgrazing by livestock is also a potential threat to the orchid.

At the present time the NRD recognizes that ground water level changes have the potential to impact endangered species. The NRD is prepared to modify the Ground Water Management Plan if it is determined that the subject endangered or threatened species environments are degraded by NRD practices. Should specific adverse effects on threatened species listed above from changing ground water levels be identified, the NRD will modify this GWMP as necessary to reduce the adverse effects on the species by maintaining ground water levels that will sustain these species (see Section 9.5.2). Such modifications should include actions within control or management areas consistent with the Nebraska Groundwater Management and Protection Act. Community education as to the potential impacts on these species is a part of the District's Ground Water Management Plan (Section 9.1.2).

Copies of recent wetland-delineation maps prepared by the Army Corps of Engineers and by the SCS are available in the local SCS offices. Copies may also be available through the Game and Parks Commission and National Forest Service offices. These maps are useful for local water table delineations and potential impact studies of ground water changes on wildlife and endangered species.

6.5 Recreation

The main recreational use of water within the NRD is associated with Box Butte Reservoir. The primary function of the Box Butte Reservoir is as a source irrigation water which may compromise the recreational usage at some times of the year.

6.6 Estimated Future Water Needs

The previous sections have documented a general decrease in population in the NRD counties, except Box Butte. The number of farms is decreasing in all four counties. At this time there is no anticipated major industrial growth and most of the agricultural acreage that can be irrigated is already under irrigation. The NRD Board of Directors anticipates that there will be no significant changes in water usage or increases in demand for water in the near future.

Due to the interpretation that the demand for water in the NRD counties will not significantly increase, little effort has been directed toward determining the possibility of acquiring alternate or additional sources of water.

6.7 Supplemental Water Supplies

Supplemental water, as defined in the "Policy Issue Study on Supplemental Water Supplies", (1984) is: "...additional water provided to supply that which is lacking (i.e., needed or desired). Because water is unevenly distributed in time and space, storage and transportation are the key elements in any strategy to provide supplemental water."

Supplemental water could be used for such purposes as:

- Development of irrigation on suitable lands if lack of an adequate water supply is constraining their development.
- Supplement existing municipal water supplies.
- Provide a source of supply for livestock and rural domestic purposes (such as that done for the Dawes County rural water system).
- Provide water for industrial development.
- Use supplemental water for fish, wildlife and outdoor recreation (such as the pumping from a well near Walgren Lake in Sheridan County to improve water quality).

Development of supplemental water supplies for the NRD includes capturing and storing unused river flow in surface impoundments. While this may be a possibility based on water-yield estimates in the surface water section of this

report, downstream senior appropriations would most likely subvert such development.

Transfer of surplus ground water from plentiful areas to water-short areas for any of the purposes mentioned above is a possibility that has been considered in the past and will probably be considered again in the future. The extensive water supplies in Sheridan and Sioux Counties have been eyed by many as potential supply sources if economic, environmental, and other factors support such use. For example, if development of the ground-water reservoir in Box Butte County reached a critical point where artificial recharge were economically feasible and socially acceptable, the water supplies of southern Sheridan County would be a likely candidate for a source of recharge water. However, the environmental factors might be prohibitive unless the impact of such withdrawal on the local wetlands could be assessed accurately. The greatest source of "supplemental" water in the NRD lies in the undeveloped areas where development would need to overcome a number of economic, environmental, and social barriers.

6.8 Economic Value of Uses

The District recognizes that the different uses of ground water have different economic values to various population segments within the NRD area. The key current uses of ground water are to meet domestic and public water supplies, industrial, agricultural, fish and wildlife and recreational needs of the NRD. From a financial aspect the economic ranking of ground water value would be: first-agricultural, followed by domestic, industrial, recreational, and fish and wildlife uses. Considered from a population use viewpoint the ranking might be: domestic-first, followed by agricultural, industrial, fish and wildlife, and recreational uses in descending economic value. The NRD will consider the economic impacts of changes in ground water use that may be required as a result of the implementation of this GWMP.

6.9 Identified Needs and Data Deficiencies

The District plans to update the water use information for domestic, industrial, agricultural and recreational needs and maintain this information to better delineate shifts in water usage as they impact the goals of the Ground Water Management Plan.

SECTION 7.0

IDENTIFICATION OF CRITICAL AREAS FOR PROTECTION

7.1 General Overview

The purpose of the objectives and goals listed in Section 8.0 of this Ground Water Management Plan is to prolong an adequate supply of useable ground water and to minimize ground water quality degradation by managing its use and development. This section identifies key issues and areas of concern based on water quantity and quality and those areas requiring protection in order to be able to fully utilize the ground water resources of the District. The programs that the NRD will use to implement the objectives are summarized in Section 9.0.

7.2 Ground Water Quantity Issues

The District's water quantity goal is to minimize ground water depletions (short term) and sustain the aquifer (long term). Utilizing 1990 as a base year, changes in spring static water levels will be monitored yearly. If static water levels within a ground water management sub-area meet or exceed the trigger for entering a phase of this plan, then that ground water management sub-area will enter that management phase directly.

Ground water level declines indicate that the use of the ground water resource has locally exceeded the recharge. The obvious problems resulting from the lowering of the water table include:

- Increased lift
- Significant reduction in saturated thickness
- Drying up of shallower wells
- Reduced yields of partially penetrating wells
- Increased competition among users
- Reduction of base flow in streams
- Drying up of wetlands.

Less obvious problems include:

- Change of water quality
- Change of soil fertility
- Wasting of water

If development and use of the ground water resource continues to go unchecked in areas of insufficient natural recharge, water levels will decline at an increasing rate.

A large and unknown potential problem is the wasting of water. Over application of irrigation water is wasteful when the excess water applied does not result in increased

yield. Souders (1980) estimates that only 10 percent of irrigated water is recharged, so any excess water applied beyond crop needs may be lost to evaporation. The ground water decline resulting from waste is one of the most important aspects of water level control. The unknown aspect of the problem results from the honor system used by irrigators. When water use is not measured, the sharing of the ground water reservoir is left to the conscience of the users. Mandatory metering and irrigation scheduling are potential solutions to reduce waste.

7.3 Ground Water Quantity Problem Areas

In 1980, the Upper Niobrara White NRD entered into an agreement with the Nebraska Conservation and Survey Division, the agency that has monitored ground water levels in Nebraska since 1930, to obtain District-wide ground water level measurements twice a year and to analyze that data.

The District also receives ground water elevations from the long-term records from the USGS continuous-recorder wells. The USGS wells give the NRD a more reliable indication of what is happening to the water table.

A review of the hydrographs from the irrigation wells in Sheridan County does not indicate widespread declines. Recent ground water level measurements in Box Butte County indicate that moderate ground water level declines are continuing to occur. The hydrograph of the Mirage Flats recorder well indicates that the water table is declining significantly, but with the influence of surface water from the Mirage Flats Irrigation District, it is hoped that this indicated recharge of the aquifer has potential for reversing the trend of ground water level declines in this area.

Box Butte County has a decline area that has been monitored for many years. The drying of shallow wells, the required deepening of wells to maintain yield, the increased lift and the drying up of Bronco Lake and Snake Creek, had all occurred before the 1985 Ground Water Management Plan was developed. If the decline continues, the competition between users will be accentuated. At the same time slight declines in water levels in parts of Sheridan County had been observed, especially near Mirage Flats.

The Hat Creek-White River basin has been characterized as a particularly water-short area. The localized areas that yield sufficient water for domestic and livestock needs are a very precious commodity. Care must be taken to preserve what supply there is in this area by prevention of well interference or supply depletion problems that could result if developments in the area were not closely monitored. Priority of use must be protected to preserve the viability of the area.

7.4 Ground Water Quality Issues

Maintaining water quality is an important management concern for the ground water resource. As water levels decline, water quality may deteriorate as older, deeper waters

are used. Knowledge of water quality from various depths is essential to forecasting aquifer life.

Chemical pollution of the aquifers could take place very quickly without much warning. Nitrates, pesticides, herbicides, and industrial waste are the greatest threats to the ground water. This topic is discussed in detail in Section 5.0 - Contaminant Source Inventory.

Nitrate contamination of ground water has appeared in an increasing number of areas within the State of Nebraska since the introduction of large-scale application of nitrogen fertilizer. The first known high-nitrate areas are located in conjunction with shallow depths-to-ground water. Contaminated areas with greater depths-to-ground water appeared later in time. This seems to suggest that the unsaturated soil above the water table acts as a buffer which delays the time that nitrates take to finally reach ground water. The earliest detection of nitrate in the District is where the unsaturated soil is thin (Alliance area) or very sandy (Sand Hills). Based on limited data, it was suggested in the 1985 GWMP that other areas of the NRD were beginning to show increasing nitrate concentrations. This was one of the main incentives for the expansion of the ground water monitoring program outlined in Section 3.0.

Pesticides, herbicides, and industrial waste represent other common and persistent threats. Improperly used and stored chemicals can soak into the ground and infiltrate to the water table. The treatment of water contaminated with these chemicals is so difficult that small quantities are of great concern. This represents a large potential problem for some areas of the state. Data in Section 3.0 indicates that this may not be as significant in the District at this time. Many of the high Nitrate levels observed in individual wells may be indicative of point source contamination rather than more wide spread non-point source problems. This interpretation is based on the apparent variability in Nitrate levels in wells that are in close proximity. One of the proposed programs in Section 9.6.2 addresses this condition.

7.5 Existing and Future Impacts of Land Uses on Ground Water Quality

The primary non-point source impact on ground water quality in the NRD is irrigation-related agricultural activities involving fertilizers, pesticides and herbicides. The current level of irrigated agricultural land is relatively constant within the NRD, as most all of the easily irrigated acreage is in production. The District does not foresee any significant changes in the amount of irrigated acreage. If the District continues to see population declines, there is potential for reduced numbers of irrigated acres. The percentage of total irrigated acreage using chemigation has increased dramatically during the past four years (See Section 5.3.2). As previously identified in Section 2.2 and in Figure 2-25, the areas of significant soil vulnerability have been identified. Those areas indicated by the DRASTIC survey as having significant soil vulnerability and irrigated agricultural acreage need to be better defined so that the NRD can better focus its educational programs to make landowners aware of surface chemical usage and its potential impacts on ground water quality. The better delineation of those critical areas for quality

protection may result in the delineation of Special Study Areas or Ground Water Management Areas if the ground water in an area is sufficiently impacted by contaminants.

Point sources of contamination are a significant concern for the NRD as their areal impacts tend to be much smaller than non-point sources, but the intensity of contamination may be significantly higher. The NRD will maintain its point source data base and include this information in studying critical protection areas.

Potential problems of contamination of usable aquifers from the activities of in-situ uranium mining exist in the Crawford area. Monitoring and inspection are part of the requirements of the permit to mine. The local aquifer units in this area include the basal Chadron sand of the Chadron formation and in specific localities the Brule formation. Water quality in the Brule is generally low in TDS and sulfates and considered of high quality. Although the water in the Chadron formation is poor in quality, it does not exceed the EPA criteria for exemption, which is 10,000 ppm TDS. Ground water monitoring data (see Section 3.0) from the area indicates that to date, there is no indication of any problem resulting from mining activities.

7.6 Existing and Future Impacts of Quantity Depletion on Ground Water Quality

Potential problems in the District related to water level declines, include change of water quality. As wells are deepened, the probability of pulling inferior quality water up from the bottom of the aquifer is increased. The reversal of ground water flow near Alliance (now east to west) could introduce water having high TDS into Box Butte County from Sheridan County. TDS concentrations in former discharge areas such as Snake Creek could be mobilized by solution in percolating water and reach the ground water pool. Soil productivity in the irrigated areas will deteriorate as salts accumulate in the soil by evaporation of applied water. In other areas of the country, lands have been abandoned after salt accumulation ruined the productivity.

Currently, the NRD has not observed any significant water quality deterioration that can be attributed to quantity depletion. The District plans to continue water quality monitoring in those areas of continuing water level declines in order to determine if quality is being threatened. Special studies or more stringent management plans will be implemented if co-dependent quality and quantity degradation is observed within the NRD.

SECTION 8.0

8.1 General Overview

The Upper Niobrara White Natural Resources District's (UNWNRD) primary goal is to manage for an adequate supply of high quality ground water for reasonable uses. The objectives and policies given in this section are designed to sustain the supply of high quality ground water. Ground water management goals relating to quantity and quality issues are set by the UNWNRD Board. The two goals established are:

I. Short term goal of minimizing ground water depletions and long term goal of a sustained aquifer.
II. Prevention of ground water contamination and, where ground water is already contaminated, sufficient reduction in the level of contaminants to meet applicable water quality standards.

The Upper Niobrara White NRD is in a District-wide Ground Water Management Area for Information and Education Purposes. The District has been divided into ground water management sub-areas based on hydrogeological and physical conditions of the District (See Figure 8-1 "Map of Ground Water Management Sub-areas"). Ground water management sub-areas will be subject to the phases of this plan based on the historic spring static water level changes within those ground water management sub-areas. Utilizing 1990 as a base year, changes in spring static water levels are monitored yearly. If static water levels within a ground water management sub-area meet or exceed the trigger for entering a phase of this plan, then that ground water management sub-area will enter that management phase directly. In addition to ground water levels, ground water quality will be monitored and management options initiated if ground water quality thresholds are met or exceeded. Utilizing the maximum contaminant levels (MCL) for various contaminants set by the United States Environmental Protection Agency, ground water quality data will be collected and reviewed annually for each ground water management sub-area to determine if there are ground water quality concerns within the District.

8.2 Ground Water Quantity Related Goals And Objectives

GOAL I: Short term goal of minimizing ground water depletions and long term goal of a sustained aquifer.

8.2.1 OBJECTIVE A: Decrease water use by improving irrigation efficiency, crop water use efficiency and promotion of other conservation practices.

Policies/Programs:

A. Develop projects to demonstrate improved irrigation efficiency including new irrigation technology, irrigation scheduling, alternative cropping practices such as conservation tillage and planting crops that are less water intensive. Indicate the need to the Natural Resources Conservation Service and other appropriate state and federal agencies to target additional technical personnel for ground water management support.

B. Maintain an irrigation scheduling education network for the UNWNRD.

C. Study effectiveness of well metering programs in other Districts to assess their feasibility and impact on ground water levels. Work towards an increase in irrigation well metering by providing information on the economic and management benefits of metering.

D. Provide access to an irrigation system efficiency evaluation program.

E. Provide a voluntary program for reporting water use to help gauge whether the research and education efforts are having an impact on reducing water use.

F. Provide assistance for conservation practices under the Nebraska Soil and Water Conservation Program, UNWNRD Conservation Program and any other conservation cost-share programs that are available.

8.2.2 OBJECTIVE B: Implement ground water quantity management activities to address ground water level declines.

Utilizing 1990 as a base year, maintaining spring static water levels above the 1990 static water level will be the management goal. The entire Upper Niobrara White NRD will be subject to Phase I of this plan. Ground water management sub-areas will be monitored yearly for static water level changes; any changes will be reviewed over a monitoring period, as specified in the Ground Water Management Area Rules and Regulations. Spring to spring static water level changes will be averaged for each well monitored in a ground water management sub-area. Over 150 wells will be included in the monitoring network with at least one well being in each ground water management sub-area. If in a monitoring period, the average static water level measurements in a ground water management sub-area meet or exceed the decline triggers, which are at 3-foot (Phase II) and 6-foot (Phase III) increments below the spring 1990 level that ground water management sub-area will enter into the appropriate phase of this management plan. The District shall implement the controls outlined in this plan for the specific phase the ground water management sub-area has triggered.

Polices/Programs

Phase I Designation for Ground Water Quantity

A. The entire District will be in Phase I of this plan. The following controls will affect the entire District:

   1. A free education class will be available every year. Water users, e.g. agriculture producers, industrial users and city water managers, will be encouraged to attend an education class presented by the District. The District shall use professionals in various water related fields as well as District staff to hold educational classes.

   2. Flow meters will be required on all regulated wells and actual water use will be reported. Agricultural flow meters installed must be a District Approved Flow Meter. Municipalities and

any other regulated uses that are not metered will be required to have all services metered.

3. All irrigated acres serviced by a regulated well in the District will be certified during the first year the District goes into a Phase I designation. Municipalities will certify acres within the city limits. All other regulated uses will also be certified.

Phase II Designation for Ground Water Quantity

B. A decline of static water levels equaling or exceeding 3 feet below the spring 1990 static water level, during a monitoring period, in a ground water management sub-area will be the management trigger for entering Phase II. Management options will be implemented to sustain the aquifer life. If ground water declines with the potential to impact public health or the environment warrants it, the District Board may vote to enter Phase II prior to meeting the 3-foot decline trigger.

When a ground water management sub-area enters into Phase II the following management controls will take affect:

1. All controls implemented in Phase I will continue as outlined in section 8.2.2.A. of the District's Ground Water Management Plan.

2. There will be a suspension on the issuance of well permits. Well permits will be granted only for replacement wells or wells for which a variance has been granted.

3. There will be a suspension on increases in irrigated acres.

Phase III Designation for Ground Water Quantity

C. A decline in static water levels equaling or exceeding 6 feet below the spring 1990 static water level, during a monitoring period, in a ground water management sub-area will be the management trigger for entering Phase III. Management options will be implemented to sustain the aquifer life. If ground water declines with the potential to impact public health or the environment warrants it, the District Board

may vote to enter Phase III prior to meeting the 6-foot decline trigger.

When a ground water management sub-area enters into Phase III the following management controls will take affect:

1. All controls implemented in Phase I and Phase II will continue as outlined in section 8.2.2.A. and 8.2.2.B. of the District's Ground Water Management Plan.

2. Ground water will be allocated based on certified acres. All regulated water users will be subject to allocations, based on an allocation period. Allocations will be set by the Upper Niobrara White NRD's Board of Directors using static water level information and any other pertinent information e.g. precipitation. The board will reevaluate the allocation to determine if the allocation needs to be adjusted prior to each new allocation period.

8.3 Ground Water Quality Goals And Objectives

GOAL II: Prevention of ground water contamination and, where ground water is already contaminated, sufficient reduction in the level of contaminants to meet applicable water quality standards.

8.3.1 OBJECTIVE A: Monitor ground water quality throughout the District to characterize the ground water resource.

Policies/Programs

A. Sample all aquifer formations throughout the District with a combination of irrigation, domestic, livestock and dedicated monitoring wells.

B. Collect or analyze the following from ground water samples obtained as deemed necessary:
   1. Temperature
   2. pH level
   3. Conductivity
   4. Total Dissolved Solids

5. Nitrate-Nitrogen concentration
6. Chloride concentration
7. Sulfate concentration
8. Total Coliform Bacteria
9. Pesticide concentration
10. Well information as available (registration number, current ownership, location [including global positioning system coordinates], depth, screen placement, casing, category of use and well condition).

***Note**: The UNWNRD reserves the right to collect and/or analyze for additional parameters if needed according to well type, ground water chemistry and source of contamination.

C. Send results and explanation of analyses to appropriate landowner and/or operator.

D. Review and analyze data collected annually.

E. Determine where more intensive sampling is necessary to evaluate aquifer conditions and sample accordingly.

F. Establish a fixed monitoring network of ground water wells to be sampled annually. A floating network of wells will also be used along with a general goal to sample 25 percent of the registered irrigation wells in the district each year.

1. Potential for ground water contamination will be determined by depth to ground water, soil type, soil permeability, land use and other information that is deemed relevant.

2. Regions of low potential for ground water contamination will be sampled as needed to establish characteristic background aquifer conditions. Review sample data annually to determine whether more frequent sampling is necessary.

3. Regions of high potential for ground water contamination will be sampled annually on a continuing basis. Review sample data annually to determine whether more frequent sampling is

necessary.

4. Determine where existing wells do not allow for adequate sampling. Consider installation of additional monitoring wells in such regions.

G. Coordinate ground water sampling efforts with other local, state and federal agencies to maximize efficiency and avoid duplication of effort.

H. Support education and demonstration programs of Best Management Practices (BMP's) for irrigation and nutrient application.

I. Support education programs that relate soil characteristics to the potential for downward movement of contaminants through the soil profile.

J. Coordinate a soil sampling effort throughout the District to identify the most vulnerable regions where the potential for leaching of agri-chemicals and non-point source nitrate contamination of the underlying ground water is greatest. Monitor these regions accordingly.

K. Administer the Chemigation Program and collect ground water samples while conducting chemigation inspections.

L. Participate in Nebraska's Water Well Decommissioning Program by working with landowners and various local, state and federal agencies to locate and properly abandon unused water wells. Cost-share will be available to help defer a portion of the decommissioning expense.

M. Provide input to county and city government on zoning in accordance with UNWNRD ground water goals and objectives.

N. Submit UNWNRD ground water quality data to the Quality-Assessed Agrichemical Contaminant Database for Nebraska Ground Water.

O. Develop, implement and maintain quality assurance programs and standard operating procedures to insure data quality and consistency.

8.3.2 OBJECTIVE B: Implement ground water quality management activities to address elevated contaminant levels.

Using the maximum contaminant levels (MCL) for various contaminants set by the United States Environmental Protection Agency, ground water quality data will be collected and reviewed annually for each ground water management sub-area to monitor trends and determine if there are ground water quality concerns within the District. Once results from wells within each ground water management sub-area are reviewed, then the results from each legal township will be analyzed and reviewed. If the concentration of a particular contaminant from wells in a region meet or exceed the pre-determined levels of contamination for the phases outlined below, then the appropriate controls will be implemented by the District.

Additionally, if results from a well exhibit a concentration at or above 50% of the Maximum Contaminant Level for a particular contaminant, then results from surrounding wells will be analyzed including a region no smaller than a township in size to determine if there is a more isolated ground water quality sub-area that needs delineation and/or further investigation.

Polices/Programs:

Phase I Designation for Ground Water Quality

A. Phase I will be triggered if contamination in 45 percent or greater of the wells sampled in a region exceeds 50 percent of the MCL for a particular contaminant. If ground water contamination with the potential to endanger public health or the environment warrants it, the District Board may vote to enter Phase I prior to meeting Phase I quality triggers. Once this trigger is met or exceeded, management options will be implemented to improve aquifer quality and determine the extent and magnitude of contamination. The following actions will take place once this condition is met and prior to implementing Phase I controls.

    - District staff will resample as many of the wells as possible which exhibit elevated levels within 90 days to verify the trigger conditions.

- Total area included within the ground water quality sub-area will be determined according to severity of quality degradation, density of development, physical characteristics of the aquifer or other factors deemed important by the Board of Directors. Ground water quality sub-areas designated will be no smaller than a township.

When a ground water quality sub-area enters into a **Phase I** designation the following management controls will take affect:

1. Ground water wells within the Phase I ground water quality sub-areas will be sampled at least annually and as intensively as needed to determine the cause of ground water contamination. The sampling will consist of the fixed network wells, as well as a portion of the floating network wells, within the ground water quality sub-area.

2. The producers within the ground water quality sub-areas will be encouraged to sample the soil in each field greater than 20 acres annually for residual nutrients according to current University of Nebraska or Certified Crop Consultant (CCA) recommendations and to encourage nutrient applications within the recommended rates.

3. The UNWNRD will offer free education class at multiple locations throughout the District each year. Water users operating and/or living within the ground water quality sub-area (e.g. agricultural producers, industrial users and city water managers) will be encouraged to attend an education class presented by the District at least once every four years. This class will include professionals in various water quality related fields in addition to District staff as presenters.

B. Phase II will be triggered if contamination in 45 percent or greater of the wells sampled in a ground water quality sub-area exceeds 70 percent of the MCL for a particular contaminant. If ground water contamination with the potential to endanger public health or the environment warrants it, the District Board may vote to enter Phase II

prior to meeting Phase II quality triggers. Once this trigger is met or exceeded, management options will be implemented to improve aquifer quality and determine the extent and magnitude of contamination. The following actions will take place once this condition is met and prior to implementing Phase II controls.

- District staff will resample as many of the wells as possible which exhibit elevated levels within 90 days to verify the trigger conditions.

- Total area included within the ground water quality sub-area will be determined according to severity of quality degradation, density of development, physical characteristics of the aquifer or other factors deemed important by the Board of Directors. Ground water quality sub-areas designated will be no smaller than a township.

Phase II Designation for Ground Water Quality

When a ground water quality sub-area enters into a **Phase II** designation the following management rules and regulations will take affect:

1. All controls implemented in Phase I will continue as outlined in 8.3.2.A of the District's Ground Water Management Plan.

2. Water users, e.g. agricultural producers, industrial users and city water managers, operating and/or living within the ground water quality sub-area, will be required to attend an education class presented by the District at least once every four years. The free education class will be offered at multiple locations throughout the District each year. This class will include professionals in various water quality related fields in addition to District staff as presenters.

3. Annual soil sampling for residual nutrients on every field greater than 20 acres in size within the ground water quality sub-area will be required. Current University of Nebraska

or CCA recommendations must be used and nutrient applications will be planned within the recommended rates. Record of results must be submitted to the NRD for verification of sampling.

4. All water users operating and/or living within the ground water quality sub-area will be required to have their irrigation wells tested annually for the contaminant of concern. Results will be submitted to the District office and be used to determine if any usable residual nutrients are available in the water and may be credited towards application.

5. All water users operating and/or living within the ground water quality sub-area will be encouraged to schedule irrigation water applications using BMP's approved by the District.

6. The UNWNRD will initiate a more concentrated shallow and deep soil (vadose) sampling analysis program to determine depth and intensity of soil contamination and the amount of nutrients leaching toward the water table. Determine appropriate soil sampling requirements (type of fields, analysis methods, data needed) to address the source concerns.

C. Phase III will be triggered if contamination in 45 percent or more of the wells sampled in a ground water quality sub-area exceeds 95 percent of the MCL for a particular contaminant. If ground water contamination with the potential to endanger public health or the environment warrants it, the District Board may vote to enter Phase III prior to meeting Phase III quality triggers. Once this trigger is met or exceeded, management options will be implemented to improve aquifer quality and determine the extent and magnitude of contamination. The following actions will take place once this condition is met and prior to implementing Phase III controls.

- District staff will resample as many of the wells as possible which exhibit elevated levels within 90 days to verify the

trigger conditions.

- Total area included within the ground water quality sub-area will be determined according to severity of quality degradation, density of development, physical characteristics of the aquifer or other factors deemed important by the Board of Directors. Ground water quality sub-area designated will be no smaller than a township.

Phase III Designation for Ground Water Quality

When a ground water quality sub-area enters into a **Phase III** designation the following management rules and regulations will take affect:

1. All controls implemented in Phase I and Phase II will continue as outlined in 8.3.2.A and 8.3.2.B. of the District's Ground Water Management Plan.

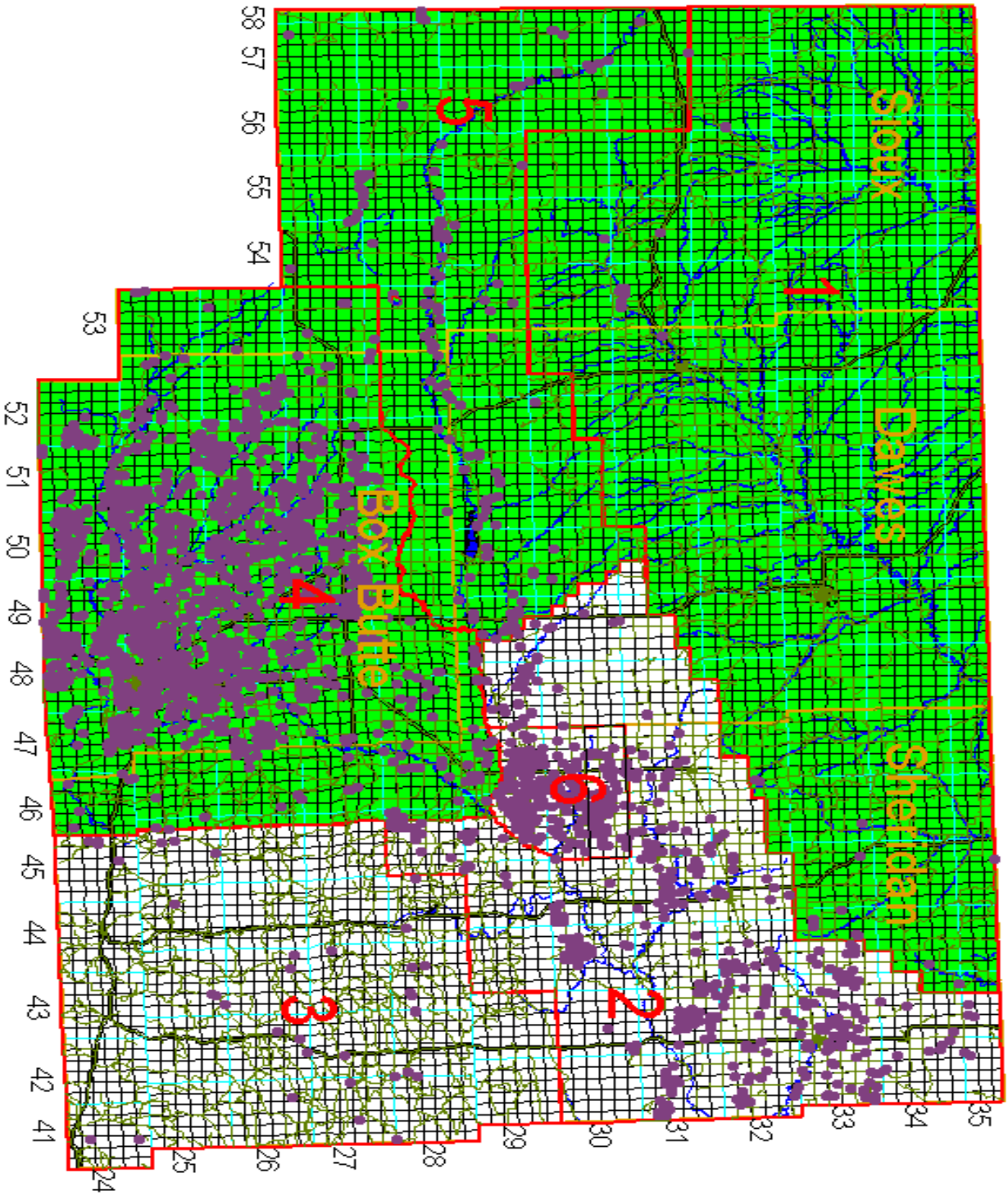
2. All water users operating and/or living within the ground water quality sub-area will be required to schedule irrigation water applications using BMP's approved by the District.

3. Application of source contaminants for spring seeded crops within the ground water quality sub-area must be deferred until March 1. If deemed necessary, this may also extend to applications during the growing season, depending upon the nature of the problem and the severity of potential economic impact.

4. Limit the application of source contaminants through mandatory soil analysis program within the ground water quality sub-area where soils are primarily sandy and depth to ground water is relatively shallow.

5. Free application certification for any operator applying fertilizer or other chemicals to a field greater than 20 acres in size within the ground water quality sub-area will be required bi-annually.

Figure 8-1 Ground Water Management Sub-areas



SECTION 9.0

GROUND WATER MANAGEMENT PROGRAMS AND PRACTICES

9.1 Educational Programs

9.1.1 Ongoing Educational Programs

Informing and educating the public as to the importance and value of ground water has been an important part of the District's mission. The Upper Niobrara-White NRD has taken several approaches to educate the public. The NRD has used an irrigation and fertilizer management display at county fairs and other community events. The District provides ground water flow models for each county to use at extension offices and schools. The District develops a monthly column for district newspapers and has also offered slide shows for special events.

Teacher Education

The Upper Niobrara-White NRD, along with the North Platte and Middle Niobrara NRDs, support the Environmental Workshop for teachers at Chadron State College and provide range camp scholarships. The District has offered scholarships to teachers to attend the Workshop. The District also provides resource people for school conservation day programs and organizes conservation tours.

Best Management Practices Education

The approach the District has taken to educate agricultural producers to protect the quantity and quality of ground water in the District is the Best Management Practices (BMPs) methods. BMPs refers to a systematic approach to protect the natural resources of the District while maintaining profitability. The NRD wants to encourage farmers, ranchers and others who affect water quality, such as gardeners or homeowners, to use practices on the land that will safeguard water quality. The Best Management Practices advocated by the District include:

- Soil conservation measures to keep sediment from entering lakes and streams.

- The proper management of irrigation water to avoid depleting the water supply and to prevent excess irrigation water from carrying away soil or harmful chemicals.

- The management of agricultural chemicals by correct timing and application to maximize efficiency and reduce runoff and infiltration.

The District encourages voluntary adoption of BMPs, where possible, in order to protect the quality of the ground water. When producers use BMPs that are suited to their local conditions, they not only protect water quality, but are likely to maximize their own economic return.

Public Information Programs for Soil Conservation

- Newspaper ads and releases (includes releases by both NRD and NRCS.

- Radio/TV interviews.

- Informational meetings (usually conducted in cooperation with other local, state and federal agencies).

- Public presentations to service clubs, church groups and other organizations.

Conservation Education

- Sponsor teachers workshops such as Project Wild.

- Make presentations and demonstrations to schools at both the elementary and secondary levels.

- Provide educational materials to public and private schools including materials from Nebraska state agencies and the NRCS.

- Provide scholarships for high school age students to attend the Nebraska Range Youth Camp.

9.1.2 Proposed Educational Programs

The NRD will initiate a program of training on the aspects of Wellhead Protection for public water supply systems. This program will be available to municipal and county officials and water operators. In addition the NRD will work toward the incorporation of Wellhead Protection information into other ground water related educational programs.

The NRD will support the incorporation of information on the relationship of ground water and wetlands and the potential impacts that ground water level changes have on wildlife, endangered species and recreation usage into existing and future public education programs.

9.2 Irrigation Related Programs

9.2.1 Ongoing Programs

Chemigation

Starting in 1989, the Upper Niobrara-White NRD initiated an ongoing system of chemigation inspection to comply with Nebraska Department of Environmental Quality Title 195 Chemigation Rules and Regulations. District personnel inspect each chemigation system before a permit is issued. In addition, chemigation systems are scheduled for periodic inspections. The District maintains a complete set of records of inspections, repairs needed, revoked permits, specific chemicals applied, and how many acres received applications. Details of the NRD chemigation programs and the observed results are discussed in Section 5.3.2 of this document.

Irrigation Scheduling

Irrigation scheduling determines when and how much water is needed for soil application to meet crop demand. Soil with moisture contents below the wilting point results in crop damage and if soil moisture is too high, water moves either downward toward the water table or is lost to the air through evaporation. By avoiding excessive irrigation, farmers can reduce the leaching of chemicals below the root zone where they can potentially reach the water table and pollute the ground water. Proper irrigation

scheduling will also maximize the economic use of ground water. The determination of soil water status and current crop water use are key factors in determining when to schedule irrigation. Traditionally, farmers have used field observations and crop growth stage as important factors in their decisions to schedule irrigation. Scheduled irrigation results in better utilization of rainfall, and minimization of ground water pumping while avoiding crop water stress or excessive irrigation. The District supports irrigation scheduling and provides weekly scheduling services for both gravity and sprinkler systems.

Irrigation Energy Conservation Project

The District was a co-sponsor of a Center-Pivot Irrigation Energy Conservation Project for Western Nebraska in 1991 and 1992. Low pressure spray devices were compared to regular spinner spray devices on center pivots in order to determine which spray device system minimizes runoff. The results of the study indicate the importance of proper design of the irrigation system to avoid runoff and poor uniformity of coverage. All spray devices should be designed to apply water at a rate that is less than the rate the soil can absorb water. The results of this type of research are being utilized in educational programs stressing Best Management Practices to more effectively use irrigation water with minimizing waste.

Irrigation Improvement Cost Sharing

The District provides cost-share assistance for irrigation reuse systems, surge valves, flow meters, goose necks, land leveling, drop pipes, conversion nozzles, and rainfall auto-shutoff valves under the Nebraska Soil and Water Conservation Program.

Irrigation Run-off Control Project

Improper irrigation run-off shall mean the occurrence of irrigation run-off water which causes or contributes to the accumulation of water upon or beneath the surface of the lands of any other person(s) to their detriment. To implement control of such waters, the District established a program to enforce the provisions of LB-577 (1975) and all rules and regulations adopted pursuant thereto by the issuance of cease and desist orders and by bringing appropriate actions in the district court of the county in which

any violations occur for enforcement of such orders. Details of this program are contained in Appendix III of the 1989 Master Plan.

Vadose Zone Sampling Project

As part of the NRD's assistance to the Mirage Flats Irrigation District, the District sponsored vadose zone soil coring at six locations in the Mirage Flats area in 1991. The University of Nebraska-Lincoln Water Center sampled and analyzed the soil cores for residual Nitrate contents in both the soil and pore water. The results indicated highly variable nitrate concentrations which relate to frequency and amounts of fertilizer applied. Additional sampling and study are needed prior to relating this data with local Nitrate concentrations in the ground water at Mirage Flats.

Abandoned Irrigation Well Decommissioning Project

The NRD has implemented a cost-share program for the decommissioning of abandoned irrigation wells. This cost-share program is for the location and proper abandonment of those abandoned or poorly maintained irrigation wells where there is potential for ground water contamination.

9.2.2 Proposed Programs

In the event the bi-annual reviews of this Ground Water Management Plan indicate the need for additional study, monitoring, or regulation of irrigation in the District, the NRD will implement additional programs.

9.3 Agricultural Related Programs

9.3.1 Ongoing Programs

The NRD encourages farmers and ranchers to use Best Management Practices for correct timing and application of agricultural chemicals.

9.3.2 Proposed Programs

No additional programs are planned at this time. Implementation of additional programs may result from the bi-annual review process.

9.4 Soil Conservation Programs

9.4.1 Ongoing Programs

Soil conservation is one of the key directives of a Natural Resources District. The Upper Niobrara-White NRD has established and maintained an ongoing program of soil conservation centered around Best Management Practices (BMPs) methods.

The NRD staff encourage farmers, ranchers and others who might impact the land surface, such as gardeners, homeowners, and construction project designers, to use practices that will safeguard and preserve the soil cover in the District.

The District provides a complete tree program for windbreaks and shelterbelts service. In 1972 the NRD assumed responsibility for the tree planting programs in the area. The Upper Niobrara-White NRD is currently distributing and overseeing the planting of approximately 120,000 trees per year.

<u>Erosion and Sediment Control Program</u>

The objectives of many federal, state and NRD programs are to eliminate excessive soil erosion and the resulting problems. While the basic approaches utilized to accomplish the objectives may differ for the federal, state and NRD erosion control programs, an attempt has been made to maximize compatibility and minimize inconsistencies between the programs.

The purpose of the NRD erosion and sediment control program is to continue reducing erosion on highly erodible land within the Upper Niobrara-White Natural Resources District and to reduce sedimentation and other problems which result from that erosion.

The Erosion and Sediment Control Act (LB 474) adopted by the 1986 Nebraska Legislature is a commitment by the State of Nebraska to reduce erosion from Nebraska lands and to reduce sedimentation and other problems that result from that erosion.

Lands needing treatment are those eroding at a rate that could cause a decline in long-term productivity. The NRD erosion and sediment control program continues and strengthens the already existing erosion and sediment control efforts of individual landowners and of the federal, state and local governments. These efforts are designed to reduce damage from wind erosion and stormwater runoff, to reduce non-point pollution from sediment and related pollutants, and to conserve and protect land, air, and other resources of the state.

Much of the program is devoted to the establishment of a system for the filing and processing of complaints concerning sediment damage from land where erosion is exceeding the soil loss limits established in accordance with the act. Data on the specifics of this program are contained in Appendix V of the December 1989 Master Plan for the NRD.

This program augments many existing federal and state erosion and sediment control efforts, including those interrelated in a regulatory sense with the Sodbuster and Cross Compliance portions of the Food Security Act of 1985. Those provisions impose sanctions on agricultural producers who cultivate what is called highly erodible land. Sanctions consist of withholding participation in many federal farm programs unless adequate conservation practices are applied to prevent excessive soil erosion.

NRCS technical guides have been adopted by the NRD as technical standards and they will serve as criteria for determining "acceptable treatment". Therefore <u>what</u> a landowner might have to do to prevent excessive erosion will normally be identical for NRD, state and federal programs.

Appendix E contains a 1982 inventory of land uses and conservation treatment needs and the erosion control goals for the Upper Niobrara-White Natural Resources District.

<u>Erosion from Nonagricultural Land Disturbing Activities</u>

While the primary focus of the Erosion and Sediment Control Act is on erosion and sedimentation from agricultural lands, the Act also allows complaints on some non-agricultural activities that disturb the land surface. Such activities are generally described as any tilling, clearing, grading, excavating, transporting, or filling of land which may result in

soil erosion and the movement of sediment and sediment related pollutants. However, some nonagricultural activities that would fall under this general definition are specifically excluded, these include:

- Installation of the above ground public utility lines and connections, fenceposts, sign posts, telephone poles, and other kinds of posts or poles.

- Emergency work to protect life or property.

- Activities related to the construction of housing, industrial, and commercial developments.

For those nonagricultural land disturbing activities that remain subject to the law, an option to strict enforcement of the soil loss limits is available. The NRD or responsible city or county may allow the adopted soil loss limits to be exceeded if, and only if, the sediment resulting from that excessive erosion is controlled and prevented from leaving the site on which the activity is occurring.

There are no city, village or county regulatory programs that would qualify for the LB 474 exemption and limit the District's jurisdictional area.

Natural Resources District Goals and Strategy for Reducing Soil Losses

The NRD goal is to complete 80 percent of the remaining treatment needs by the year 1020.

Other Conservation Programs

- The District administers the Nebraska Soil and Water Conservation Program that provides cost-share assistance for conservation practices.

- The District cooperates with two other NRDs and the University of Nebraska on research on conservation tillage.

- The District assists other local units of government with various resource problems within their jurisdictions.

- The District provides technical assistance for irrigation management to encourage irrigation practices that reduce soil erosion.

- The District cooperates with Game and Parks Commission in administering a wildlife habitat program that indirectly reduces soil erosion.

- The District cooperates with the Soil Conservation Service and the Conservation and Survey Division in an accelerated soil survey program. Special emphasis is on areas of the NRD with large acreages of cropland that need treatment.

9.4.2 Proposed Programs

No new soil conservation programs are proposed at this time.

The Upper Niobrara-White Natural Resources District needs to strengthen the existing district programs, especially technical assistance, and cost-share funds as the means of accelerating land treatment.

9.5 Recreational and Wildlife Related Programs

9.5.1 Ongoing Programs

The NRD currently cooperates with Game and Parks Commission in administering a wildlife habitat program. There are ongoing informal discussions and consultation between the NRD staff and the Game and Parks Commission regarding wildlife related issues.

9.5.2 Proposed Programs

No additional programs are planned at this time. Should specific adverse effects on threatened species listed in the GWMP from changing ground water levels be identified, the NRD will implement such additional programs as are necessary to reduce the adverse effects on the species by maintaining ground water levels that will sustain these species.

Informal discussion and consultation between the NRD staff and the Game and Parks Commission regarding endangered or threatened species issues will be encouraged by the NRD Board.

9.6 Domestic And Municipal Water Programs

9.6.1 Ongoing Programs

Current regulation of municipal water programs falls under the Nebraska Department of Health (NDOH). Water quality monitoring, well location, well construction, and similar aspects are regulated by NDOH.

The District is informing owners of those water wells that exhibit contaminants during the ground water sampling conducted by, or supervised by, the NRD.

The NRD has implemented a cost-share program for the decommissioning of abandoned wells. This cost-share program is for the location and proper abandonment of those abandoned or poorly maintained wells where there is potential for ground water contamination.

The Nebraska Department of Environmental Quality (NDEQ) oversees implementation of a voluntary EPA approved Wellhead Protection Program. NDEQ has delineated wellhead protection areas (WHPAs) for three of the municipalities in the District (Table 5-4, Section 5.4).

9.6.2 Proposed Programs

The NRD proposes assisting the municipal and county governments in evaluating and selecting Wellhead Protection options for public water supply wells, following the guidelines set by NDEQ.

9.7 Remedial Action Programs

9.7.1 General

Remedial Actions are activities that are designed to investigate or correct contamination or other problems.

9.7.2 District Programs

The NRD has at this time has not initiated any remedial actions beyond investigations based on the ground water monitoring program and the notification of well owners.

9.8 Regulations

The Upper Niobrara-White NRD is supporting state-wide regulations and programs for the protection of ground water resources. In addition the NRD encourages the local entities within its boundaries to regulate ground water activities.

9.9 Timing

9.9.1 Short-term Programs

Table 9-1 gives the proposed timing for the short-term programs being continued or implemented under this Ground Water Management Plan.

9.9.2 Long-term Programs

Table 9-2 gives the proposed timing for the long-term programs being continued or implemented under this Ground Water Management Plan.

9.10 Program Economics

9.10.1 Program Implementation Costs

The past and ongoing expenditures by the NRD for ground water management are discussed in Sections 7.0 and 8.0, and listed in Appendix C.

9.10.2 Program Impact Costs

The impacts of implementation of the new programs contained in this Ground Water Management Plan have yet to evaluated.

SECTION 10.0

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