UPPER REPUBLICAN NATURAL RESOURCES DISTRICT

GROUNDWATER MANAGEMENT PLAN

FALL
1995

Upper Republican NRD Groundwater Management Plan
Table of Contents

Figures

Page

* WRI Report 95-4014-U.S.G.S. Water-Resources Investigations Report

Figures Page

Tables | Page

Appendix Page

References

Changes in the Water Supply in the Upper Republican Natural Resources District, Southwest Nebraska, from 1952-75 by Eric G. Lappala

Simulated Response of the High Plains Aquifer to Ground-Water Withdrawals in the Upper Republican Natural Resources District, Nebraska U.S.G.S Water-Resources Investigations Report 95-4014

Simulated Response to Stress of the High Plains Aquifer in the Upper Republican Natural Resources District, Nebraska, 1993 by J.M Peckenpaugh, R.A. Kern, J.T. Dugan, and J.M. Kilpatrick, USGS.

Twin Platte Natural Resources District Ground Water Management Plan Jan. 1, 1986

Groundwater-Level Changes in Nebraska, 1991 Gregory V. Steele, U.S. Geological Survey and Perry B. Wigley Conservation and Survey Division.

Estimated Use of Water in Nebraska, 1985 by Eugene K. Steele, Jr.. U.S.G.S. Survey Paper #64.

The Groundwater Atlas of Nebraska Resource Atlas No. 41, 1986. Conservation and Survey Division, Institute of Agriculture and Natural Resources, The University of Nebraska-Lincoln.

Middle Republican Natural Resources District Groundwater Management Plan, Jan. 1, 1986

Upper Republican Natural Resources District Master Plan, 1989-2000.

Water-Level Changes in the High Plains Aquifer-Predevelopmnet to 1990. U.S. Geological Survey Water-Resources Investigations Report 91-4165.

Special Report-Republican River Basin Water Management Study Colorado, Kansas, Nebraska. Feb. 1985. Department of the Interior, Bureau of Reclamation.

Rules and Regulations for Groundwater Control of the Upper Republican Natural Resources District Control Area, June 15, 1995.

Superior Hardy Special Protection Area, Ground Water Quality Project for Southern Nuckolls County, Lower Republican NRD and Little Blue NRD.

Special Protection Area Red Willow and Hitchcock Counties, Special Protective Measures-Middle Republican NRD.

Republican River Basin, Nebraska, Water and Related Land Resources Study Report U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service; Soil Conservation Service; Forest Service.

Safe Domestic Wells, Water Quality Handout, Cooperative Extension Service, Manhattan, KS, Jan. 1992, File Code: Engineering 4-5.

I. Introduction

The Legislature in 1975 enacted legislation that provided regulatory authorities to Nebraska's Natural Resources Districts declaring that ground water is one of the most valuable natural resources in the State and that an adequate supply of ground water is essential.

Ground Water Quantity

To conduct a ground water management program in the district that will keep our ground water level at its present level or at the minimum possible decline to ensure future generations an adequate water supply.

Ground Water Quality

To improve overall efficiency to plant nutrient and water application management to keep the level of agricultural fertilizers and agricultural chemicals in the ground water as low as possible for the benefits of all concerned.

The Upper Republican Natural Resources District has monitored uniform declines and in 1977 was designated a Groundwater Control Area. In 1978 the district adopted Rules and Regulations for the Groundwater Control Area.

Irrigation development started on a very limited basis in 1935. Flood and hand moved sprinklers started in the 1950s and in the late 1960s. Center pivot irrigation started a boom in ground water irrigation development. There are approximately 3200 registered irrigation wells in the district and approximately 430,000 irrigated acres.

The first ground water study was a study by Cardwell and Jenkins in the mid 1950s. The District contracted the United States Geological Survey to do a computer model study in 1973. This study was completed in 1976. The District has continued to update this study each year and in 1988, the District again contracted the U.S.G.S. to reprogram the study on a new updated computer model program.

The ground water quality within the District is good. Contamination of nitrates in the ground water greater than 10 part per million has been observed in localized areas and are carefully monitored. Future tests will be done to identify agricultural chemicals (i.e. Atrazine) and for all fertilizers (i.e. nitrate/nitrogen).

The potential for future problems exists for both contamination and level declines as additional acres are irrigated and as the need of irrigators to increase yields exists.

Philosophy of the Upper Republican Natural Resources District:

The Upper Republican Natural Resources District represented by the Board of Directors realize that the underground aquifer partially underlying the URNRD is a laterally confined aquifer and that there have developed, and will continue to develop, conflicts between users. Such conflicts between users are based on a steadily declining water table within the aquifer in the URNRD. Therefore, the statement of objectives and long term goals become of utmost importance in protecting all uses of groundwater, which include domestic, agricultural, municipal, industrial, wildlife, and recreational uses, from further unmanageable declines.

II. Hydrogeologic Characterization

A. Aquifer Description

1. Geographic Description

a. The geographic boundaries for this plan will coincide with the boundaries of the Upper Republican NRD. The District consists of Chase, Dundy, and Perkins Counties, in the southwest corner of Nebraska. The URNRD is bounded on the west by Colorado and on the south by Kansas. (Fig. 1 & 2)

b. The District has a total land area of 2697 square miles. The population of the three counties is 10,330 residents according to the 1990 Census. There are three county seats in the URNRD located at Benkelman, Grant, and Imperial.

<u>Figure 1.</u> - Location of model study area and the Upper Republican Natural Resources District. This map shows the location of the U.S.G.S. Ground Water Model Study Area. When referring to "the study area" in some of the following text, this is the area being referred to. (U.S.G.S. WRI Report 95-4014)

Figure 2. - Map of the Upper Republican NRD and map of wells measured by the URNRD, continuous recorder wells, and observation wells measured by the U.S.G.S. (NRD Data)

2. Proposed Stratigraphic Boundaries
   a. The rock unit known as the Ogallala Group and all other deposits of more recent geological age in the three counties make up the stratigraphic boundaries.
   b. The youngest unit underlying the URNRD is the Pierre Shale, which is Cretaceous in age. The Pierre Shale consists mostly of blue to black shale and clay. The Pierre Shale is the uppermost bedrock unit in the district except in parts of Perkins and Keith Counties, where it is overlain by the White River Group.
   c. The White River Group consists of two units, the upper of which is the Brule Formation and the lower of which is the Chadron Formation. The Chadron Formation generally consists of olive-green to brick-red silty to sandy clay and claystone (Cardwell and Jenkins, 1963), while the Brule Formation, which conformably overlies it, contains buff to olive-green clayey silt and silt-stone. These units are overlain where they exist by the Ogallala Formation of Tertiary Age. The Ogallala Formation underlies all but the extreme southern part of the District.
   d. The Ogallala Group ranges in thickness from a feather's edge to more than 400 feet (Cardwell and

Jenkins, 1963 p. 42). The Ogallala Group consists of beds of silt, sand, gravel, caliche, and clay with considerable variability in lithology over short vertical or horizontal differences. These variations are consistent with the fluvial environment in which Ogallala was deposited, which is characterized by a series of braided streams carrying sediments eastward. Some of the sand and gravel beds are cemented weakly by calcium carbonate into rocks ranging from friable sandstone to relatively hard, ledge-forming mortar beds (Cardwell and Jenkins, 1963, p. 42). Except in a few areas, most notably western Perkins and Chase Counties, the Ogallala Group is overlain by unconsolidated Quaternary deposits.

e. The unconsolidated Quaternary deposits, which comprise the land surface of most of the study area and the district, consist of sands, gravels, silts, and clays of fluvial origin and sands, silts, and clays of eolian origin. These deposits range in thickness from a feather's edge to over 100 feet. These deposits occur as alluvial and terraces in stream valleys and dune sand and loess deposits in upland areas and on high terraces.

<u>Figure</u> <u>3.</u> - Geologic section B-B' from Lappala (1978). This map shows the geologic section of the model study area. (U.S.G.S. WRI Report 95-4014)

<u>Figure</u> <u>4.</u> - Lateral extent of the Ogallala Formation (Lappala, 1978; Eversoll & others, 1988) and the trace of geologic section B-B' from Lappala (1978). This map

shows the lateral extent of the Ogallala Formation, and also shows the areas underlain by the Ogallala Formation and the areas underlain by rocks other than the Ogallala Formation. (U.S.G.S. WRI Report 95-4014)

Table 1. -Generalized stratigraphic column in the study area. (Modified from Cardwell & Jenkins, 1963). This table shows information about the stratigraphic area of the URNRD and model study area. (USGS WRI Report 95-4014)

3. Physical Characteristics

a. Transmissivity

--The transmissivity values provide an indication of the capacity of an aquifer to transmit water. These values are a function of aquifer permeability and saturated thickness. The transmissivity values may be used to estimate well yields in any particular area.

--In this District every county has an area of high transmissivity, high being more that 100 thousand of gallons per day per foot. These areas include the southern quarter of Perkins County that extends into the central part of Chase County; the southwestern part of Chase County; and parts of the northwestern corner of Dundy County. There is a small area of southwestern Perkins County that extends into a small area of Chase County and the southern areas of Dundy County that have a transmissivity of 0-20 thousands of gallons per day per foot. The rest of the areas of the counties have a transmissivity of 20-100 thousands of gallons per day per foot.

Figure 5. - Map of Nebraska that shows the Transmissivity of the Principal Groundwater Reservoir. ("The Groundwater Atlas of Nebraska, 1986")

b. Saturated Thickness

--The saturated thickness of the aquifer, defined as the difference between the water-table evaluation and the elevation of the base of the aquifer, fluctuates along with water-table fluctuations. In 1989, the saturated thickness of the High Plains aquifer in the study area and the district ranged from greater than 400 feet in western Lincoln County, Nebraska to less than 50 feet in Sedgewick County, Colorado and along the southern edge of the study area in Dundy County. The volume of water in storage was estimated to be 189 million acre-feet in 1952 and 168 million acre-feet in 1989. All of this water cannot be withdrawn by dewatering or pumping. Based on a typical specific-yield value for the aquifer 0.18, the amount of recoverable or available water in the High Plains aquifer was estimated to be 97 and 86 million acre-feet in 1952 and 1989, respectively.

--The saturated thickness of the district varies from one area to another. The largest areas of the three counties have 20-60 feet of groundwater in storage and have a saturated thickness of 100-300 feet. In a small area of southwestern Chase and northeastern Dundy Counties the groundwater in storage is 60-100 feet and has a saturated thickness of 300-500 feet. There is also the southeastern corner of Perkins County that has a saturated thickness of 300-500 feet.

Figure 7. - Saturated Thickness of Aquifer, Spring 1994. This is a map of the URNRD showing the saturated thickness.

Figure 8. - Average percent loss of saturated thickness, 1991-94. This is a map of the URNRD showing the percent loss of saturated thickness in the district.

Figure 9. -Percent loss of saturated thickness 1989 to 1992 period. This map shows percent loss of saturated thickness by township average.

c. Base & Top of Aquifer and Water Table

--The uppermost aquifer in the study area is the High Plains aquifer (Pettijohn and Chen, 1983a). It consists of the saturated parts of the Quaternary deposits and the underlying Ogallala Formation. This aquifer is unconfined and its upper surface is the water table.
In the spring of 1989, water-table altitudes in the study area ranged from over 3,600 feet in Yuma County, Colorado to less than 2,800 feet in Hitchcock County, Nebraska (fig. 10). In general the regional ground-water flow in the study area is west to east except in the immediate vicinity of the Republican River, a prominent discharge area. Average ground-water flow velocities range from less than 50 feet per year to more than 200 feet per

year.

--The White River group and the Pierre Shale are relatively impermeable in the study area (Cardwell and Jenkins, p. 34,36,40) and form the base of the High Plains Aquifer. (fig. 11) Figure 12 was constructed on the basis of analysis of driller's or geologist's logs of 149 test holes and 1,174 irrigation wells. Several drainage channels are distinguishable on this erosional surface, which slopes to the east at about 20 feet per mile (Lappala, 1978). (USGS Water Resources Investigations Report, 95-4014.)

Figure 10. - Water table in the High Plains aquifer, 1989. This map shows the altitude of the water table in 1989 in the study area. Contour interval is 50 feet. (U.S.G.S. WRI Report 95-4014)

Figure 11. - Altitude of the base of the High Plains aquifer. This map shows the altitude of the aquifer base of the model study area. Contour interval is 100 feet. (U.S.G.S. WRI Report 95-4014)

d. Hydraulic Properties

--The hydraulic properties of the aquifer in the study area were determined from the analysis of 149 test holes and 1,174 irrigation well logs, which represent more than one-third of the irrigation wells in the study area. The location of the test holes and irrigation wells is shown in figure 12. Hydraulic properties estimated from these logs include hydraulic conductivity and specific yield.

The hydraulic conductivity and specific yield of the aquifer were calculated using data from table 2, which was modified from Peckenpaugh and Dugan (1983, p. 41 and 98). For each lithologic unit within the test hole and irrigation well logs, hydraulic conductivity and specific yield values from table 2 were assigned according to grain size of the material composing the unit and the degree of sorting or silt content of the unit. A thickness-weighted average value then was calculated for each test hole or irrigation well.

--The distribution of hydraulic conductivity used in the model study is shown in figure 13. Hydraulic conductivity values for individual wells or test holes were averaged by quarter township throughout the study area because of the extreme variability of these values within short distances. Hydraulic conductivity values assigned in areas with little or no test hole or well data were based on date from Lappala's (1978) model. Assigned hydraulic conductivity values ranged from 20 to 155 feet per day and most commonly ranged from 50 to 75 per day. (USGS W-RI Report, 95-4014.)

Figure 12. - Location of test holes and irrigation wells used to determine aquifer properties. This map shows the model study area including the Upper Republican NRD, the location of test holes and irrigation wells used to determine aquifer properties. (USGS WRI Report 95-4014).

Table 2. - Hydraulic conductivity and specific yield estimated from description of materials comprising a lithologic unit (Modified from Peckenpaugh and Dugan, 1983). (USGS WRI Report 95-4014).

Figure 13. - Distribution of hydraulic conductivity in the High Plains Aquifer. This map shows the line of equal hydraulic conductivity-contour interval is 25 feet per day. (U.S.G.S. WRI Report 95-4014).

e. Water Level Change

--The depth to ground water level in the District varies greatly from one area to the next. In northwestern Perkins County and some small areas of southeastern Chase County, and northeastern Dundy County the depth to water is greater than 200 feet.

Figure 14. - Map of Nebraska showing groundwater-level changes, predevelopment to fall 1991.

Figure 15. - Map of Nebraska showing groundwater-level changes, spring 1990 - spring 1991.

--Chase and Dundy Counties have a great variety of depths to water. The western halves of the two counties have depths to water levels of 0-100 feet.

--In the Upper Republican Groundwater Control Area the estimated predevelopment water levels are representative of the approximate average water level prior to 1935. Infiltration of surface water from canal systems has raised groundwater levels approximately 20 feet in extreme northeastern Perkins County. Available data also indicate that as a result of intensive use of groundwater for irrigation, a trend of declining water levels began in about 1966 in Chase, Perkins, and Keith Counties. Interruption of these progressive water-level declines occurred during 1981 and 1982, when levels rose in most wells due to above-normal precipitation. With the return of near normal precipitation since 1983, water-level declines have resumed.

--During 1991, water-level declines for predevelopment-to-fall 1991 generally stayed within the delineated areas described in previous reports. Declines from predevelopment to fall 1991 generally ranged from 5 to 40 feet in most of the area, but local declines of as much as 49 feet occurred in parts of Chase County. Declines of 5-49 feet occurred in areas totaling approximately 1.23 million acres.

--In Perkins County, available data indicate that the total size of the water-level decline areas remained relatively constant, as reported in the 1990 groundwater-level report, but the areas where water levels declined more than 30 feet decreased substantially during 1991. In the rest of the Upper Republican Groundwater Control Area, the only substantial change in size or shape of water-level decline areas from the 1990 groundwater-level report was the enlarging of the area of 20-25 foot declines in Dundy County. Otherwise, the size and shapes of water-level-decline areas remained relatively constant.

Table 3. - This table shows ranges and approximate areas of water-level decline, Upper Republican Groundwater Control area. (Groundwater Level Changes in NE 1991.)

Figure 16 a, b, c.. - These pages show several hydrographs of the Upper Republican NRD recorder wells. These figures show the changes in the water levels in the predevelopment years to the year 1991. As shown in these hydrographs most of the levels in the wells have been declining.

Figure 17. - Water Table in the High Plains Aquifer, 1952. (U.S.G.S. WRI Report 95-4014).

Figure 18. -Simulated water table in the High Plains Aquifer, 1989. This map and Figure 12 can be used with Figure 10, "Water in the High Plains Aquifer", 1989; to compare the water table changes. (USGS WRI Report 95-4014)

B. Vulnerability Description

1. Surficial & Vadose Zone Description

a. Topography

--The topography of the URNRD is made up mostly of plains and sand hills. In the eastern parts of Chase and Dundy counties there are sections of dissected plains as well.

--In southern Dundy county is an area of valleys along the Republican River. There is a small area of southeastern Chase County that has a valley running through it. (Fig.

19).

Figure 19. - Map of the Upper Republican NRD showing the topographic regions of the district. ("The Groundwater Atlas of Nebraska, 1986).

b. Surficial Soil Description

--The soils is the study area are quite variable because of differences in parent materials, but they can be grouped into eight mappable units (fig. 20 and table 4). Each mappable soil unit consists of a soil series principally grouped by hydrologic characteristics including permeability, available water capacity, and slope. The mappable soil units that include soils of the bottomlands and terraces tend to include diverse soils that exhibit great differences among their hydrologic characteristics. The complex distribution and small area often covered by these soils necessitate the grouping of somewhat different soils for mapping considerations.

--Classified by texture, permeability, and available water capacity, (Dugan, 1984) upland soils can be placed in three groups reflecting the parent material differences; silt loam to silty clay loam soils (available water capacity 0.18 to 0.21 per in.), sandy soils (available water capacity 0.05 to 0.08in. per inch), and sandy loam soils transitional between the silty and sandy soils (available water capacity, 0.11 to 0.17 inch per inch). The silty upland soils are classified further into three slope groups to reflect surface water runoff potential and irrigability; nearly level to undulating (0 to 7 percent); undulating to rolling (7 to 15 percent); and rolling to very steep 15 to 45 percent). Very steep silty soils are highly dissected or eroded.

--Bottomland and terrace soils compose only about 5 percent of the soils in the study area. These soils have been classified into two groups, the sandy loam to silt loam soils (available water capacity 0.13 to 0.19 in. per in.) (Dugan, 1984), and the sandy to sandy loam soils (available water capacity 0.04 to 0.13 in. per in.) (Dugan, 1984). The large ranges in available water capacity in these soils reflect the large range of soil texture types included in these mapping units.

Figure 20. - Distribution of mappable soil units (Modified from Dugan, 1984). This map is to be used with Table #4, showing the soil groups and their hydrologic properties. (USGS WRI Report 95-4014).

Table 4. - Mappable soil units in the study area and their hydrologic characteristics (USGS WRI Report 95-4014).

c. Land Use

--Soils and topography largely determine land use in the study area. Soils derived from sand dunes or with large topographic slopes, such as these included in mappable soil unit 8 (table 4), often are left uncultivated and in native vegetation. Soils with less sloping topography and less sandy textures, including mappable soil units 1, 2, 4, 5, and 6, are generally well-suited for cultivation and irrigation.

--About 40 percent of the area is currently grassland (all pasture and range not harvested for hay). Cultivated land including unharvested crop and fallow, accounts for slightly more than 50 percent of the area. Less than 5 percent of the area is used for nonagricultural purposes, including transportation, communication, farmstead, commercial, and urban functions. Natural woodlands occupy less than 1 percent of the study area. (US Dept. of Commerce, Bureau of the Census, 1989). Natural woodlands generally only occur along permanent streams and consist largely of phreatophytes such as willows and cottonwoods that thrive under shallow water-table conditions (Weaver and Albertson, 1956; Kaul and Rolfsmeier, 1993.)

--Vegetation or land-use changes through time have occurred largely on cultivated land. Although the percentage of land area classified as cultivated has remained generally constant through time, small, short-term fluctuations have occurred as some rangeland has been temporarily cultivated but later allowed to revert to rangeland depending on the agricultural economy. Large changes in cropping patterns have occurred on cultivated land related to irrigation development and changes in the agricultural economy (table 5).

--Since 1950, total acreage of crops harvested has not changed substantially in the study area, but crop types have shown considerable variability. Wheat acreages have decreased gradually, while corn acreages have increased substantially. Grain sorghum acreages also have decreased gradually through time. These changes are principally related to the widespread development of ground water irrigation between the mid-1960's and the late 1970's and, to a lesser extent, to changes in government agricultural programs.

Table 5. - Selected crops harvested in Chase, Dundy, and Perkins Counties (in thousands of acres). This table shows the four major crops that are harvested in the district for the years 1950-1989. (USGS WRI Report 95-4014).

Table 6. - Crops Raised and Average Yields of the Upper Republican NRD. (Agricultural Statistical Handbook, 1991/1992)

2. External Ground Water Recharge Source

a. Recharge Characteristics

--The recharge is provided from precipitation and surface water. Surface water can include rivers, lakes, canals, etc.

--Pumpage and recharge values were distributed in the model over time by dividing the simulation period into 111 intervals or stress periods, with each full year represented by 3 stress periods: January-May, June-August, and September-December. The first stress period simulated June-August, 1952 and the last stress period simulated January-May, 1989. Pumpage and recharge values were assigned to designated cells for each stress period on the basis of soil and land-use characteristics and the number of irrigation wells in that cell for the time period being simulated and output values from the Soil-Water Program for that soil and land-use type for that time period. Figure 21 shows the average recharge values assigned using the recharge package to each node from 1952 through 1988. Nodes that were assigned pumpage values for the June-August 1988 stress period using the well package are shown in figure 22.

--The South Platte, Republican, and North Fork of the Republican Rivers are lateral boundaries simulated as constant-head nodes. Enders Reservoir also was simulated using constant head cells. Other perennial streams and rivers and large irrigation canals were simulated in the model using the stream-routing package (Prudic, 1989). Streams, rivers, or canals that were simulated include the Western and Sutherland Canals: Spring, Stinking Water, and Frenchman Creeks in Chase County; Buffalo, Rock, Indian, Muddy, Horse, and Spring Creeks in Dundy County.

<u>Figure 21.</u> - Average recharge from 1952-1989 in inches. This is a map showing the average recharge in inches in the district. (USGS WRI Report 95-4014).

<u>Figure 22.</u> - Nodes which were assigned pumpage for the June-August 1988 stress period. This map shows each node that used irrigation water in the June-August

pumping season. (USGS WRI Report 95-4014).

b. Annual Precipitation

--The climate of the Upper Republican NRD is transitional between continental subhumid and semiarid, with semiarid conditions predominant in most years. Winters are normally cold, and summers are usually hot. Average annual precipitation (1951-89) ranges from about 17 inches in the northwestern and southwestern part of the study area to nearly 20 inches in the southeastern part, (fig. 23). Annual amounts, however, are quite variable. During 1951-89, Imperial, in Chase County, with average of 19.02 inches, had 5 years of greater than 25 inches and 6 years of less than 15 inches of average annual precipitation. (National Oceanic and Atmospheric Administration, 1951-89)

--About 75 percent of the annual precipitation occurs in the warm season (April-September). This peak precipitation season coincides with large rates of evapotranspiration, which generally results in no seasonal surplus of soil water. Cool seasons (October-March) are often very dry. Warm-season precipitation, which often occurs as small, scattered thunderstorms, generally is distributed irregularly within the study area. The cool season (Oct.-March) is often very dry.

--The District has a semiarid climate that is punctuated by periods of drought and dry winds. The average annual precipitation is 18.75 inches over a 70 year period according to National Weather Service Data. Records show that the normal precipitation in the winter months is less than 1/2 inch per month. The spring and fall months receive 1.25 of an inch of precipitation, while the summer months have an average of 2.9 inches per month.

Figure 23. - Average annual precipitation, 1951-1989 (National Oceanic and Atmospheric Administration). This map shows the locations of precipitation measurement stations and the line of equal average annual precipitation, 1951-1989. (USGS WRI Report 95-4014)

c. Surface Water Supply

--Reservoir life goals example:

Maintain a supply of water within the groundwater reservoir that would support an irrigated agricultural economy infinitely.

--The main lakes and reservoirs in the district are as follows: Enders Reservoir, which has 1242 average surface acres, is located in southeastern Chase County; and Rock Creek and Hatchery has 75 surface acres and is located in southwestern Dundy County.

--Enders Reservoir, which began filling in October 1950, is used for storing irrigation water derived from Frenchman Creek within the study area for the Culbertson and Culbertson Extension Canals and their irrigation areas east of the study area. Water is diverted from Enders Reservoir into Frenchman Creek during the irrigation season and flows out of the study area where these irrigation canals divert this water for irrigation. Enders Reservoir provides no irrigation water for lands within the study area.

--Other lakes or dams that are located in the district include Champion Lake; Nolan Dam; Imperial Light Dam, southwest of Imperial; Arrowhead Dam, north of Benkelman; and a dam located on Buffalo Creek, north of Haigler.

--The effect of conservation practices (ecofallow, ridge till, minimum till, terracing, and the Conservation Reserve Program) on the amount of water available to leave a field site, from precipitation or irrigation, and become streamflow should not be discounted or minimized. This runoff has not occurred to the extent it once did. The wide use of many conservation tillage systems roughly parallels the development of groundwater irrigation in the district. Though this water could potentially become streamflow, most of it is likely put to good economic use on site as stored soil moisture for crops grown. Long term gains from conservation practices is better for the environment than the continued erosion and increased quantity of water rushing to the river or streams resulting from clean tillage.

--The surface water supply for the Republican River Basin originates as rainfall, accumulates as surface water runoff, and runs downstream to the confluence of the tributaries. Base flow from the alluvial aquifers and return flows from surface irrigation are other surface water sources.

--Streams with significant changes in base flow are the Arikaree River at Haigler, Buffalo Creek near Haigler, and the Frenchman Creek near Imperial. The Frenchman Creek near Imperial, the base flow decreased 28% in 1968. The change in base flow was 16,200 acre-feet decline.

--The Republican River Compact Administration was formed to administer the water of the river between the states of Colorado, Nebraska, and Kansas. The Administration computes the annual virgin water supply based on the present supply and compact agreement.

--Surface runoff constitutes about 2/3 of the inflow into the reservoirs. However, Enders Reservoir water supply is almost entirely from baseflow, and overland runoff is of short duration that it can be considered negligible. The inflow into Enders Reservoir in recent years has been declining. Consequently, the water supply for farm use has been curtailed. This has resulted in inefficient farm operations as acreages irrigated must be reduced, or crop irrigation needs will be only partially met.

--The streamflow depletion of the Frenchman River is attributed to the rapid increases in the use of groundwater for irrigation, application of conservation practices, and climate variations of streamflows at the Imperial gaging station on Frenchman River above Enders Reservoir is about 19%. Stinking Water and Spring

Creeks above the gaging station at Palisade have been depleted about 18% since 1976, according to estimates in U.S.G.S. Open File Report 76-498.

Figure 24. - Schematic diagram of the surface water system in the model study area. (USGS WRI Report 95-4014).

Table 6a. - Comparison of measured and simulated streamflow at seepage measurement selected sites in the study area. This table shows the base flow sites and the measured flow of fall 1952 and Spring 1989 and the simulated flow, May 1989. (USGS WRI Report 95-4014).

Table 7. - Comparison of streamflow simulated in 1989 and projected for 2010 and 2030 under the consumptive irrigation requirement scenario at selected sites in the study area. This table shows information showing computed flow scenarios. (USGS WRI Report 95-4014).

Table 8. - Seepage losses and gains for Enders Reservoir during pumping and nonpumping periods, 1952 through 1988. This table shows the seepage losses and gains for Enders Reservoir for every year starting in 1952 and ending in 1988. (USGS WRI Report 95-4014).

d. Subirrigation

--Subirrigation use in the Upper Republican NRD is not significant in land or agricultural use at this time. The subirrigated areas in the district make up less than 1 percent of the area. The land area percentage is small enough not to be considered as part of this groundwater management plan.

3. Irrigation

a. Spacing: The Upper Republican NRD has a Groundwater Control Area that currently has Rules and Regulations that are updated every year. In these Rules and Regulations are the irrigation well spacing requirements. (Refer to the Appendix 1.: Rules and Regulations for Groundwater Control of the Upper Republican NRD Control Area, 1995).

b. Water demand

Table 9 shows the average crop water use in each county of the district. At the end of 1993, Chase County had 193,434.9 irrigated acres, Dundy County had 118,960.9 irrigated acres, and Perkins County had 129,888.5 irrigated acres. The district total of irrigated acres was 442,284.3. The current allocation for irrigation water is 14.5 inches per acre per year or 72.5 inches for the 1993-1997 five-year allocation period.

Table 9. - Average Crop Water Use 1988-1994, All Crops, Inches Per Certified Acre in the District (Data from: Upper Republican NRD, 1994).

Figure 25. - Graph showing the Ground Water Pumped, Acre Feet by County, 1990-1994. (URNRD Data, 1994).

Figure 26. - Graph showing the Acres Irrigated, 1980-1989 in the URNRD. Data from: URNRD, 1989).

III. Water Quality Inventory

A. Current Water Quality Monitoring Program

1. The URNRD began a groundwater monitoring program in 1974

and is continuing this program to date. The NRD collects water samples every winter. The samples are sent to Olson's Lab in McCook and a State Health Lab, both being approved testing labs.

Appendix 4. - Nitrate Water Sample Levels, 1974, 1980-1995. Chase, Dundy, and Perkins Counties. Data from URNRD, 1974, and 1980-1995.

2. 53 water samples are collected in the entire district. More samples are collected now than when the program was started in 1974. (Fig. 27a-c)
3. One of the services offered through the URNRD is individuals may come in and have their domestic or irrigation water samples sent to Olson's Lab in McCook and have the samples checked for several items. Items to be analyzed for include the following:
   a. Nitrate
   b. Purity (Coliform bacteria)
   c. Sulfate in irrigation water
   d. Domestic suitability which includes: pH, electrical conductivity, total dissolved solids, hardness, calcium, magnesium, sodium, chloride, nitrate, sulfate, iron, manganese, and the lab has been approved for lead testing.
   e. Irrigation suitability.
4. In 1994, approximately 20 individual water samples were sent to Olson's Lab for testing.
5. All of the NRD technicians are Water Well Monitoring Supervisors through the Nebraska Department of Health.

These certificates will be kept current according to the rules and regulations of the Health Department, section 006.10 of Chapter 10, Title 178 (Regulations Governing Licensure of Water Well and Pump Installation Contractors and Certification of Water Well Drilling and Pump Installation Supervisors).

Figure 27 a-c. - 1995 Nitrate water sample locations in Chase, Dundy, and Perkins Counties. Also on these maps are the nitrate readings from the location sites. (URNRD)

6. The levels of nitrates in the water samples taken in 1995 ranged from 1.2 to 16.5 parts per million with the majority being in the 3-5 parts per million range. The ground water in the URNRD is of good quality except in a few localized areas. There is concern for the potential of nitrate contamination in the ground water.
7. The District has some high nitrate readings in localized areas in each county. Some of these nitrate readings are shown in Figures 28-31.

   Figures 28-31. - 1974-1995 Nitrate Water Sample Levels, line graphs. Fig. 28 & 29 Graphs of Chase County wells; Fig. 30, Graph of Dundy County wells; and Fig. 31, Graph of Perkins County wells. (Data from: URNRD, 1974-1995)
8. The U.S.G.S. had extensive water samples analyzed in 1975. These records are on file at the NRD office.
9. Primary sources of the nitrates are believed to be fertilizer, feedlots and septic tanks or a combination

thereof. Commercial fertilizer on agricultural land presents the greatest opportunity for infiltration into the aquifer. It is believed that improved management in fertilizer application will lower the nitrate content in higher nitrate areas. Recent educational efforts and the economy have encouraged more efficient management of the application of these fertilizers.

10. Most septic tank or feedlot contamination can be corrected by relocating the well or taking preventative measures to keep surface waters from entering the well. Location and proper construction of septic tanks and feedlot facilities is important.
11. Other ground water pollution concerns within the Upper Republican NRD are the use of chemigation, industrial wastes, and seepage from underground fuel storage tanks.
12. Chemigation is the process of applying fertilizers, herbicides, insecticides, and other similar agricultural chemicals to crops and fields with the irrigation water.
    a. The major objective of chemigation in the district is to determine every farmer wanting to use chemigation to apply the herbicides, pesticides, or fertilizer to have their chemigation sites inspected on an annual basis. At this time every known chemigation site is to be inspected every irrigation season.
    b. The chemigation site will be inspected every irrigation season by a NRD staff member and an operator. Six main items will be checked at each chemigation site:

1. Mainline Check valve

2. Vacuum relief valve

3. Inspection port

4. Low pressure drain and hose

5. Chemigation injection valve

6. Interlock system

c. The chemigation site will not be issued a valid permit unless or until all of the items are in proper working condition.

d. By inspecting the chemigation sites annually, this should help to prevent any backflow problems. By checking mainline check valves and chemigation check valves on an annual basis, future backflow problems can by found by locating leaky valves and having them repaired or replaced.

e. Local chemigation operators/cooperators must have a valid State of Nebraska Department of Environmental Quality Chemigation Applicator Certification Card.

f. The URNRD will update chemigation rules and regulations as required by federal and state law. These rules and regulations will be available from the URNRD office.

g. Currently, the NRD staff members who regularly do the chemigation inspections, hold valid Chemigation Applicator cards.

h. The URNRD will continue to send annual reports to the Department of Environmental Quality to report what chemicals have been applied in the previous year.

i. There has been some fertilizer spills or leaks on farms in this district. The NRD was contacted and was able to help to provide information to help the cooperators to clean up the spill.

j. The district will investigate all chemical spills that are reported to the NRD. The district will then contact the Department of Environmental Quality on the procedures of cleanup requirements.

k. Table 10 shows the amount of Chemigation Permits issued in the 1994 irrigation season. (Chemicals applied graph, fig. 32)

Figure 32. - Chemicals Applied Through Chemigation in 1993 (Data from: 1994 Chemigation Report, URNRD).

l. Table 11 shows the amount of registered wells in the district. Each of the irrigation wells could be set up to apply chemicals through chemigation, making each irrigation well a potential point source for contamination.

Table 10. - Chemigation Permits Issued, 1993 (Data from: URNRD, 1994).

Table 11. - Nebraska Department of Water Resources, Completed and Registered Wells, Report of Wells Registered by Use Through 1994 (Data from: NDWR, 1994)

Figure 33. - Map of the District Model Study, Location of registered irrigation wells drilled before 1952. (USGS WRI Report, 95-4014)

Figure 34. - Map of the District Model Study, Location

of registered irrigation wells drilled before 1975. (USGS WRI Report, 95-4014)

Figure 35. - Map of the District Model Study, Location of registered irrigation wells drilled before 1989. (USGS WRI Report, 95-4014)

B. Existing Water Quality Summary

1. The water quality program in the URNRD has been adequate in the past few years. The URNRD realizes that improvements will need to be made in the future, and they will be by the implementing of the ground water quality management program.

C. Suitability Characteristics

1. Domestic
2. Irrigation
3. Livestock

D. Identified Needs and Data Deficiencies

IV. Land Use and Contamination Source Inventory

A. Land Use

1. Urban
2. Agricultural
3. Other

Table 12. - Estimated Acreage by Broad Land Use. (1987 National Resources Inventory, Soil Conservation Service). This chart shows the land use in the Upper Republican NRD by hydrologic unit. It also shows the percent change from 1982 to 1987. This is a three page inventory showing all of the broad land use.

B. Contamination Source Inventory

1. Nonpoint Source Controls

   a. Domestic wells

      --A general rule for protecting the water supply is to keep the well upslope and as far as possible from potential sources of contamination.

      --On reconstruction of old wells:

      1. Isolate the well from potential sources of contaminants as much as possible.
      2. Seal the well against all pathways through which water and contaminants may enter.
      3. Control activities that may contribute contaminants within at least 200 feet of the well and, in sensitive areas, increase this distance as necessary.

      --No well is completely safe. Testing well water annually for contaminants of concern is the only way to be assured that the water if safe to drink. If contaminants which may pose a health risk are found, take action to locate the source and test more frequently to determine if there is a trend.

   b. Public water supply

      --The cities that currently provide public water supply test the water in the municipalities and towns on a regular basis. The cities and villages will continue to do extensive water testing as needed.

      --If necessary, the NRD may need to add additional restrictions on outlying areas, depending upon the model study's determined rate of water movement.

c. Abandoned Wells - Decommissioning Water Wells

1. This practice shall allow for cost-share for the proper plugging of abandoned wells according to Title 178, Chapter 12 of the Department of Health Regulations governing water well abandonment standards and additional restrictions established by the Board of Directors of the Upper Republican Natural Resources District. This practice will comply with Title 259 NNRC, Rules and Regulations for Administration of the Water Well Decommissioning Fund.

   --All below ground pipe and any above ground pipe, tower or other apparatus that may impede the plugging activity must be removed and any cost incurred in this removal is not eligible for cost-share.

   --All plugging work must be performed by a licensed well driller or pump installer.

   --From bottom of well to surface of groundwater, shall be filled with chlorinated gravel.

   --From surface of groundwater, shall be filled to a height of 5 feet with bentonite chunks.

   --From 5 feet above surface of groundwater to 8 feet below the surface of the ground, shall be filled with gravel or other approved material.

   --From 8 feet below the ground, shall be filled with bentonite chunks to 3 feet below the ground.

   --Backfilling and capping may be accomplished by either (1) removing the top 3 feet of casing, capping the well three feet below the surface with a concrete slab at least for inches thick extending at least one foot beyond the edge of the casing or fastening a 1/4 inch steel plate and by backfilling the remainder of the hole with sand and gravel, concrete, cement grout, or native top soil mounded for settlement; or

(2) Filling the remainder of the casing with concrete or cement grout and installing a permanent watertight cover of adequate strength on the top of the casing.

2. Report material and quantities used to the Upper Republican Natural Resources District and the Department of Water Resources, if appropriate.
3. Cost-share rate is 75% of actual cost not to exceed $300 for all wells except for a hand dug well.
4. The bentonite plugs may be 3 foot thick on sealing of hand dug wells.

2. Point Source

a. The above ground storage tank inventory is shown in Table 13 and the below ground storage tank inventory is shown in Table 14. This information was found from the Nebraska Department of Environmental Quality, RCRIS. The URNRD realizes that these tanks could be potential point source contaminates.

Table 13. - Upper Republican NRD Above Ground Storage Tanks (Nebraska Dept. of Environmental Quality, RCRIS, 1992).

Table 14. - Upper Republican NRD Below Ground Storage Tanks (Nebraska Dept. of Environmental Quality, RCRIS, 1992).

b. The other potential point source contaminant could be the chemigation sites in the district. Every registered irrigation well could become a point source due to the fact that each well could be set up to use the chemigation system. Every known chemigation site is inspected every year by the staff of the URNRD, not just a percentage of the sites.

C. Identified Needs and Data Deficiencies

V. Water Usage and Demand

A. Domestic

1. A water uses table has been compiled to show the uses of water in the Upper Republican NRD.

Table 15. - Water Uses in the Upper Republican NRD (Data from: "Estimated Use of Water in Nebraska, 1985, Eugene K. Steele, Jr.)

B. Agricultural

1. Refer to the Table # 9, "Average Crop Water Use", and Figures 25 and 26, Ground Water Pumped and Acres Irrigated.

2. Refer to section II. B. 3. Irrigation.

C. Industrial

1. Refer to the Table #15, "Water Uses in the Upper Republican NRD").

D. Fish and Wildlife

1. The supply of water is adequate to maintain the amount of fish and wildlife that are in this district. Improvements will be made when needed to maintain streamflow for present and future generations.

E. Recreation

1. At the present time, the main sites of recreation are more than adequate.

F. Water Quantity Monitoring Program

1. The water quantity program consists of:

   a. The measuring of approximately 100 wells in each county of the district twice a year. The wells are measured in the spring and in the fall.

   b. The URNRD staff that measure wells are all Water Well Monitoring Supervisors through the Nebraska Department of Health and the Well Driller's Association. These certificates will be kept current according to the rules and regulations of the Health Department, section 006.10 of Chapter 10, title 178 (Regulations Governing Licensure of Water Well Drilling and Pump Installation Supervisors).

VI. Identification of Critical Areas for Protection

A. Impact of Existing Land Uses on Ground Water Quality

1. The impact of existing land uses on the quality of the ground water in the District could have the potential for contamination if nitrogen use is not efficient. This makes the Phase II program of the Ground Water Quality Management Plan very important.

2. The education of the general public about possible ground water contamination will become an important part of the Upper Republican NRD program.

B. Potential Impact of Future Land Uses on Ground Water Quality

1. There will be limited development of irrigation in the future.

a. The reason for limited development of irrigation in the future is due to the Rules and Regulations for Groundwater Control of the URNRD Control Area.

--The Rule 8: Well Spacing is the rule that pertains to the development of irrigation. The Rule states: " A. In Critical Townships wells may not be drilled within 5,280 feet of any existing well, except those wells used strictly for domestic, livestock or monitoring purposes." The rule also states " B. Any irrigation well drilled in the Control Area after June 1, 1981, must be at least 1,320 feet from any stock or domestic well not belonging to the groundwater user owning or controlling the land upon which said irrigation well is established."

C. Existing Quantity Depletion and the Resulting Impact on Ground Water Quality

1. These following statements have been taken from the U.S.G.S. Model Study, Preliminary Report, 1993.

   a. Figures 36 and 37 show changes in water levels from 1989 to the years 2010 and 2030, respectively, resulting from long-term pumping at this rate. The maximum declines for both time periods occur in northwest Chase County. The hydrographs shown in figures 38,39,40 also illustrate the steady water-level declines that occur as a result of this scenario. The saturated thickness of the aquifer is shown in figure 41 and can be compared with the saturated thickness in 1989 (fig. 42) to determine areas where the saturated thickness has decreased. The effects of this pumping scenario on streamflow at selected sites are listed in table 7. For example, the streamflow in Frenchman Creek near Imperial at the end of May 1989 is 32.6 feet per second, while the simulated flow at the same location in May 2030 is only 10.2 cubic feet per second.

   Figure 36. - Projected changes in water-levels in the High Plains Aquifer, 1989-2010, under consumptive irrigation requirement scenario. (USGS WRI Report 95-4014)

   Figure 37. - Projected changes in water-levels in the High Plains Aquifer, 1989-2030, under consumptive irrigation requirement scenario. (USGS WRI Report 95-4014)

   Figure 38. - Hydrographs showing measured, simulated, and projected water levels over time for wells 2N38W10DD and 4N38W30BCC. (USGS WRI Report 95-4014)

   Figure 39. - Hydrographs showing measured, simulated, and

projected water levels over time for wells 5N41W19CBD and 7N40W28BBB. (USGS WRI Report 95-4014)

Figure 40. - Hydrographs showing measured, simulated, and projected water levels over time for wells 10N36W13BACC and 11N39W35DDD. (USGS WRI Report 95-4014)

Figure 41. - Projected saturated thickness of the High Plains Aquifer in 2030 under the consumptive irrigation requirement scenario. (USGS WRI Report 95-4014)

Figure 42. - Saturated thickness of the High Plains Aquifer, 1989. (USGS Model Study, 1993)

b. The second scenario simulated the application of 13 inches of water to irrigated fields during the irrigation season (June-August) of each year. Maximum water-level declines by the year 2010 (fig. 43) and 2030 (fig. 44) were about 40 and 90 feet, respectively, in northwestern Chase County. The projected saturated thickness of the aquifer for this scenario (fig. 45) is smaller than for the CIR pumping scenario (fig. 41). Streamflows under the 13-inch pumping scenario also are smaller. The flow in Frenchman Creek near Imperial in May 2030 is predicted to be only 1.6 cubic feet per second (table 7), much lower than the 10.2 cubic feet per second predicted under the CIR pumping scenario.

Figure 43. - Projected changes in water-levels in the High Plains Aquifer, 1989-2010, under 13-inch scenario. (USGS WRI Report 95-4014)

Figure 44. - Projected changes in water-levels in the High Plains Aquifer, 1989-2030, under 13-inch scenario.

(USGS WRI Report 95-4014)

Figure 45. - Projected saturated thickness of the High Plains Aquifer in 2030 under the 13-inch scenario. (USGS WRI Report 95-4014)

D. Potential Quantity Depletion and the Resulting Impact on Ground Water Quality

1. Refer to the Previous Section C. Existing Quantity Depletion and the Resulting Impact on Ground Water Quality.

VII. Ground Water Quality Goals and Objectives

A. Ground Water Objectives

1. It is the continuing goal of the Board to ascertain the amount of groundwater being withdrawn from the aquifer within the Control Area. Further, it is the goal of the board to reduce the amount of groundwater being withdrawn from the aquifer, within the Control Area, from the amount that might be withdrawn if no restraints upon groundwater users were imposed. The continued monitoring of groundwater quality is essential to ensure that the groundwater quality remains the same or is improved. Information from the continued monitoring of groundwater quality and water use is to be used to set future allocations so that the groundwater aquifer will be available for present and future generations. It is believed that reduced consumption of groundwater within the Control Area will result in a longer economic life for the aquifer and thereby, continued and increased prosperity will ensue.

B. Long Term Goal

1. It is the long term goal of the Upper Republican Natural Resources District Board to manage the groundwater aquifer within its boundaries by balancing groundwater withdrawals with annual recharge to prevent groundwater mining and to protect the natural water quality of the aquifer and remediate groundwater contamination.

C. Goal Implementation Procedures

1. Continue to develop and enforce rules and regulations necessary for conservation, preservation, protection, recharge and prevention of waste water from the URNRD Control Area.
2. Continue to gather information to assist in interpretation of physical characteristics and prevention of pollution of the aquifer.
3. Develop programs that will assess and implement ideas and methodologies designed to improve water use efficiency.
4. Provide residents of the URNRD with reliable information about the chemical makeup of the underground water.
5. Provide contacts for residents of the URNRD with agencies associated or responsible for water related issues.
6. Provide information regarding the background and changes in water quantity and water quality in the URNRD.
7. Provide information for better understanding the occurrence, movement, recharge, and discharge of the aquifer and to make information available to landowners and others so the aquifer can be effectively managed and maintained.
8. Provide material that will inform citizens about District activities. Additionally, the District will furnish material

to schools in the District to inform students about District programs and activities, and principles of water conservation.

9. Develop and promote activities that will expand and enhance the District's purpose, objectives, and long term goals.
10. Monitor, provide testimony, and inform citizens of the impact of pending legislation and to work with legislators to introduce and support legislation that will promote URNRD concerns, conservation, and management of the Ogallala Aquifer.
11. Continue cooperation and participation with other ground and surface water users in the Republican River basin.
12. To contract or have a working agreement with all local, state, and federal agencies in installing recorder wells and monitoring wells to keep an accurate record of groundwater levels in the district.
13. To work with the Southwest Irrigators, County Extension Agents, and the University of Nebraska, North Platte Experiment Station on irrigated crop water-use programs.
14. To work with the environmentalist and the Nebraska Game and Parks Commission in keeping stream flow to a level so that this area will have fish and waterfowl for future generations.
15. To continue to update the groundwater model of this district with the Natural Resources Commission and the U.S.G.S. This model will be used to determine the amount that is available for domestic, livestock, irrigation, commercial, and fish and wildlife need so that there will be an adequate supply for future generations.

16. The District will implement a special protection area or the Ground Water Management Act provision in areas where groundwater quality is being contaminated or may be contaminated.

VIII. Ground Water Quality Programs and Practices

A. The entire Upper Republican Natural Resources District will be included in Phase I of the Ground Water Quality program.

B. The area to be designated as Phase II or Phase III will be no smaller than one (1) township, 36 sections, which may consist of parts of more than one township; or as large as the entire district.

C. Administration of Groundwater Quality Management Plan

1. Phase I: 0-40% of the allowable contaminant level of nitrates or any contamination with potential to impact health or environment.

2. Phase II: over 40% of the allowable contaminant level of nitrates or any contamination with potential to impact health or environment.

3. Phase III: over 60% of the allowable contaminant level of nitrates or any contamination with potential to impact health or environment.

4. The basic philosophy of the plan will be: to improve overall efficiency to plant nutrient and water application management to keep the level of agricultural fertilizers and agricultural chemicals in the ground water as low as possible for the benefits of all concerned.

D. Phase I would contain: 0-40% of the allowable contaminant level of nitrates or any contamination with potential to impact health or environment.

1. Phase I would consist of monitoring the groundwater samples taken by the NRD each year (Figures 28 a-c). The District will also monitor the samples that have been taken as requested by individuals.
2. Intensive water sampling program. Expand and add more homes or operations in the current water sampling program.
3. Having water samples analyzed for more than just nitrates, start to include any other contamination that would have the potential to impact health or the environment.
4. May require water samples of wells with high water use. If wells used more than 25% of the average county water use on each individual crop, water sampling may be necessary. This would provide information of possible contamination sites. These sites may be subject to a two year history of water, fertilizer and agricultural chemical use.
5. The District will use the groundwater samples that are taken each year (Figures 28 a-c & Appendix 4) and samples that are requested to be taken by individuals. When a sample is taken in a Phase I area and the contamination indicates more than 40% of the EPA and NDEQ standards or if an area is in Phase II and the contamination indicates more than 60% of the EPA and NDEQ standards, the District will determine if the contamination is point source or non point source.

a. The NDEQ will be notified if the District has determined if the contamination occurred from a point source.

b. When the District determines that the contamination is non point source, the District will take a minimum of twelve (12) groundwater samples in a radius of three (3) miles. The District will set up a map of the area divided into four equal areas from the location of the groundwater sample source, this would be approximately 1 (one) township, 36 square miles. (See Figure 46.)

c. When 25% of the no less than 12 groundwater samples taken, indicate more than 40% of the standards set by the EPA and NDEQ in a Phase I area, this will trigger the area to be designated as Phase II.

d. When 25% of the no less than 12 groundwater samples taken, indicate more than 60% of the standards set by the EPA & NDEQ in a Phase II area, this will trigger the area to be designated as Phase III.

e. If villages and/or towns would be in the three mile radius, the water sample from those wells would be used as one of the twelve sample sites.

f. The Board of Directors will set information meetings in September and October of each year. Information meetings will be held in October and November for groundwater quantity and quality. The information meetings will be held to discuss amendments to the groundwater quantity Rules and Regulations and to discuss groundwater quality implementations of Education programs, Reporting programs, groundwater quality and methods to reduce potential contamination risks.

b. The training of farm operators in the use of BMPs (Best Management Practices) and other measures necessary to increase nitrogen-use efficiency.

c. To establish a data base of operation activities in the area to track the progress and effectiveness of the program.

F. Phase III would consist of: over 60% of the allowable contaminant level of nitrates or any contamination with potential to impact health or environment.

1. Phase III would still continue to have extensive testing done to help provide research to aid in preventing any higher contaminant levels to be found.
2. The boundaries of Phase II will be extended when found necessary.
3. <u>The District will use the same procedure as outlined in Sec. E.4. page 47 of this document for Phase III for determining actions to be used for continued upward levels of atrazine or other herbicides or pesticides.</u>
4. Fall and winter application of commercial N fertilizer are prohibited prior to March 1st or row crop ground for the ensuing year.
5. All fall applications of nitrogen fertilizers in designated Phase II and III fields is prohibited for spring planted crops unless inhibitors are used at approved rates.

and other key elements of the Phases steps of the Groundwater Management Plan.

--In December the Board of Directors will present proposals for both groundwater quantity and quality for a public hearing to be held in January each year. In February and March the Board will adopt amendments to the groundwater quantity Rules and Regulations and the procedures of implementing the groundwater quality management plan.

6. Keep sending a percentage of water samples to approved testing labs for further nitrate and or chemical testing.
7. Define and/or identify point sources: Abandoned wells, feedlots, sewage sites, septic tanks, chemical warehouses, elevators with pesticides for grain storage, chemigation sites, lawns, gardens, and recreational areas.
   a. point source: is any water contamination that originates from a specific location such as a sewer pipe, a leaking chemical pipeline or a factory.
   b. Non Point source: comes from nonspecific, different sources such as ag cropland and urban runoff.
8. Information program: To inform citizens of these potential problems:
   a. Leaching in sandy areas.
   b. Runoff awareness
   c. Help the small towns and villages identify point source pollution.
   d. Contacting the EPA when necessary for needed information.

9. Deeper soil sampling to help identify areas that could be trouble spots. If nitrates/fertilizers/ag chemicals are found at 48 inches, to go to deeper depths of 60-72 inches or depths of 25-75 feet if necessary.

10. The Upper Republican NRD is currently trying to develop a deep soil sampling program that would include having 50 deep core soil samples done in the Spring of 1996, if funds become available.

    a. The Upper Republican NRD would like to intensify their current water quality program by having 50 deep core soil samples done to find if there is any evidence of nitrates 30 to 50 feet below the surface of the ground.

    b. The URNRD has excellent records of water use for the past 15 years due to the fact that the URNRD has had a groundwater control area in effect and flowmeters are in place at every irrigation site. This information may be used to pinpoint the areas of high water usage and the possibility of high fertilizer and/or chemical usage in those areas. These areas would be checked to find out what kind of impact high water use has had on groundwater contamination.

    c. The URNRD would like to have the 50 samples done in the District on a variety of different sites. Sites where samples would be done would include:

       --Ground involved in the groundwater control area allocation since the beginning of the control area.

       --Dryland acres not having high chemical and/or fertilizer use.

--Pastureland.

--Flood irrigated acres

--Pivot irrigated acres

--Sandy sites

--Hard ground: clay, loam sites

--Areas of known high nitrogen application rates, sandy and loam areas.

--Areas of known low nitrogen application rates, sandy and loam areas.

E. Phase II would consist of: over 40% of the allowable contaminant level of nitrates or any contamination with potential to impact health or environment.

1. The process of determining the boundaries of Phase II will begin by doing extensive study and testing. The Board will proceed with the procedure of implementation each year as outlined in Section D.5.f. on page 44 of this document.

2. The types of studies done in Phase II could include but not be limited to:

   a. Deep soil sampling

   b. Groundwater well testing

   c. Soil sampling

3. When the boundaries of Phase II have been designated, the following practices of Phase II will be implemented.

4. The District does not anticipate any regulations of atrazine or other herbicides and pesticides. If however, the

contaminant level of any chemical continues upward, when it reaches 40% of the MCL over any 36 square mile area, the district will consult with the Nebraska Department of Environmental Quality and the Nebraska Department of Agriculture for assistance in determining the necessary controls that may be needed. If these agencies determine that certain herbicide or insecticide application should be limited or banned in this area, their recommended controls would be incorporated into the URNRD Groundwater Management Plan.

5. All operators must attend nitrogen and/or irrigation management training workshops and become certified at the end of training. Similar to the Chemigation training workshops.
   a. Operator training will be offered annually.
   b. Re-certification every four years.
   c. Alternate workshops could be offered.
6. Each operator is required to take soil samples annually on Phase II fields, on which livestock waste or commercial nitrogen fertilizer will be applied. If the farm does not have 160 acres of total cropland, the largest field will be sufficient.
   a. Soil sampling will commence when the ground water quality management plan is put into effect. All required samples will be at the owner's or operator's expense.
      1. Sampling and analysis will be done prior to fertilization of each crop which commercial nitrogen fertilizer or livestock waste will be applied in the ensuing crop year.

2. One composite sample will be collected for analysis from each 40 acre tract.
3. The depth of the sample will be samples at stages from 0-36 inches.
4. Provide representative samples following the guide lines provided in UNL Neb Guide G91-1000.
5. Sample shall be sent to NRD approved soils labs.
6. The recommended nitrogen application rate will be determined by the nitrogen accounting method.

b. All Phase II fields irrigated with ground water will also have a water sample from the supplying well analyzed for the nitrate/nitrogen level. Water samples will be sent to NRD approved testing labs. Credit will be given for the nitrates in the water if applicable.

c. The owner/operator will be required to apply no more than the UN-L fertilizer recommendation for all Phase II fields.

d. Irrigation scheduling shall be conducted by the operator or consultant on the Phase II field.

e. In the localized areas of high nitrates or contamination with the potential to impact health or environment, do water samples of an area three miles around the point of high nitrates or contamination.

f. Adding more water sample sites around the areas that are high, testing them annually in the water sampling program.

g. Testing may not be limited to domestic/livestock wells, will also include irrigation wells. (Municipal wells are checked once a year, there are six points in Imperial, six checks per year.)

h. Establish data bank for water,chemical, and fertilizer use.

i. The start of filing of annual reports for owner/operators of Phase II fields showing specific information will be implemented.

--soil test results --water test results

--N credits for residual nitrates from all known sources (including water).

--Crop grown that year --Projected yield

--UN-L nitrogen

--Fertilizer N applied

--Legal description of tract

--Amount of water applied

--Other related data

j. Having water samples analyzed for more than just nitrates, will also include any other contamination that would have the potential to impact health or the environment.

k. May require water samples of wells with high water use. If wells used more than 25% of the average county water use on each individual crop, water sampling may be necessary. This would provide information of possible contamination sites. May be subject to a two year history of water and chemical use.

7. Extensive testing will still be continued in Phase II to help prevent an area from going into Phase III.

8. Primary goals of Phase II:

a. The education of the general public about threats to