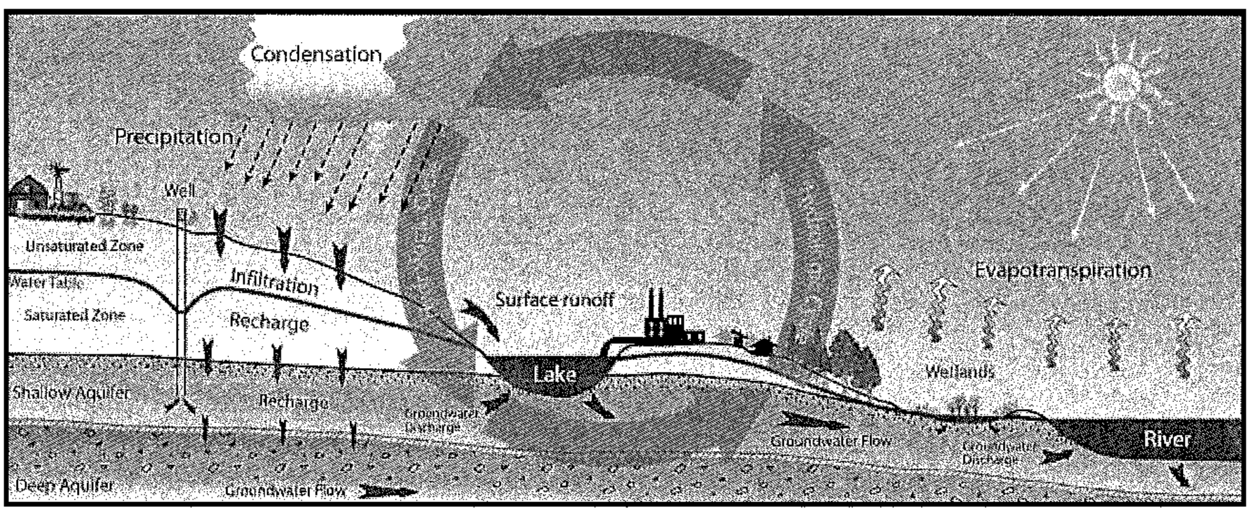
GROUNDWATER MANAGEMENT PLAN

LITTLE BLUE

NATURAL RESOURCES DISTRICT



ORIGINAL PLAN SEPTEMBER 1995
PLAN AMENDED DECEMBER 13, 2005

GROUNDWATER MANAGEMENT PLAN
LITTLE BLUE NATURAL RESOURCES DISTRICT
AMENDED DECEMBER 13, 2005

BOARD OF DIRECTORS

NAME	TOWN	NAME	TOWN
Richard Kahman - Chairman	Fairfield	Joseph Hergott	Hebron
Jerrad Stroh - Vice Chairman	Juniata	Bill Johnson	Roseland
Jon Lichti - Secretary	Shickley	Charles Rainforth	Hastings
Tim Pohlmann - Treasurer	Deshler	Jason Reiners	Hastings
Diane Beachly	Hastings	Duane Schliep	Clay Center
James Cunningham	Fairbury	Bryan Skalka	Deweese
Ross Fisher	Fairfield	Gene Thomas	Daykin
Ed Fleharty	Hastings	Wryan Wright	Hastings
Lyle Heinrichs	Shickley		

GROUNDWATER COMMITTEE

Jerrad Stroh - Chairman
Jason Reiners – Vice Chairman
Lyle Heinrichs
Jon Lichti
Tim Pohlmann
Charles Rainforth
Duane Schliep
Wryan Wright

STAFF

Michael D. Onnen - Manager
Kevin Orvis - Water Resources Manager
Daryl Andersen – Water Resources Specialist
Marlene K. Faimon - Programs and Information Coordinator
Kent Thompson – Operations Supervisor
Marie Herbek - Administrative Secretary
Ruth Oellerich - District Secretary

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LIST OF ACRONYMS

ASCS	Agricultural Stabilization and Conservation Service
BMP	Best Management Practices
CA	Control Area
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CDC	Nebraska Department of Health Center for Disease Control
CES	Cooperative Extension Service
CSD	Conservation and Survey Division
CWA	Clean Water Act
DEC	Nebraska Department of Environmental Control (now DEQ)
DEQ	Nebraska Department of Environmental Quality (formerly DEC)
DOH	Nebraska Department of Health
DWR	Nebraska Department of Water Resources
EPA	U.S. Environmental Protection Agency
ET	Evapotranspiration
FmHA	Farmers Home Administration
G & P	Nebraska Game and Parks Commission
GWMA	Groundwater Management Area
GWMP	Groundwater Management Plan
GWMPA	Groundwater Management and Protection Act
LBNRD	Little Blue Natural Resources District
LUST	Leaking Underground Storage Tanks
MARC	Meat Animal Research Center
MCL	Maximum Contaminant Level
msl	mean sea level (Datum for USGS elevations)
NAWQUA	USGS National Water Quality Assessment Program
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source (of contamination)
NRC	Nebraska Natural Resources Commission
NRCS	Natural Resources Conservation Service (formerly SCS)
NRD	Natural Resources District
NWQL	U.S. Geological Survey National Water Quality Laboratory
PMCL	Primary Maximum Contaminant Level
PS	Point Source (of contamination)

RCRA	Resource Conservation and Recovery Act
SCS	U.S. Department of Agriculture Soil Conservation Service (now NRCS)
SMCL	Secondary Maximum Contaminant Level
SPA	Special Protection Area
T	Transmissivity
TDS	Total Dissolved Solids
UNL	University of Nebraska-Lincoln
USDA	U.S. Department of Agriculture
USGS	U.S. Geological Survey
WHPA	Wellhead Protection Area

ABBREVIATIONS AND CONVERSION FACTORS

cfs or ft^3/sec = cubic feet per second

AF or af = acre-foot or acre-feet

gpm = gallons per minute

Conversion Factors

cfs x 1.9835 = acre-feet per day (AF/d)

Example: 10 cfs = approximately 20 AF/d

cfs x 59.51 = acre-feet per 30-day month

Example: 100 cfs - 5,951 AF/mo

cfs x 724 = acre-feet per 365-day year

Example: 1000 cfs = 724,000 AF/year

1 cfs = 7.48 gallons per second (gps)

1 cfs = 448.8 gpm

2 cfs = approximately 900 gpm

1 acre-foot = 325,851 gallons

1 day = 1440 minutes

Examples: 1 gpm = 1440 gpd

100 gpm = 144,000 gpd or 0.44 AF/d

1000 gpm = 1,440,000 gpd or 4.4 AF/d

750 gpm = approximately 1,000,000 gpd or 3.3 AF/d

Chemical Concentrations, Abbreviations and Equivalencies

parts per million (ppm) = milligrams per liter (mg/l)

1 microgram per liter (µg/l) = 1 part per billion (ppb) or 0.001 mg/l

Example: manganese, 50 µg/l = 0.050 mg/l

picocuries per liter = pCi/L (radioactive term)

Example: uranium, 10 pCi/L = 30 ppb or 0.030 mg/l uranium - 238

1.0 Introduction

In 1984, the Nebraska Legislature passed LB 1106, a statute which required Natural Resources Districts (NRDs) to prepare groundwater management plans based on available information and to submit them to the Department of Water Resources (DWR) for review by January 1, 1986. This legislation was the result of growing concerns about groundwater supplies, historical groundwater declines and projected declines in this valuable resource. The Little Blue Natural Resources District (LBNRD) Board of Directors and staff prepared and adopted a Groundwater Management Plan (GWMP) in July 1986, after the plan had been approved by the DWR.

Then, in 1991, due to growing concerns about groundwater contamination, the Nebraska Legislature passed LB 51. This statute required the NRDs to amend their existing GWMPs to address water quality. The LBNRD, enlisting the services of Olsson Associates Consulting Engineers, decided in 1993 to not only amend the existing GWMP but to completely revise and update the seven year old plan to reflect current thoughts on groundwater management.

This 1995 plan is a stand-alone document replacing the 1986 GWMP. The original intent of the LBNRD's 1986 plan, including the Groundwater Reservoir Life goal and all other goals and objectives, has been carried over into this plan, while programs and future plans have been revised to reflect current concerns with added emphasis on groundwater quality issues.

This plan is generally organized in the format recommended by the Nebraska Department of Environmental Quality (DEQ) and the Nebraska Department of Water Resources in their joint publication "Reference Outline - Groundwater Management Plan Amendments" dated July 1992. Information carried over or updated from the 1986 GWMP has been re-organized to fit into this format.

1.1. Previous NRD Water Quality or Quantity Studies and Planning Efforts

1.1.1. 1986 Groundwater Management Plan

The 1986 GWMP (Reference R43) was created to fulfill a requirement of LB 1106, passed by the 1984 Nebraska Legislature, to address concerns about threatened groundwater supplies. This plan established separate NRD goals for the management of groundwater quantity and quality and presented the LBNRD's management objectives and the programs planned to achieve their goals. The NRD's groundwater management policies and implementation practices were also discussed. The 1986 plan addressed mainly nitrate-nitrogen contamination in setting water quality implementation policies.

The 1986 GWMP has been successfully implemented by the LBNRD over the past nine years.

1.1.2. Groundwater Control Area Studies

Concerns regarding groundwater declines prompted the LBNRD, in 1974, to request the Nebraska Natural Resources Commission (NRC) to prepare a groundwater modeling study to determine what effects current and future rates of development would have on future water levels. Average water usage was figured at 15.8 inches per irrigated acre per year. The only variable factor was the rate of development. Three predictive runs were made with the following results. The first predictive run was made assuming a 1977 development rate which resulted in a large area of the Little Blue River Basin, north of the Little Blue River, experiencing water level declines of 50 feet or more by the year 2000. The second predictive run was made assuming a low rate of development which resulted in an estimate of over 90% of the Little Blue River Basin, north of the Little Blue River, having water level declines of 50 feet or more. The third predictive run was made assuming a high rate of development which resulted in an estimate in which over 95% of the Little Blue Basin would have water level declines of 50 feet or more by the year 2000. This information was presented at meetings across water level decline areas of the District. Testimony at those informational meetings and at the public hearing was supportive of adoption of some type of restrictions to control water level declines. Meetings were scheduled by the District with the Conservation and Survey Division (CSD) and the NRC to develop boundaries of a control area. It was agreed that any area which had a water level decline of 5 feet or more from predevelopment levels would be included in a control area. Hydrologic conditions along the perimeter of the decline area were also considered in determining the exact boundary lines.

On January 2, 1979, approximately the northern one-third of the District was declared a Groundwater Control Area (Figure 13-23). This area consisted of approximately 600,000 acres, containing 2,700 wells. Groundwater level declines of 0.9 foot per year were being experienced at the time of the declaration.

Intensive educational programs were instituted involving Best Management Practices (BMPs), including minimizing irrigation run-off, the use of re-use pits to return the water to the land and irrigation efficiency contests. Also, an aggressive water metering program was developed. In 1983, the District began a Meter Maintenance Program whereby a landowner and/or operator could get water flow meters repaired or replaced by the District. Eligibility for the program required reporting irrigated acres and wells to the District and purchasing and installing a water flow meter which met District specifications.

Although weather conditions through the 1980's and early 1990's were quite varied from normal, and fluctuations in the water table were experienced, the long term trend of annual declines was broken. The water table appears to have reached a level of relative stability. This is attributed not only to climatic conditions but also to significant changes in the conservation and management of groundwater use by irrigators and others.

In 1993 the Little Blue NRD Board asked the Department of Water Resources to conduct a public hearing to determine if the Control Area should be retained. After the presentation of data by the District, state and local agencies and the public, the Director of DWR agreed that the Control Area should be dissolved. Although the Control Area is no longer in effect, the impacts of its 15 year existence are very evident. There is a much greater awareness and stewardship of water, many management practices are in place and are being used, and operators are making efforts to reduce consumption. The District will continue to work with farmers on an individual basis to improve management and collectively through training activities to further our conservation efforts.

1.1.3. Adams County Water Supply Study

In 1983 a reconnaissance level investigation was completed by the District in cooperation with the Central Nebraska Public Power and Irrigation District which studied two approaches to providing supplemental water to Adams County. One component of the study looked at diverting water from the Platte River to irrigate lands in northern and central Adams County. Due to the political and environmental concerns of this component, it is doubtful that this project will be pursued. A second component studied the development of well fields in western Adams or northern Kearney counties to meet the expanding needs for municipal water supply for Hastings. Because of groundwater contamination in and around Hastings, this alternative is still a viable option which may be pursued in the future.

1.1.4. Catherland Irrigation Project

In 1976 the District assumed sponsorship of a proposed project for development of a water storage dam and distribution lateral system to irrigate 66,500 acres of south central Nebraska lands. The project came to be known as the Catherland Project. The project also offered considerable benefits for groundwater recharge, flood control, recreation, and wildlife habitat.

Due to complexity of the permit process, cost factors and political pressures, the District transferred the pending water rights applications to the Catherland Reclamation District in March 1985. Subsequent action by the Nebraska Department of Water Resources granted the permits for surface water appropriations utilizing Central Nebraska Public Power and Irrigation District's canals. However, on the appeal of several objectors, the Nebraska Supreme Court ruled that the permits were not valid because the LBNRD did not have authority to transfer the applications and thus the permits were declared invalid. The project was not actively pursued by the Reclamation District.

One positive aspect of the Catherland Project effort was the overturning of a 50 year old court ruling which prohibited transbasin diversion in the state.

1.1.5. Lake Hastings Wastewater Reuse Study

In 1985 the District cooperated with the City of Hastings to carry out a reconnaissance level study to identify alternatives for enhancing the water level and water quality in Lake Hastings. A key objective was to examine ways of reusing Hastings' effluent water, if possible, to maintain required lake levels while reducing outright groundwater withdrawals in the City. Two alternatives which proved most desirable included: 1) the construction of an upstream detention cell to capture storm water flows thereby improving water quality, and 2) using treated effluent water for agricultural irrigation where wells are presently being used and, in exchange, pump supplemental water to Lake Hastings from one of the City's power plant wells. The estimated capital costs ranged from $1,000,000 for the smallest detention pond option to $4,000,000 for the combined system of wastewater irrigation exchange and a larger detention pond. The measures, if implemented, could reduce overall groundwater pumpage by 300 to 1200 acre feet per year depending on which alternatives are pursued.

The City of Hastings has shown some interest in the detention pond concept but no action has been taken to date.

1.1.6. 1983 Edgar Sandpit Water Quality Sampling Study

In 1983 the District, with assistance from the Nebraska Department of Environmental Quality (DEQ) and the University of Nebraska, started a three year project testing the quality of runoff water in the Big Sandy Creek near Edgar.

The sampling site was near the Edgar Sandpit located one-half mile north and one mile east of Edgar. Sand and gravel have been mined from this pit since the mid-1950's and were still being taken at the time of this study. The Big Sandy Creek, which at one time flowed across the pit site, was rechanneled around the pit. The District spearheaded a stream quality project to help plan the future uses of the ground and surface water in this area. It should be noted that the sandpit is within the pool of Structure 24-5N-6W, a prospective dam site on the Big Sandy Creek.

The ISCO 1640 automatic sampler was installed on the northeast corner of the southeast quarter of 24-5N-6W on April 25, 1983. The sampler starts taking samples when the water level in the creek reaches the set height and will shut off when the water drops below the same level. The sampler can be set at a wide variety of sampling quantities and intervals and can take up to 28 samples. For this project one-half of the full 400 ml sample was taken every 30 minutes. This was done to get the best possible representation of the runoff event.

The results reported by the DEQ were given in Table 27 of the 1986 GWMP (Reference R43). The DEQ also requested that the District collect groundwater samples from the area. Results from samples taken were presented in Table 26 of the 1986 GWMP (Reference R43).

1.1.7. Groundwater Recharge Projects

The occurrence of groundwater level declines in the basin has created interest in artificially recharging the groundwater reservoir. Groundwater is recharged primarily by percolation of precipitation through the crop root zone. This recharge was estimated to average about 1.5 inches (3.8 centimeters) annually in this area of the state. Some irrigation water also returns to the aquifer as deep percolation. Recharge projects could be effective in balancing the overdraft in groundwater supplies, thereby extending the aquifer life. Flood control reservoirs offer an advantage over other types of recharge systems in that they can be used for other purposes as well, including recreation, wildlife habitat, and irrigation.

The District has completed two dams within the Big Sandy Creek watershed, one located on the Meat Animal Research Center (MARC) near Fairfield, and the other northeast of Bruning. Both structures should provide substantial benefits from recharge. Studies conducted by the University of Nebraska South Central Station indicate that recharge potential in the Big Sandy area is exceptional. Monitoring of the MARC Dam's recharge began in 1981, shortly after its completion. A water budget equation of precipitation plus inflow, minus the change in reservoir level, minus evaporation, minus outflow, was used to determine infiltration. Results from the 53 months study period indicated that infiltration rates varied between 2.5 inches per day to less than 0.1 inches per day. The average infiltration rate during the first 18 months was 0.71 inches per day, for the 12 months of 1984 it averaged 0.56 inches per day, and for the first 11 months of 1986 it averaged 0.34 inches per day. This compares to a seepage rate of 0.50 inches per day at another Clay County Reservoir over a 3 year study period.

Known details about the topography and capacities of the reservoir at various elevations have assisted in determining cumulative volumes of infiltration. During the first 18 months, 4,800 acre feet of infiltration occurred. Because of wet conditions, in 1984 infiltration was again high with a cumulative total of 3,400 acre feet. The total volume infiltrating during the 30 month and 53 month monitoring periods was 8,200 acre feet and 11,770 acre-feet, respectively. The original engineering analysis estimated 792 acre feet per year for the first year of operation, dropping gradually to 683 acre-feet per year by the 25th year.

An observation well located on a railroad grade in the center of the reservoir was monitored to show the response of the groundwater system to recharge. The water level in this well showed a positive response shortly after the initial filling of the reservoir as it rose nearly 5 feet. Following the initial period of high infiltration, the recharge mound started to dissipate and receded to a elevation 1.5 feet above preconstruction groundwater levels. Since that time, the water levels in the monitoring well have fluctuated in concert with water levels in the surface of the reservoir.

1.1.8. <u>Recharge Site Water Quality Studies</u>

In agricultural areas of Nebraska, surface water contains significantly greater amounts of pesticides than does the underlying groundwater since all but the most persistent, most soluble, and least adsorptive pesticides normally are removed from the infiltrating water. The efficiency of this removal process is dependent upon the thickness and character of the unsaturated layer.

The District, in cooperation with University of Nebraska Conservation and Survey Division (CSD), conducted a study to determine if groundwater recharge projects undertaken by the District contribute to contamination of the underground aquifer. This study was initiated in the fall of 1984.

The three goals of this study were (1) to evaluate the potential of two storage structures for groundwater contamination, (2) to determine the velocity of the groundwater in the vicinity of the recharge mound, and (3) to estimate the magnitude of pesticide attenuation within the aquifer.

At the Bruning site (structure 35-5N-2W), the water table lies about 35 feet below the land surface, while at the MARC site (structure 20-6N-7W), there are approximately 80 feet of unsaturated sediments. While solutes in the seepage water can interact with the soils before the water enters the regional aquifer, the thinner unsaturated zone and the occurrence of shallow gravels at the Bruning site suggest it may be susceptible to groundwater contamination.

Twenty-eight dedicated monitoring wells were installed in four clustered locations around the pool of the Bruning Dam. Two wells were installed near the MARC Dam. The wells were screened at varying depths.

In 1985, the Bruning Dam was spiked with a sodium bromide solution to serve as a surface water to groundwater tracer. Results of monitoring well samples showed a fairly rapid impact on wells screened at a very shallow depth. Wells screened at a medium depth showed a much slower response time to the tracer and deep wells showed little response. A perched water table was identified as the reason for only minor impacts in the deep wells.

Water samples for pesticides were collected from the lake surface and all monitoring wells on three occasions over a one year period. Surface water concentrations of alachlor (3.6 u/l), atrazine (18.9 u/l), cyanazine (2.9 u/l), metolachlor (5.4 u/l), and trifluralin (ND) were recorded at their highest level immediately after planting season in early June. These contaminent levels were significantly higher than groundwater samples extracted from the monitoring wells. Atrazine was the most prevalent pesticide detected in the monitoring wells and was found in 55 of 61 samples with 21% of the samples over the MCL. The range was 0.0 ppb to 8.8 ppb with highest levels, as expected, in the shallow wells.

The study indicated that contaminants have an impact on groundwater via recharge structures especially in areas of high permeability. Contaminant concentrations in surface water are attenuated by natural process and dilution over time (Reference 3).

Downward movement of water may be impeded by lenses of impermeable material preventing recharge to the regional aquifer.

The Little Blue NRD also sampled 15 household wells in the area in 1985 to obtain background water quality data. These wells continue to be periodically sampled to detect any changes in groundwater quality in the vicinity of the recharge dam.

1.2. Progress to Date Towards Achieving the 1986 GWMP Groundwater Quantity and Quality Goals

This section reviews progress made towards implementing the objectives of the 1986 Groundwater Management Plan. In each case, the 1986 objective is stated followed by a brief discussion of the LBNRD's progress made toward implementing that objective.

1.2.1. 1986 Goals and Objectives for Groundwater Quantity Management

The 1986 GWMP goal for Groundwater Quantity Management for the LBNRD was "to maintain an adequate groundwater supply to meet the future needs for domestic, agricultural, and industrial use".

The following objectives were established to achieve that goal:

1.2.1.1. Provide an adequate observation well program to identify changes in groundwater levels.

- Expanded observation wells from 311 in 1986 to 340 in 1995.
- Requested information from well drillers for well permits to monitor the exact location of the well before drilling.
- Cooperated with the Blue River Management District and USGS in acquiring seasonal groundwater level readings.

1.2.1.2. Provide irrigation scheduling training programs to irrigators.

- The early irrigation scheduling program was considered successful. The program was discontinued because many private consultants were establishing businesses which included scheduling services.
- Employed seasonal workers to enhance the program.
- Supplied crop water usage information to the general public.
- Annual workshops with the NRCS and CES.

1.2.1.3. Participate in irrigation water management clinics.

- Integral in the Mid-Nebraska Water Quality Demonstration Project which utilizes the best irrigation water management techniques.
- Water pumping plant efficiency demonstrations. This demonstration promotes the maximum GPM one can expect from a water well.
- Verification of pumping plant efficiency using the latest metering technology.
- Consultation with the CES in developing operator training sessions for the Superior-Hardy SPA.

1.2.1.4. Sponsor water use efficiency contests.

- Contests conducted for three years with volunteer cooperators with the goal to achieve better irrigation practices.

1.2.1.5. Sponsor new irrigation technology through demonstration sites and research.

- The LBNRD coordinates and disseminates information concerning drop nozzle devices on pivot plots via the Mid-Nebraska Water Quality Demonstration Project.
- Participation in the "Husker Harvest Days". The Natural Resources Booth draws thousands of people annually.
- Installation of drawdown instrumentation in high capacity wells for fact gathering information in the District.

1.2.1.6. Loan flow meters to cooperators for educational purposes.

- The LBNRD will loan flow meters to a water consumer for a season to determine an exact water withdrawal figure, and has worked with the consumer to help reduce water usage.

1.2.1.7. Sponsor or provide technical assistance and/or cost share assistance for structural projects that will capture surface water flows for multipurpose uses (e.g., flood control, sediment and erosion control, groundwater recharge, wildlife habitat and recreation) when such projects are engineeringly, economically and environmentally sound.

- The LBNRD enforces the Erosion and Sediment Control Act throughout the District. The program was updated the Summer of 1995.
- The LBNRD offers cost share for dams, terraces, underground outlets, water impoundment dams, and soil grade stabilization structures. Also, pasture planting or range seeding, critical area planting of grasses and windbreaks, planned grazing systems and a concise well abandonment program.
- Provided approximately $20,000 annually for field technicians for design and certification of conservation practices.

1.2.1.8. Provide information on proper irrigation management and water saving techniques to news media and information disseminators.

- Information distributed through media, newsletters and newspapers. Also, radio and television broadcasts are utilized to inform the public of current activities.

- County fairs are used to inform the public of water management practices and technology.

1.2.1.9. Certify installation of all meters currently purchased but not installed.

- The LBNRD has certified approximately 1,700 meters.

1.2.2. <u>1986 Goals and Objectives for Groundwater Quality Mangement</u>

The 1986 GWMP goal for Groundwater Quality Management for the LBNRD was "to maintain groundwater quality for all current and foreseeable uses based on standards which are acceptable to the Department of Health and the Department of Environmental Control (DEC)".

The following objectives were established to achieve that goal:

1.2.2.1. Monitor groundwater quality throughout the District by sampling domestic and irrigation wells for nitrates, pesticides, and chemicals, within budgetary capabilities.

- An on-going study of chemical analysis is being done throughout the District.

1.2.2.2. Establish a program for deep soil sampling for contaminants in open fields or near potential contamination sources such as sewage lagoons or feedlots.

- Contracted with USGS for deep soil sampling in the Hardy area (SPA).
- Deep soil cores in cooperation with UNL/Burlington Northern Project and analysis for pesticide leaching on cropland.

1.2.2.3. Continue studies which monitor agricultural chemical contamination from recharge sites or other potential sources.

- Samples drawn from established monitoring wells near MARC and the Bruning Dam every three years.
- Surface water samples from three watershed dams for pesticides.

- Collected surface water stream samples from the main stream of the Big Sandy Creek.
- Clean Lakes study for Buckley Creek Reservoir.
- Analyzed sediment samples from lake bottoms for pesticide residue.

1.2.2.4. Provide technical assistance and cost share assistance for conservation practices which reduce sedimentation and hold possible contaminants on the land instead of allowing them to enter the watercourses.

- Cost-share programs have been established and carried out to address erosion and sediment control.
- Annual budgetary allocation of funds for field technical assistance and land and water conservation practices.
- Provided cost-share for well abandonments.

1.2.2.5. Provide concise reporting of water quality conditions, research, and activities to the news media and public.

- News releases to all District newspapers.
- News letters printed in papers.
- Fliers and brochures.
- Topical radio and television interviews.

1.2.2.6. Promote nitrogen management and restraint in high fertilizer use areas.

- Annual letters and posters to all fertilizer dealers discouraging fall fertilizaton and encouragement to support fertilizer best management practices.
- News articles to District media during fertilizer seasons.
- SPA - no fall fertilizing.

1.2.2.7. Encourage crop rotations to reduce requirements for fertilizer and pesticides.

- Newspaper articles.

1.2.2.8. Promote technical assistance when possible for proper fertilizer and chemical recommendations, applications, calibration, storage, handling, and disposal or recycling of chemical containers.

- Mid-Nebraska Water Quality Demonstration Project.
- Advertisements via media.
- Participated in chemical applicator training sessions.
- Produced a 5 article series for newspapers regarding solid waste management, legislative restrictions and recycling alternatives.

1.2.2.9. Maintain open lines of communication with the Area Planning and Zoning Commissions.

- Adams County planning and zoning regarding livestock waste facility and discharge.

1.2.2.10. If potential contamination areas are located, notify responsible parties and/or controlling agencies.

- Field checking and follow-up on trash or waste dumping, livestock facility discharges, fish kills, chemical spills, center pivot end gun violations and well contaminations.

1.2.2.11. Support legislative concepts which address specific concerns and needs dealing with water quality (e.g., chemigation, sediment and erosion control, nitrates).

- Supported legislation initiatives for chemigation, erosion control, FIFRA, well registration, contractor licensing, water quality maintenance funds, abandonment of wells fund and groundwater transfers.
- Participated in public information sessions and hearings on the above mentioned topics.

1.2.2.12. Seek additional state assistance in the form of funding and/or water quality analysis to conduct expanded monitoring programs in the District.

- Supported and contributed to the implementation study of the Natural Resources Enhancement Fund.
- Applied for and received a Clean Lakes grant.

- Requested two SPA studies by DEQ.
- Cost-shared with USGS for monitoring well installation and sampling.
- Cooperative water quality venture with UNL/CSD for installation and monitoring of dedicated wells surrounding groundwater recharge sites.
- Cooperative effort with UNL for groundwater recharge impacts near MARC Dam.

1.3. Review Letters on the 1986 Groundwater Management Plan

The 1986 GWMP was reviewed by the following state agencies: Natural Resources Commission, Department of Environmental Control, Department of Health, Conservation and Survey Division, and Game and Parks. The GWMP was subsequently approved by the Department of Water Resources. All review letters from these state agencies are on file at the LBNRD office in Davenport, Nebraska.

1.4. Documentation of Public Participation

Any available documentation of public response to the 1986 GWMP (including public hearing agenda items, minutes, public comments, written comments, and correspondence) is on file at the LBNRD office.

1.5. A General Description of the Little Blue Natural Resources District

1.5.1. General

The Little Blue Natural Resources District (LBNRD) is located in the south-central region of Nebraska and includes all of Thayer County and portions of Jefferson, Fillmore, Nuckolls, Clay, Webster, and Adams counties (Figure 13-1 in Chapter 13 of this plan). The total area within the boundaries of the LBNRD is approximately 2,402 square miles.

The LBNRD boundary approximates the hydrologic area known as the Little Blue River Basin which is located between the Republican, Middle Platte, and Big Blue River Basins. The Little Blue River rises in the plains near the Middle Platte River Basin and leaves the state at the Kansas-Nebraska State line southeast of Fairbury, Nebraska.

The main discrepancy between the District and the Basin boundary is in the upper reaches of the Basin. While the western edge of the District ends at the western boundary of Webster and Adams counties, the Basin continues into Franklin and Kearney counties.

1.5.2. Climate

The average annual precipitation varies from about 25 inches at the western end of the NRD to 31 inches in the east (Figure 13-2). Most of this comes as rain during the crop growing season, but supplemental water for irrigation is generally required to insure against crop failure. This is especially true for the land at the western end of the District.

Temperatures in the NRD vary widely between summer and winter. July temperatures normally range from 66°F to 91°F with a highest recorded temperature of 113°F in July 1954. January normal temperatures range from 11°F to 33°F with a lowest recorded temperature of -21°F in January 1974. Based on records from 1951 to 1980 at the Hebron weather station, the annual normal temperature is 51.8°F, the annual maximum normal temperature is in July (90.5°F), and the annual minimum normal temperature is in January (11.3°F).

1.5.3. Drainage

The Little Blue River begins in the southern plains of Kearney County south of Minden, Nebraska. Acquiring flows from a number of small tributaries throughout the drainage area, the river flows generally east-southeast until leaving the state at the Nebraska-Kansas border southeast of Fairbury.

The largest tributary to the Little Blue River in the watershed is the Big Sandy Creek system which drains most of the area north of the river in Clay, Fillmore, and Thayer counties.

In the western end of the Little Blue River basin, the lands are loess plains with poorly defined drainage patterns. The plains become gently rolling in the central part of the basin with a much better defined drainage pattern on the south side of the river. Severe erosion is frequent in such areas. The flood plain of the river becomes much narrower in the eastern end of the basin.

The character of stream flow in the Little Blue River is influenced by the water bearing Pleistocene deposits that, where intercepted by the stream channels, contribute to a steady base flow. Stream flow still varies greatly in direct response to precipitation, especially in lower reaches of the river. The base flow comes mainly from those tributaries north of the river which receive groundwater influent.

1.5.4. Hydrogeology

The District is underlain by unconsolidated deposits of the Pleistocene (Quaternary) age and semiconsolidated deposits of the Pliocene (Tertiary) age. Underlying these deposits is a thick sequence of consolidated rocks of Cretaceous and other ages. The bedrock formations consist mainly of marine deposits of sandstone, shale, chalk, and limestone (Figure 13-3). The bedrock surface is a buried erosional terrain developed on the Niobrara Formation and Pierre Shale of the late Cretaceous age. Ogallala Formation, of the Tertiary age, which extends into Adams County from the west, overlies the bedrock in about one-fifth of the county. This formation consists largely of lenticular deposits of sand, silts, and clay, some of which are poorly cemented. Originally these sediments are believed to have extended throughout the area, but subsequent erosion by streams removed them from most of the central part of Adams County.

Soil parent materials across the District include loess, eolian sand, recent alluvium, water deposited sand and gravel, and limestone residuum.

Loess is the principal parent material and is from the Peoria and Loveland Formations. In Adams and Webster counties, the thickness of Peoria loess varies from a few feet to 25 feet. The remaining part of the District varies from less than 1 foot to 30 feet.

Loveland loess, which underlies the Peoria loess, is found at the surface on lower slopes of hillsides along the Little Blue River and along many of the intermittent drainage ways in Adams, Clay, Nuckolls, and Jefferson counties. It is also found in large surface deposits in northeastern Webster County, along Ox Bow and Elk Creek in Nuckolls County, along the Little Blue River in Clay County, and between Gilead and Hubbell in Thayer County. Loveland loess varies in thickness in Fillmore County from 0 to 160 feet.

In western Adams County there are deep, sandy soils on uplands formed in eolian sand. Hummocks range in height from 2 to 15 feet. The sand is not uniformly distributed and thickness varies from 2 to 50 feet. In some areas, the sand is mixed with loess.

Recent alluvium consisting of clay, silt, sand, and gravel was washed from the uplands and deposited on stream terraces and bottom lands along major drainage ways. Recent alluviuum is found throughout the District in the flood plains.

Water deposited sands and gravels are found beneath the Loveland loess in Adams, Clay, Fillmore, Thayer and Jefferson Counties. Some surface exposures of these deposits can be found along the slopes of the Little Blue River valley in Adams, Clay, Nuckolls, Thayer, and Jefferson Counties. It also can be found along the lower side slopes of several large drainage tributaries on the north side of the Republican River in Nuckolls County, and along the Pawnee and Big Sandy Creeks in Clay County. In Fillmore County, sand and gravel deposits range in thickness from 0 to 200 feet. The shallowest areas are located in the southeast corner of the county.

Limestone residuum form weathered Greenhorn limestone, which is underlain by Graneros shale, outcrops on severely eroded areas in Jefferson County. Rough stony land can also be found in Jefferson County in areas of steep, irregularly shaped slopes that have numerous outcrops of limestone, sandstone and shale.

Groundwater supplies are plentiful in the northern and western parts of the District where the Pleistocene deposits of sand and gravel occur (Figure 13-4). Elsewhere, high capacity wells are difficult to obtain and only small to moderate yields are generally available. In the southeastern corner where glacial deposits underlie the loess soils, deep wells may obtain large supplies of water from the Dakota sandstones, but the water can be highly mineralized.

The groundwater moves very slowly form northwest to southeast. Under natural conditions, groundwater moves laterally through the substratum at a rate of approximately 1 to 1-1/2 feet per day.

1.5.5. Land Use

Most of the land in this District, which covers 1,537,280 acres, is well suited to agriculture. About 1,486,580 acres are classified as agricultural lands and of that, 84 percent is arable. The northern part of the District is almost entirely devoted to cultivated cropland. Corn, sorghum, and soybeans are the major crops grown. Clay County, which lies partly in the Little Blue and partly in the Big Blue Basin, is the state's leading producer of irrigated sorghum. In the rest of the District, the smoother uplands and bottom lands near the streams are cultivated, but the rougher dissected plains are used mainly for pasture.

There are a number of light industries in the LBNRD such as manufacturing plastic or paper products; fabrication of iron, steel, and aluminum products; ethanol production; beef packing; and manufacturing of other light items requiring high amounts of labor and small shipping costs. Much of the industry in the District is oriented toward supplying the needs of agriculture or marketing agricultural products.

The rainwater Basins located in Adams, Clay, Fillmore, and Thayer Counties are considered some of the better waterfowl production areas in the state. The U.S. Fish & Wildlife Service and the Nebraska Game & Parks Commission have purchased a number of land tracts containing marshes and wetlands for production of waterfowl and for public utilization (hunting and wildlife observation).

A generalized Land Use map is provided as Figure 13-5 in Chapter 13 of this plan. Additional Land Use discussion is included in Chapter 4.

2.0 Hydrogeologic Characteristics

2.6. Aquifer Description

2.6.1. General

An aquifer is described as any water-bearing stratum of rock or sediment capable of yielding supplies of water. The principal aquifer is the water saturated body of rock or sediments including both high permeability and low permeability (aquitard) materials in a given area which is the most important source of groundwater for that area. (The principal and secondary groundwater aquifers in the LBNRD are shown in Figure 13-4.)

A secondary aquifer may be any aquifer other than the principal aquifer and may be either the sole source of supply to wells in a given area or may be a secondary source in some areas underlain by the principal aquifer. Secondary aquifers in the LBNRD may be perched or separated from an underlying body of groundwater by an aquitard or may occur below the principal aquifer. A few wells in the LBNRD obtain water from both the principal and a secondary aquifer. In some areas (notably the buried bedrock valley, (ie; paleovalley) from Chester to east of Fairbury) the Dakota Sandstone Formation lies below and beside the principal aquifer.

2.6.2. Physical Characteristics

A series of exhibits have been prepared, many based on published maps and reports, to identify groundwater reservoir characteristics in the LBNRD. The reader should refer to these exhibits as a visual aid in reviewing the following text discussion. Figures referred to in this plan are included in Chapter 13.

A number of studies concerning the geology and groundwater resources in the LBNRD have been published. One of the earliest reports which addresses much of the western portion of the LBNRD was by Lugan and Wenzel in the 1930s (Reference 6). County preliminary groundwater maps were prepared by E.C. Reed, 1946-1948 (Reference 13). These preliminary sets of maps illustrate the geology by a series of cross sections, water-table contour and depth to water maps, and evaluations of groundwater potential.

A number of other reports have been published or are available in map format. They include studies in Clay County, 1959 (Reference 8); Blue River Basin, 1959 and 1960 (References. 9 and 12); and most recently by Link, 1995 (Reference 24). A series of maps prepared for the Nebraska Department of Environmental Control by the Conservation and Survey Division depict base and thickness of the principal aquifer and the configuration of the water table, spring 1979 (Reference 25 and Figures 13-6, 13-7 and 13-8).

Geology and groundwater-stream flow relationships of the Little Blue River Basin are discussed by Ellis (Reference 5). Detailed studies in Jefferson County were done by Veatch (References 29 and 30). Bedrock geologic maps encompassing the LBNRD area (References 27 and 28) by Dreeszen, Burchett and others also show thickness of the Quaternary deposits and locations where bedrock is exposed at or near the land surface. Figure 13-3 is a bedrock geologic map compiled from References 27 and 28 showing the distribution and stratigraphic sequence of the bedrock formations in the LBNRD. Except where the bedrock outcrops, the LBNRD is mantled with thick to thin deposits of Quaternary Age.

Bedrock of the Permian formations underlie the Cretaceous formations. The Permian limestone and shales are the oldest bedrock near the surface and occur as the first bedrock encountered in wells only in the lower reaches of the Little Blue River near Steele City. No wells are known to be producing water from the Permian in the LBNRD. Elsewhere to the east some wells with poor quality and small yields have been obtained from the Permian. Prior to the deposition of the rocks of Cretaceous age (the Dakota through the Pierre), uplift occurred and the Permian formations were tilted and eroded. Rocks of Permian age dip to the west-southwest at about 8 ft/mi and the Cretaceous formations dip to the west-northwest at about 6 ft/mi (Reference 5). Although minimal research has been done to determine faulting or the extent of faulting of the bedrock in the area, faulting almost surely has occurred. There is a suggestion that faulting has occurred in the Fairbury area as the paleovalley from Chester to Fairbury appears to be offset to the south on the east side of the Little Blue River near Fairbury. If this is the case, faulting has occurred in Quaternary time.

The Dakota sandstone consists of interbedded sandstone and shale and underlies the LBNRD except as noted above. The total thickness of the Dakota is from 0 to about 600 feet. The Dakota is a secondary aquifer in Jefferson County (Areas 1, 2 and 3 in Figure 13-4). The Dakota is a source of water to domestic and a few irrigation and municipal wells. A few wells may be obtaining water from both the Dakota and overlying Quaternary deposits. Brackish to highly saline water can be expected in the Dakota in the western portion of Area 1 and west of Fairbury in Area 2 (as shown in Figure 13-4). The salinity appears to increase with depth. Water quality in sandstones east of the Little Blue River generally is similar to that in the Quaternary deposits although total dissolved solids and iron is usually somewhat greater. Hydraulic conductivity of the fine to medium sandstones is relatively low ranging from less than one hundred to several hundred feet per day expressed in Meinzer units.

The combined thickness of the Cretaceous Greenhorn limestone and Graneros shale which overlie the Dakota and where not removed by erosion is about 100 feet. The lower part of the Graneros is a non-calcareous plastio shale. The upper portion is calcareous and has thin limestone layers. The Greenhorn for the most part is a limestone to shaley limestone. Neither of these two formations are known to be a source of water to wells in the LBNRD. However, it is possible that some domestic or stock wells have been developed from joints in the Greenhorn on the bedrock ridge in southern Thayer county.

The Carlile Shale formation is the first bedrock encountered in the subsurface in much of the central part of the LBNRD (Figure 13-3). The maximum thickness of the formation of medium to dark gray marine shale is about 250 to 300 feet. The lower portion of the Carlile is calcareous and may include a fine-grained siltstone to sandstone near its base. The Carlile is not an aquifer in the LBNRD.

The Niobrara formation is a white or yellow (where weathered) to light and medium gray chalky shale and chalk. The Niobrara immediately overlies the Carlile shale and, where not removed by erosion, is about 380 feet thick. The Niobrara is the bedrock over much of the western portion of the LBNRD (Figure 13-3) and it outcrops extensively in the Nelson and Oak area of Nuckolls County. The Niobrara is not generally an aquifer but, where weathered and jointed, crevices enlarged through water solution can be an important local secondary aquifer. The City of Nelson has wells in the Niobrara chalk north of the City. A few irrigation wells have also been completed in the Niobrara in Nuckolls County and it is a source of water for domestic and stock wells in Nuckolls and Webster Counties and over the bedrock ridge east of Clay Center in Clay County. For many years the water supply for the City of Nelson was taken from springs and shallow wells in the Niobrara in the upper reaches of Elk Creek west of the City. The water-bearing characteristics of the Niobrara are quite variable and no data is available on the hydrologic properties of the formation. Water quality generally is similar to that in the Quaternary deposits.

The Pierre shale is the youngest of the cretaceous rock and it is present overlying the Niobrara in the extreme western portion of the LBNRD. The non-calcareous medium to dark gray marine shales are not aquifer in the district.

The Ogallala Group (Miocene Age) of continental partly consolidated sands, silty sands, and sandy clay occur as buried knobs or ridges in parts of Adams, Webster and Nuckolls Counties (Figure 13-3). The Ogallala overlies the bedrock of Cretaceous age in these counties. The Ogallala is thin, ranging from zero to a few tens of feet in thickness. Although an important aquifer as part of the High Plains aquifer in areas north and west of the LBNRD, it is a secondary aquifer in the LBNRD. No irrigation wells are known to obtain water from the Ogallala in the LBNRD. Some stock and domestic wells have been constructed in the Ogallala in northern Webster County, extreme southeast Adams County and in northwest Nuckolls County. Much of the Ogallala is fine grained and the hydraulic conductivity and transmissivity are very low, transmissivity probably ranges from near 0 to less than a 5,000 gallons per day per foot.

Associated with the Ogallala is a unit of reddish brown clayey silt and siltstone in part of northeast Webster, southeast Adams and northwest Nuckolls Counties. The deposit, with a maximum thickness of about 100 feet, occurs as a bedrock valley fill. (Geologic cross section along Webster-Nuckolls County line, Reference 13) The deposit is a source of water to a few domestic wells and the Village of Lawrence apparently obtained some of its water from this unit. The volcanic ash may be a source of radon in wells in the area. Little is known about the hydrologic properties of this deposit. The hydraulic conductivity and transmissivity are very low.

2.6.3. Principal Aquifers

Figure 13-4 illustrates the areal distribution of the principal aquifer. Saturated thickness of the principal aquifer is illustrated in Figure 13-7, and the amount of groundwater in storage is shown in Figure 13-9. The depth to water, 0 to 50 feet in the valleys and 50 to 100 feet in the uplands, is illustrated in Figure 13-10. The depth to water is as much as 130 feet in the uplands overlying the paleovalley from Chester to Fairbury. The configuration of the water table is shown in Figure 13-8. The direction of groundwater flow is generally from west to east and toward the stream valleys. Figure 13-11, shows the location of registered irrigation wells and also serves to delineate the extent of the principal aquifer.

Hydraulic conductivity of an aquifer system is the capacity of a porous material to transmit water under a unit hydraulic gradient through a unit area of the system measured at right angles to the direction of flow usually expressed in feet per day. If the pore spaces in the formation are large and well connected, such as in sand and gravel, the hydraulic conductivity is large. Conversely, if the pore spaces are small and not well connected, such as in silt and clay, the hydraulic conductivity is small.

Transmissivity (T) is the rate at which water is transmitted through a unit width of the entire saturated thickness of an aquifer under a unit hydraulic gradient and can be expressed in gallons per day per foot (gpd/ft.). Transmissivity can be computed by multiplying the hydraulic conductivity by the saturated thickness of the aquifer system. For example, in some areas the hydraulic conductivity may be large, but because the saturated deposits are thin, the transmissivity will not be great and the aquifer may yield relatively small quantities of water to wells. Conversely, if the hydraulic conductivity is small but the saturated deposits are thick, the aquifer may yield relatively large quantities of water to wells.

Information from registered irrigation wells (locations shown in Figure 13-11) was used to develop the Transmissivity map (Figure 13-12) using the formula T = 2000 Q/S where Q is the reported pumping rate and S equals Specific Capacity, ie yield per foot of drawdown. Also used were the logs of test holes drilled by CSD-USGS. Hydraulic conductivity (permeability) values were assigned to each interval, multiplied by the footage for that interval and added to obtain a T value for each test hole.

The transmissivity map can be used to estimate the ability of the aquifer(s) to transmit water. It can also be used to estimate the potential yield of a well. The area with the highest transmissivity is in Adams County where T values of 150,000 to more than 200,000 gpd/ft. occur in a broad band through the center of the county. T values decrease eastwardly as the broad paleovalley also narrows through the center of the Clay County portion of the LBNRD. Values of T decrease to the south in Township 5 North in Adams, Clay and Fillmore counties where the range in values is from less than 20,000 to about 100,000 gpd/ft. Values of T decrease (as in northeast Nuckolls County) primarily because the aquifer thins.

Another area with high T values joins the broader paleovalley from the west. Values in the range of 150,000 to 200,000 gpd/ft. occur in a relatively narrow band trending north from the southeast corner of Thayer County past Deshler and then trending east through the Davenport area. The merged paleovalleys narrow to a width of about six or seven miles north of Alexandria where they exit the LBNRD. The T values are low in the Bruning area where the aquifer thins over a bedrock ridge of Carlile and Greenhorn - Graneros. Bedrock is also high in the subsurface in the Ohiowa area, although a narrow relatively deep paleovalley occurs southwest of Ohiowa that is filled with silt and clay (Reference 10).

The areas described above with T values of above 20,000 gpd/ft. constitute a large groundwater reservoir made up of deposits of sand, gravel, silt and clay that were for the most part deposited by streams filling old valleys cut into the bedrock. Several episodes of cutting and filling occurred during the late Pliocene to mid-Pleistocene time.
A distinctly separate aquifer or "groundwater reservoir" is present from the Byron-Chester area through southern Thayer and Jefferson counties to the Little Blue River west of Fairbury. The Little Blue River has cut through the aquifer and separates the paleovalley into western and eastern segments. The alluvial fill in the Little Blue River Valley is thin, groundwater potential is low, and the valley alluvium constitutes a secondary aquifer. Values of T range from less than 20,000 up to 100,000 to 150,000 gpd/ft. through the western segment of the paleovalley and from 20,000 to more than 50,000 gpd/ft. in the eastern segment.

The areas of lowest transmissivity shown on Figure 13-12 are generally those where the principal aquifer is absent or thin. Generally large capacity wells of 100 gpm or more cannot be obtained in these areas with the exception of bedrock wells in the Niobrara or Dakota as discussed previously. Domestic wells are also difficult to obtain over much of these areas either because no aquifer is present or because of mineralized poor quality water. Rural water districts serve some of the area where these conditions prevail (Figure 13-13). Sand or sand and gravel does occur in some of the low T value areas as remnant pockets or as the fill of tributaries to the major paleovalleys.

In general there does appear to be a hydrogeologic influence on the occurrence of high values of nitrate-N found in domestic and irrigation wells (as discussed in Chapter 3). Nitrate-N is commonly high in the Nora, Ruskin, Hardy, and Bryon to Deshler area and in the Ohiowa area where both non-point and point source of contamination is suspected and where transmissivity values are generally low. Nitrate-N values are also relatively high in the Bruning area where non-point source is suspected. However, nitrate-N values are generally low in Webster County, in the Nelson to Lawrence area in Nuckolls County, and south of Rose Creek in Jefferson County. Nitrate-N values are also relatively high (Figure 13-16) in the Platte River Valley portion of Adams County where the depth to water is relatively shallow. Conversely some of the lowest values of nitrate-N occur in Adams County where the T values are the greatest. The apparent difference in part may be dilution in the areas where T values are greatest and the groundwater reservoir the most extensive.

2.7. Potentiometric Surface

2.7.1. Unconfined Conditions

Figure 13-8 is a map showing the configuration of the water table in the Spring of 1979. The water table in previous years is shown in published reports referred to previously. The water table contour map is generalized and shows only 100 foot intervals. Detailed water table contour maps (References 31 and 32) for Adams County have been prepared representing pre-development (about 1950) conditions and conditions during the Fall of 1981. Contour intervals on these maps are at 10 foot intervals. Maps showing pre-development conditions for the whole LBNRD should be prepared as a basis for evaluating changes in water levels over time. Long range plans of the LBNRD contemplate programs to accomplish this task.

Available data suggests that the Spring 1979 water table (Figure 13-8) approximates current conditions. The change that has occurred in water levels from pre-development to 1992 is shown in Figure 13-14. Groundwater storage in the areas with less than five feet of decline is considered to be unaffected by groundwater withdrawal. Declines of about 5 to 20 feet have occurred in most of the area north of the Little Blue River and in the western part of the southern paleovalley (Chester area). Declines of 20 feet to isolated spots of up to 30 feet have occurred in the eastern Clay County and Fillmore portion of the LBNRD. Noteworthy is the absence of significant declines in most of Adams County. An exception is the area southeast of Hastings where declines of 15 to 20 feet or more have occurred. The amount of groundwater that has been taken from storage has been calculated to be about 1.5 million acre-feet. This figure was derived by determining acres in each area of more than five feet decline, using the mean value of decline in feet of each area and assuming a specific yield of 20 percent.

Specific yield is the ratio of the amount of water a unit volume of saturated material will yield, by gravity, divided by that volume. Specific yield was estimated by Pettijohn and Chen (Reference 33) for the High Plains Aquifer system in Nebraska, including the Little Blue NRD. They assign values ranging from about 20 to 30 percent for much of the coarser grained portion of the aquifer north of the Little Blue River. Specific yield of the sand and gravel in the aquifers probably is close to its porosity. On this basis, specific capacity of the aquifers is estimated to be about 20 percent.

Testimony by the NRD staff and Board Members and by Dr. David Gosselin of UNL's Conservation and Survey Division at the Control Area Dissolution Hearings in December 1993 indicated that the groundwater level in the Control Area had reached somewhat of an equilibrium (Reference 44). Evidence presented showed that, after reaching a low point in the late 1970's or early 1980's, groundwater levels in the area increased slightly over three or four years and then displayed a leveling trend over the next 10 to 12 years (see Reference 44 and Exhibits for details of this evidence and transcribed testimony). According to the testimony given, this "equilibrium condition" has come about due to one or more of the following reasons: (1) Much of the irrigatable land in the area had been developed by the mid-1980's and the rate of developing new irrigated land has decreased markedly; (2) As a result of the Control Area programs, irrigators have become more educated with regards to water conservation and have put water conservation measures into practice (either voluntarily or involuntarily); (3) Irrigators are using more efficient irrigation methods and/or equipment; (4) Irrigators have reduced the overall amount of irrigated corn (a big water-consuming crop) they are raising, replacing it with less water - demanding crops, and (5) After dry years in the 1970's, precipitation and climate in the area have returned to more "normal" levels overall. Whatever the reasons, the evidence that a groundwater level equilibrium has been reached played a big part in DWR Director Michael Jess's decision to dissolve the Control Area.

Except, perhaps for very localized conditions, groundwater in the LBNRD is unconfined. That is, the water table is considered to be the upper surface of the first saturated rocks encountered below the land surface. Locally, stratification of fine and coarse grained sediments (low and high permeability) may permit slightly different water levels in wells screened at different depths.

2.7.2. Confined Conditions

Groundwater generally has been known or suspected to occur under confined conditions in most bedrock aquifers, including the Dakota and the Niobrara Formations in the LBNRD. The Dakota is almost surely confined in the area west of the Little Blue River. However, because of the poor water quality, few wells have been completed and little is known about the potentiometric surface. Wells in the Dakota east of the Little Blue River are also few in number and little data is available with respect to potentiometric surface or storage coefficient. Water levels in the Dakota wells and that in the principal aquifer appear to be about the same suggesting that the Dakota is essentially unconfined there.

Also, little is known about the potentiometric surface in the wells constructed in the Niobrara Formation. The Niobrara, in wells that supply water for the City of Nelson, is overlain by a thick section of silt and clay, so by definition water in these wells, which rises above the permeable aquifer, is confined.

2.8. External Groundwater Recharge Sources

2.8.1. Natural Recharge Sources

All areas in the LBNRD are considered to be natural areas supporting recharge. The exception to this would be the very steep slopes along the river valleys but even here runoff contributes to recharge of the valley lands.

Natural recharge does not occur uniformly even on like fields nor does it occur at the same rate or in the same amounts seasonally or annually. Based on lack of evidence to the contrary, some moisture is believed to be moving constantly but at varying rates through the unsaturated zone from the land surface to the saturated zone. Likewise, groundwater is moving constantly to discharge, either to evapotranspiration (ET) or as baseflow to the streams.

Prior to settlement, a balance between recharge to the aquifer and discharge from it was established. Both input and output varied, dependent upon climatic conditions. Fluctuations of the water table by as much as five feet or more probably occurred between drought and wet periods. Much of these same conditions prevail today. The obvious difference is that irrigation has become a practice, first from the streams and later (in the past 45 years or so) from the groundwater reservoir. The consequence has been that stream flow has been reduced by diversion and groundwater has been taken from storage.

2.8.1.1. Precipitation

One source of natural recharge is precipitation that falls on the land. Runoff from the land is concentrated in the dry creek sand, their tributaries and enhances recharge there. Quantification of recharge is difficult and estimates are usually based on certain assumptions including average annual precipitation, land slopes, soils, transmissivity and configuration of the water table.

Natural recharge from precipitation has been discussed and estimated in a number of reports including References 6, 8, 9, 10, 11, 12, and 38. Estimated natural recharge values range from about 1.5 to 2 inches per year. The history of groundwater development in the LBNRD and the resulting decline and apparent stabilization of water levels in recent years suggests that natural recharge may have been underestimated.

Average annual precipitation (Figure 13-2) ranges from about 25 inches at the western boundary of the LBNRD to about 31 inches at the eastern boundary. The average annual precipitation in the LBNRD is about 3,726,000 acre-feet (Table 1, Reference 34). Of that amount, about 410,000 acre-feet or 11 percent are discharged by streams from the district. The remainder of the average annual precipitation, about 89 percent, is either transpired by plants or evaporated. Evaporation from free water surfaces of about 31,000 acre-feet has been accounted for in the stream discharge and if that amount is taken into consideration about 90 percent of the precipitation goes to ET.

The calculations in the previous paragraph are based upon imprecise data. The area of the Little Blue River is not coincident with the district boundaries. Drainage in Kearney County was not taken into consideration, nor was the small area of Adams County drained by the Platte River. Data concerning use of water diverted from the stream are estimates as is information about evaporation from free water sources. Also not considered is groundwater inflow or outflow. The flow of the Little Blue River is reported at the gaging station 1-1/2 miles south of the state line at Hollenburg, Kansas.

Table 2 in Reference 38 is a table of estimated percentage of average recharge from precipitation within topographic regions. The natural recharge estimated for plains areas is 10-15 percent. (Note: percentages for plains and dissected plains were inadvertently transposed) (Reference 41). Most of the area north of the Little Blue River is in the plains region (Figure 2, Reference 40). Most of the remainder of the LBNRD area is in the dissected plains region. Based upon hydrologic characteristics and change or lack of change as discussed previously in this section, the percentage of estimated natural recharge for both the plains and dissected plains is probably low. If the higher figure of 15 percent is used, recharge in the western 25-to-26 inch annual precipitation belt would be about 3.8 inches. Recharge rates would be about 4.2 inches in the center of the LBNRD and about 4.5 inches in the eastern portion of the NRD. Recharge in the dissected plains perhaps is slightly less.

2.8.1.2. Streams

Very little research has been done in this area to quantify the surface/groundwater interaction. Bentall (Reference 35, Plate 18) calculates the average annual discharge of the Little Blue River at the Fairbury gage to be 381 cfs or about 276,600 acre-feet. Not included in this figure are stream diversions, evaporation or outflow from ungauged stream. Bentall also (Reference 35, p. 13) states with respect to water pumped for irrigation in the Blue River basins, "that pumping has not had an appreciable effect on riverflow. However, direct pumping from the rivers sometimes depletes flow so that administration of water rights is necessary."

With regard to administration of water rights, the State of Nebraska has agreed to regulate the diversion of natural flows in streams of the Little Blue River basin and the withdrawal of groundwater after November 1, 1968 (Reference 36) in order to maintain an agreed upon schedule of flows in the Little Blue River. The area where irrigation wells can be regulated is that area where wells obtain water from "alluvium and valley side terraces within one mile from the thread of the river between the mouth of Walnut Creek (now changed to Little Sandy Creek about six miles upstream from Fairbury) and the Kansas-Nebraska state line on the Little Blue River." Junior appropriators of natural flow have been regulated only one time (1990) since the compact was ratified and irrigation from the nine irrigation wells (one well is a cluster of six small yielding wells) has not been regulated to date (Reference 37).

2.8.2. Recharge from Other Sources

2.8.2.1. Irrigation Return Flows

Return flows from irrigation constitute a significant part of the hydrologic cycle. Return flow is inescapable under any conceivable plan of management. Management practices which are most flexible in providing water to supplement precipitation and plant needs can be expected to reduce return flow to the groundwater reservoir. A conservative estimate of return flow from irrigation, assuming average annual application of 12 inches, is in the range of two to four inches.

2.8.2.2. Groundwater Underflow

The amount of groundwater moving into the LBNRD as underflow and that leaving the district either as underflow or discharge to streams and ET can be considered a constant. There is no reason to believe that those conditions will change in the foreseeable future.

A comparison of previously published water table contour maps (References 6, Plate 5, 31, and 40) and Figure 13-8 indicate that the configuration of the water table has been little changed since the early 1930s and 1950s in most of western, central and southern Adams County. The water level decline map (Figure 13-14) substantiates that assumption as declines over much of this area of Adams County is in the zero to five or five to ten feet of decline range of values.

A major factor responsible for the smaller level of declines in Adams County compared to similar irrigated areas in the LBNRD is underflow from the Platte River. The underflow is direct in northeast Adams County (Kenesaw-Prosser area) and indirect to the south. The diversion and application of water by the Central Nebraska Public Power and Irrigation District has resulted in a rise in water levels of as much as 10 feet near Minden (about 12 miles west of the Adams-Kearney line) (Reference 26). Johnson, as early as the 1950's (Reference 9, pp 22-24), noted that water levels were rising in the area as the result of surface water diversion and application of the water.

2.9. Current Status of Groundwater Discharge/Recharge Balance

Apparently a new balance, or a new equilibrium, has been established between recharge and discharge since the mid 1980s (compare maps of significant rises and declines (References 26 and 42)). It is reasonable to assume that management practices, whereby less water is being withdrawn from wells for irrigation in recent years, have contributed to this new equilibrium.

Several factors have contributed to the widespread acceptance of best management practices by most irrigators in the LBNRD. The educational efforts of the LBNRD Board of Directors and others has been a factor. Another factor has been the installation of meters; about 1,700 wells are now metered in the LBNRD. Another important factor is that farmer-irrigators have become aware that poor water quality, particularly nitrate-N contamination, can be exacerbated by the improper timing of the application of fertilizer and water and by excessive application of one or the other or both. And finally, economics has played a key role in motivating producers to adopt practices with proven financial benefits.

3.0 Water Quality Inventory

3.10. Nitrate Contamination

3.10.1. Prior to 1985

Prior to the establishment of a nitrate sampling program by the LBNRD in 1985, only a limited amount of groundwater sampling for nitrate contamination was accomplished and reported. Results of sampling from a few wells from which water was analyzed for nitrate concentrations are reported in USGS Water Supply Papers 1839-L (Fillmore County) (Reference 10), 1468 (Clay County) (Reference 8), and 1474 (Geology and Groundwater Resources of the Big Blue River Basin above Crete, Nebraska) (Reference 12). Nitrates were reported as NO_3 in the water supply papers and have been converted to nitrate-nitrogen here by dividing the reported NO_3 values by 4.428. Concentrations may be recorded in either milligrams per liter (mg/l) or in parts per million (ppm), which are essentially equivalent units.

Nitrate concentrations from five wells in the Fillmore County portion of the LBNRD are reported based on water samples collected in August 1955. These wells were used for either public or private domestic supply. Twelve wells were sampled in Clay County in the summer of 1954. Five of these wells were used for public or private domestic supply and seven were irrigation wells. Four wells, two each in Clay and Adams counties, were sampled in 1953, but the type of well was not reported. Of the twenty-one wells sampled in the mid-1950s, thirteen had nitrate-nitrogen concentrations of zero to less than one ppm, five had concentrations of one to three ppm, and three had concentrations of 3.1 to 3.4 ppm. The results are also summarized in Table 3.1.1-1.

TABLE 3.1.1-1

Nitrate Sampling 1953-1955 USGS-CSD

In Adams, Clay and Fillmore Counties

No. of Wells	Nitrate-Nitrogen Concentration in ppm
13	0-1
5	1-3
3	3-3.4

The data, although limited, suggests that nitrate-nitrogen concentrations were generally less than 3 ppm in the three counties prior to 1955.

This conclusion is supported by reports of nitrate concentrations in public water supply wells by the Nebraska Department of Health (Reference 20). Nitrate analyses for 26 communities in the LBNRD were reported for April 1967 and September 1970 (see Table 3.1.1-2). The LBNRD has also gathered nitrate analysis data from the communities and have incorporated it in Table 3.1.1-2. Information from 4 communities (Davenport, Juniata, Kenesaw and Roseland) was not shown in DOH reports. In 1967, 9 wells had concentrations less than 1 ppm, 12 wells had concentrations ranging from 1-3 ppm, 2 wells had 5-10 ppm, and 1 had concentrations greater than 10 ppm. The results were similar for 1970 with 12 wells having concentrations less than 1 ppm, 10 with concentrations in the range of 1-3 ppm, 2 in the range of 5-10 ppm, and 1 at 10 ppm. Twenty-one of the 26 wells sampled in 1967 had nitrate-nitrogen concentrations less than 3 ppm and again, in 1970, twenty-one of 26 sampled wells showed nitrate-nitrogen concentrations less than 3 ppm.

These data suggest that concentrations of less than 3 ppm nitrate-nitrogen in groundwater in the LBNRD is the norm. Concentrations above 3 ppm show evidence, by degree, of either point source or nonpoint source contamination.

TABLE 3.1.1-2
NITRATE - NITROGEN IN
PUBLIC DRINKING WATER SUPPLIES
(Nebraska Department of Health Data)
(Little Blue NRD Supplemental Data)
(mg/l)

Town	1967	1970	1988-90	1992-1994
Alexandria	1.2	0.2		
Belvidere	0	0		1.2
Bladen	0	0	5.2-5.6	
Blue Hill	1.2	3.0	2.2	4.6-3.0
Bruning	1.6	2.7	12.0-9.3	8.4-7.7
Byron	4.6	1.6	6.7-6.8	6.2-6.5
Carleton	1.8	2.0		2.1-0.4
Chester	0.6	0.9	3.4	5.6-7.1
Clay Center	0.9	0.0		3.0-3.1
Davenport			1.2-1.0	1.0
Deshler	2.5	4.9	5.5-6.2	6.6-7.3
Deweese	--	--		
Edgar	5.2	0.6	10.3-10.3	7.2-7.3
Endicott	--	--	0.1	0.6-2.0
Fairbury	1.2	2.7	5.9-6.7	8.1-8.2
Fairfield	1.7	0.0		2.0-2.0
Glenvil	0.6	0.7		1.8-1.9
Hardy	12.0	6.5	6.3-12.9	6.5-11.8
Hastings	3.2	1.73	4.0	4.83
Hebron	2.0	2.8	4.9-5.8	3.5-4.6
Hubbell	2.5	1.2		3.4-3.7
Juniata			2.8	2.2
Kenesaw			2.2-2.3	2.6-3.1
Lawrence	0.0	0.0	0.8-1.1	1.7-0.5
Nelson	1.0	0.6	1.5-1.8	1.9-1.8
Ohiowa	0.0	1.2		
Ong	2.3	3.1	5.0-5.0	5.5-5.2
Reynolds	2.3	2.0	6.3-6.3	6.0-6.3
Roseland				6.2-6.0
Ruskin	0.1	0.0	4.7	7.7-5.5
Shickley	2.1	0.0	1.0-1.5	1.6-1.7
Steele City	7.1	10.0	6.6-8.6	6.1-7.1

3.10.2. After 1985

3.10.2.1. Nebraska Department of Health Study

Spalding and Engbert, 1978 (Reference 15, Plate 16) show the location of approximately 48 wells in the LBNRD where samples had been collected and analyzed for nitrate-nitrogen. The data was collected over a period of years by the USGS-CSD and were reported in US Geological Survey annual publication series. Concentration of nitrates are not reported in these publications but the file data, and other data collected during 1985-1989 by the Nebraska Department of Health (DOH), are the source for the determination of the distribution of nitrate-nitrogen above 7.4 ppm in Nebraska by Exner and Spalding, 1990 (Reference 14, Figure 13). The Center for Disease Control (CDC) supported the DOH study.

The area with the greatest number of wells showing high concentrations of nitrate-nitrogen was the non-irrigated portion of Nuckolls County south of the Little Blue River. Elsewhere in the LBNRD there were fewer than 20 domestic, irrigation or public water supply wells with concentrations above 7.4 ppm. The type of well by use and the location of wells are shown in Figure 11 of Reference 14. Sample collection, method of analysis, and assessment of results are discussed on pages 22-30 of Reference 14.

Figure 13-15 is a map of the DOH-CDC study showing the location and range of concentrations of nitrate-nitrogen by symbol. About 120 wells (all were used for domestic supply) were sampled in the counties or portions of counties comprising the LBNRD. Fifteen of the wells, or approximately 13 percent, had concentrations greater than 10 ppm and about half of these wells were in non-irrigated areas of the NRD. Another 8 wells had concentrations in the range from 5.0 to 7.5 ppm.

3.10.2.2. DEQ Special Protection Area Study

The Nebraska Department of Environmental Quality (DEQ) studied the eastern portion of the LBNRD in the early 1990's for possible designation as a Special Protection Area (SPA). The study area included all of Thayer County, the Fillmore and Jefferson County portions of the NRD, the southeast quarter of Clay and the northeast quarter of Nuckolls counties. The study, initiated in 1992, was requested by the LBNRD on October 4, 1991 (Reference 24). There are about 3,100 registered irrigation wells in the 1,336 square mile area.

The original intent of the SPA study was to sample approximately 300 irrigation wells (including some municipal wells) in the summer of 1992. Because irrigation wells were little used in 1992, only 31 wells were sampled. The investigation was continued in 1993 and again, because of frequent rains, only an additional 68 wells were sampled. The DEQ issued two interim reports in January 1993 and March 1994 (References 22 and 23) providing location of wells, well use and results of sample analyses.

The primary objective of the study was to determine whether nonpoint source contamination of groundwater, as indicated by elevated concentrations of nitrate-nitrogen, is occurring. All samples were analyzed for NO_3N plus NO_2N, chloride, sulfate, bicarbonate, sodium, magnesium, calcium, and potassium. Of the samples collected through 1993, seven were also analyzed for the occurrence of pesticides. A total of 98 analyses (some wells were sampled twice) were included in the DEQ interim reports. Fifty-three of the wells (about 54 percent of those sampled) had nitrate-nitrogen values below 5 ppm with a few below 0.5 ppm. Twenty-five wells, or about 26 percent, had values in the range of 5 to 7.5 ppm. Eleven wells, or 11 percent, had values ranging from 7.5 to 10 ppm and nine wells, or almost 9 percent, had values above 10 ppm. The highest value reported which was considered to be representative of actual conditions was 12.8 ppm, although one anomalously high value of 92.9 ppm was reported.

Sampling was resumed in the summer of 1994. The field portion of the study was completed with the sampling of 284 wells. Four of these wells were for public supply, one was a domestic well and the rest were irrigation wells. The final report (Reference 24) was issued April 1995.

DEQ recommended that an SPA be designated to encompass the entire 1336 square mile study area (eastern part of the district). The bases for their recommendations were as follows:

1. Conditions in the eastern part of the LBNRD are similar to those in the adjacent Upper Big Blue NRD which was designated an SPA in September 1993.

2. Where groundwater is available, irrigation is commonly practiced (over 3000 registered wells in study area).

3. Corn is a major irrigated crop.

4. Use of commercial fertilizer and pesticides is widespread.

5. Areas with elevated nitrate-N concentrations in groundwater suggest that nonpoint source contamination is occurring or is likely to occur in the foreseeable future.

The area in the western portion of the LBNRD is not mentioned in the report nor was a study conducted there. That area, also adjacent in part to the Upper Big Blue NRD SPA, has many characteristics similar to those in the eastern portion of the LBNRD.

DEQ noted that the LBNRD Board of Directors had recently voted to place the entire district in a Groundwater Quality Management Area (GWQMA) and will be including that intent in the district's Groundwater Management Plan. DEQ also noted that protection of groundwater through good management practices can be accomplished either through SPAs or GWQMAs and that a GWQMA may be an option to a SPA in this area.

A hearing was held by DEQ at Davenport on June 13, 1995, to present results of the study (including DEQ's recommendation that an SPA be designated) and to hear testimony regarding that recommendation. Testimony on behalf of the LBNRD Board of Directors was presented by Harold Fleharty, Vice Chairman of the Board (copy in Appendix 12-4 of this plan). The position of the LBNRD was that an SPA not be designated and that the district was prepared to address problems of nonpoint source contamination through a GWQMA as contained in the LBNRD Groundwater Management Plan.

The investigation done by DEQ clearly indicates that nitrate-N concentration levels in many wells are higher than what is considered background levels. Although point source contamination was considered to be a factor in some wells with high concentrations of nitrate-N (due to poor well siting or casing conditions), the preponderance of evidence does suggest that nonpoint contamination of nitrate-N has occurred or is occurring.

The sampling of wells by DEQ over a period of three years (most wells sampled in 1994) in effect constitutes a point-in-time record of nitrate-N concentrations in individual wells. Trends cannot be determined from these data alone nor is it clear that sampling of relatively widely-spaced wells allows for interpretation of nitrate-N concentrations in the aquifer. In a given area of several square miles the concentrations of nitrate-N in nearby wells can range from below background levels to relatively high concentrations of 7 to more than 10 ppm (see map p. 44, Reference 24).

A number of graphs showing nitrate-N concentrations over time for public supply wells in the study area is given in Appendix "D" of Reference 24. No clearly established trends are discernable since the early to mid-1980s. (See also Table 3.1.1-2 and discussion of trends in this Plan).

DEQ found the mean value for the 284 wells sampled in 1994 to be 5.65 mg/l nitrate-N and that almost half of the wells (48 percent) had less than 5 mg/l. Seventy percent (199 wells) had concentrations of less than 7 mg/l and 88 percent (249 wells) had less than 10 mg/l. Almost 30 percent (84) of the wells had nitrate-N concentrations of more than 7 mg/l.

DEQ identified six subareas (Figure 13, Reference 24) based mainly on geology. Two of the subareas have average nitrate levels "considerably higher than the other areas". The mean nitrate-N level for the 19 wells sampled in the Byron-Deshler area (subarea "A") was 7.58 mg/l. The other subarea with apparent higher than average levels of nitrate (8.02 mg/l) is the Bruning area (subarea "B"). Subarea "C" (Chester-Fairbury) has an average value of 5.53 mg/l, "D" (Nuckolls County south of the Little Blue River) has 4.45 mg/l, "E" (Big Sandy-Little Blue) has 5.61 mg/l and, "F" (north of Big Sandy) has 5.02 mg/l average nitrate concentration levels.

In the report, DEQ attributed the higher values of nitrate-N in the Byron-Deshler and Bruning areas to these being limited aquifer areas and/or to the absence of retarding silt or clay layers in the unsaturated zone. Other factors, including management practices, may account for the apparent higher levels of nitrogen in the two subareas.

3.10.2.3. U.S. Geological Survey Study

The U.S. Geological Survey, as part of a regional survey (References 1 and 2), sampled four wells in the LBNRD in 1991. Water samples were analyzed in the field and laboratory for specific conductance, pH, dissolved oxygen, dissolved nitrite, dissolved nitrite plus nitrate, dissolved ammonium and dissolved phosphorous. Samples were also analyzed for nine pesticides. Well depth, screened interval and aquifer characteristics and land use were noted. Wells were sampled twice, in March and in July. Location of the wells and results of analyses for dissolved nitrites, nitrates and ammonium in ppm as N follows.

Location	County	Ammonium	Nitrite	Nitrite plus Nitrate	Date
7N-11W-12AB	Adams	<.01	<.01	2.2	3/20/91
		<.01	<.01	2.7	7/24/91
2N-3E-18DO	Jefferson	.03	<.01	8.5	3/19/91
		.02	.02	9.2	7/17/91
3N-1W-11AA	Thayer	<.01	<.01	2.0	3/19/91
		.03	.02	2.2	7/18/91
3N-2W-4CB	Thayer	.02	<.01	0.98	3/19/91
		<.01	<.01	1.1	7/25/91

A slight increase in dissolved nitrate and nitrate as N from March to July was found.

3.10.2.4. LBNRD Sampling Program

Perhaps the most comprehensive and most meaningful information collected to date with respect to nitrate-nitrogen contamination in the LBNRD is that collected by the district. Few samples from domestic and irrigation wells were analyzed by the district prior to 1985. The most recent analysis for each of the approximately 1,200 wells sampled are shown on a map in Section 13 of this plan (Figure 13-16). Wells are not identified as to use of the water. Symbols are used to show concentration of nitrates in the ranges of 0 to 5 mg/l; 5 to 7.5 mg/l; 7.5 to 10 mg/l; and over 10 mg/l. Areas on the map are delineated to differentiate lands that are generally irrigated from the areas with limited or no irrigation.

An examination of Figure 13-16 strongly suggests that the major cause of nitrate contamination at levels more than 10 mg/l is from point sources. Although nitrates at that level occur throughout the NRD, the largest number are in the non-irrigated areas of Webster, Nuckolls, southeastern Fillmore, and parts of Jefferson and Thayer counties. These areas, including the one providing the supply through the rural water district(s) (Figure 13-13), generally are underlain by a limited aquifer. Wells are often relatively shallow. Contamination from animal or human waste or from the soil can move down to the water-saturated zone, particularly around wells that are poorly constructed or improperly sited in low spots or with proximity to a point source of contamination. Since these conditions have existed since settlement, it is reasonable to assume that many domestic wells now yielding water with elevated levels of nitrates have been contaminated at those levels for decades. One can also assume that some of the domestic, and perhaps irrigation and public supply wells elsewhere in the district, may also be contaminated from nonpoint sources. Determination of nonpoint versus point source contamination of a single well or of a given area can often require considerable effort.

Most of the research and investigation done in the LBNRD and elsewhere in the state with respect to nitrate-N concentrations in groundwater suggest that natural occurring levels were probably in the range of less than one to perhaps as much as three ppm. Any values above three ppm generally are considered to indicate point or nonpoint contamination. However, little is known about the levels of nitrogen in the unsaturated zone or of its distribution or disposition over time. Shallow and deep soil coring has been done in a variety of settings including fertilized and non-fertilized fields. All results seem to show that nitrate-N occurs at all levels but with different concentrations throughout the unsaturated zone even under non-fertilized grasslands.

The inescapable conclusion is that a natural balance of nitrogen exists in the unsaturated zone. Nitrates are cycled from origin through the unsaturated zone to groundwater and then to discharge from the aquifer. Nitrogen is being added at the upper soil level through addition from precipitation, conversion of organic and inorganic nitrogen by microorganisms, etc. Some will be used by plants, denitrification may occur at and below root level, and some will move to groundwater. Under natural conditions a balance between the amount of nitrates added annually and that escaping through groundwater appears to take place. That amount either in transient storage or reaching the saturated zone probably varies seasonally and over a period of time.

Some researchers have suggested that the application of irrigation water may have speeded up the natural cycle resulting in the leaching of naturally occurring nitrates to groundwater. Although there is no research to support the theory, it is possible that small capacity domestic wells in silts and clays may act as collectors of nitrates in capturing naturally occurring nitrates. This would probably account for only a small portion of the commonly found high levels of nitrates in domestic wells in parts of Nuckolls, Webster, southeast Fillmore counties and elsewhere in the district.

Support for the idea of natural occurring nitrate-N in the deep soil profile can be seen from data obtained by the LBNRD (Table 3.1.2.4-1). Ten core holes ranging in depth from 14 to 25 feet were drilled in the Hardy area, Township 1N, Range 5W, Nuckolls county in May 1990. None of the land was irrigated but wheat, milo, corn or alfalfa was fertilized in several of the fields and three of the core holes were drilled in dry-land pasture that the owner indicated had never been fertilized. A comparison of the nitrate-N between the fertilized and non-irrigated cropland and the pasture land suggests that even under fertilized dry cropland nitrates will accumulate in the soil profile. Of note is the amount of nitrates in the soil profile of the core hole in the SW1/4 - S34-1N-5W. Fertilizer had been applied to corn prior to 1984. The cropland was then converted to alfalfa and no fertilizer had been applied since. Although nitrates were distributed differently, the total amount of nitrates in this field were somewhat similar to those found in the three cores in the pasture land, all in the NW1/4 - S20-1N-5W. Nitrates in these four core holes were significantly less than the amount found in the fertilized cropland fields.

There is no simple or easy explanation for the rather widely ranging values and distribution of nitrates in the three core holes in SE 1/4 - S22-1N-5W (fertilized dry cropland) or in the three core holes in pastureland in NW1/4 - S20-1N-5W. The soils and the topography appear to be relatively uniform at the two sites.

TABLE 3.1.2.4-1

LITTLE BLUE NATURAL RESOURCES DISTRICT
MAY 1990 - HARDY AREA
NITRATE (NO3-N) DISTRIBUTION BY SOIL DEPTH

	SE/4 E 22-1-5		SE/4 M 22-1-5		SE/4 W 22-1-5		SE/4 M 36-1-5		SE/4 I 36-1-5		SE/4 O 36-1-5		SW/4 34-1-5		NW/4 8 20-1-5		NW/4 9 20-1-5		NW/4 10 20-1-5	
Crop	Dry Milo/ Wheat Rota		Dry Milo/ Wheat Rota.		Dry Milo/ Wheat Rota		Irrig. Corn		Irrig. Corn		Irrig. Corn		Corn to '84 Alf. '84-'90		Dry Pasture		Dry Pasture		Dry Pasture	
Fertil. Applied	100#/Ac.		100#/Ac.		100#/Ac.		(140-200+ Fertigation of 30-40#)						150#/Ac. None Since 1984		0		0		0	
Depth ft	ppm	lb/A	ppm	lb/A	ppm	lb/A	ppm	lb/A	ppm	lb/A	ppm	lb/A	ppm	lb/A	ppm	lb/A	ppm	lb/A	ppm	lb/A
0-.5	11	20	10	18	10	18	9	16	6	11	5	9	11	20	4	7	3	5	6	11
.5-1	10	18	13	23	10	18	3	5	4	7	3	5	8	14	2	4	2	4	2	4
1-2	3	11	4	14	8	29	2	7	3	11	1	4	2	7	2	7	2	7	3	11
2-3	2	7	2	7	3	11	1	4	4	14	1	4	2	7	2	7	2	7	3	11
3-4	2	7	2	7	1	4	1	4	7	25	2	7	2	7	1	4	2	7	2	7
4-5	2	7	2	7	1	4	2	7	6	22	4	14	1	4	1	4	1	4	1	4
5-6	2	7	3	11	1	4	2	7	4	14	4	14	1	4	1	4	1	4	1	4
6-7	2	7	2	7	1	4	3	11	2	7	4	14	1	4	1	4	3	11	2	7
7-8	2	7	3	11	2	7	3	11	3	11	4	14	1	4	1	4	4	14	2	7
8-9	3	11	3	11	2	7	3	11	2	7	5	18	1	4	1	4	4	14	2	7
9-10	3	11	3	11	3	11	3	11	2	7	6	22	1	4	1	4	3	11	3	11
10-12	5	36	3	22	3	22	3	22	2	14	7	50	1	7	1	7	1	7	5	36
12-14	7	50	4	29	2	14	3	22	2	14	5	36	1	7	1	7	1	4	4	29
14-15											5	18								
15-16	6	43	3	22	2	14	3	22	2	14	6	22	1	7	1	7			2	14
16-18	7	50	3	22	1	7	2	14	2	14	4	29	1	7	1	7				
18-20	9	65	3	22	1	7	2	14	3	22	3	16	2	12	1	7				
20-22	9	65			5	36	6	32	4	29					1	7				
22-23					1	4														
23-24									4	29					1	7				
24-25															1	4				
Total Residue In Profile		422		244		221		220		272		296		119		106		99		163

The extent and degree of nonpoint contamination is not easily determinable even given the quite extensive data base developed by the LBNRD and other agencies. The SPA study by DEQ has provided additional insight. Evidence obtained to date strongly indicates that nonpoint contamination due to use or overuse of chemical fertilizer and perhaps over application of irrigation water has occurred. Based upon the sampling of public water supplies done in the mid-1950's and that done by the DOH, it appears that nonpoint contamination (more than 3 mg/l) was not common in the LBNRD before 1970. One exception to this general observation perhaps is the Superior - Hardy area in Nuckolls County that was designated as an SPA in February 1990. The area encompassed is irrigated from surface and groundwater sources. The depth to water is relatively shallow and the thickness of saturated aquifer is relatively thin. The results of monitoring the 20 wells installed for that purpose has been summarized for 1991-1993 by DEQ in Appendix A of Reference 21.

As previously noted, the LBNRD has been sampling wells to determine concentrations of nitrate-nitrogen in water well samples since 1985. Water from approximately 1,200 wells has been collected by staff or by landowners and analyzed by the staff. Landowners, interested in the level of nitrates in their water supply, collected and submitted samples in bottles furnished by the NRD. Samples are reacted with pre-measured reagents and the color produced is measured in a spectrophotometer. Exner and Spalding, 1990 (Reference 14, p22) commented as follows about the use of the type of testing equipment used by the LBNRD: "While this test method cannot be substituted for an acceptable laboratory method, the small variability in duplicate split samples sent to certified laboratories, comparison of the results with other data from the area, knowledge of the vulnerability of the groundwater in the area to contamination, and other background information increased the level of confidence in the data."

The LBNRD plans to continue the program of water quality testing for nitrates in order to expand the data base, determine area extent of any contamination, determine the level of contamination and observe trends. The district will continue testing as a service to interested water users. The water quality testing program of the LBNRD is being revised to include; (1) purchase of new field and laboratory testing equipment; (2) revised sampling and handling procedures; (3) an updated form for reporting well location, well characteristics and land use, and (4) provisions for verifying the accuracy of their testing by submitting duplicate samples to certified laboratories.

3.1.2.4.0.1 Revised LBNRD Sampling Protocol

Future LBNRD water quality sampling will be performed according to the Nebraska Department of Environmental Quality protocol. The NDEQ protocol is as follows:

- Irrigation wells are the most desirable type of well to sample to assess regional water quality. They are usually located away from point sources of contamination, such as feedlots, septic systems, and ag chemical mixing areas. Irrigation wells will be picked, on a township basis, in a random manner from all active irrigation wells registered with the Nebraska Department of Water Resources, with a minimum of 5 wells per township. From DWR's records, it will be determined how many active irrigation wells are located in each township in the district, and from these wells, a random five percent (5%) will be chosen for the sampling program. Wells with the most complete construction and well log information will be used first with wells having less information being used if needed to fill the five percent (5%) requirement. However, some townships in the LBNRD have fewer than 50 irrigation wells. In this case, stock or domestic wells will be sampled in order to obtain the minimum 5 wells. In addition, the NRD will request all sampling information from the municipal wells in the district and any other sampling information conducted by other agencies. Before any sampling is undertaken, informational letters requesting permission to sample wells will be sent to the Owner.

- A site-specific field data sheet will be completed for each well. This sheet will include information concerning location, topographic placement, well condition, well registration number, water quality testing results, and well construction information. This information will be important in helping to identify potential point sources which may impact the water quality in the well.

The protocol for collecting the water quality samples will be:

- The NRD will be divided into three (3) zones with one zone sampled each year on a rotating basis. Thus, approximately one third of the total program wells will be sampled annually.
- NRD personnel will not start an irrigation well for the purpose of obtaining a sample. Only irrigation wells that are pumping will be tested. If a well is not running at the time a sample is to be drawn, the person taking samples will return at a later date to take a sample when the well is running. A study has shown that pumping a high capacity well, such as an irrigation well, for approximately 15 minutes is sufficient to ensure sampling from the formation water. Prior to taking the sample, a tap, pipe gate, or outlet will be located as close as possible to the well. The outlet will be opened and allowed to run to clarity. Field tests for temperature, pH, and conductivity will be taken and recorded.
- The sample will be drawn, capped and cooled, in ice, to approximately 4° C. These samples will be returned to the NRD office and analyzed on the Hach D/R 2000 Spectrophotometer for nitrates. Also, a random ten percent (10%) will be double sampled and sent to a lab for verification.

- Recent studies have shown a correlation between high nitrate-nitrogen levels and detectable levels of atrazine. Because of this correlation, at each sampling site, a field screening test for nitrates will be performed using a Hach Pocket Colorimeter. On those samples showing a nitrate concentration of approximately 10 milligrams per liter (mg/l, comparable to parts per million (ppm)) or higher a Millipore EnviroGard Test Kit for triazine will be employed to detect the presence of triazine herbicides. Samples for laboratory pesticide analysis will be collected from those wells showing positive results.

The Little Blue NRD will continue with the domestic mail nitrate sampling program. This program involves sending sample bottles to domestic well owners and having them mail the water sample back to the NRD to be tested for nitrates.

The Little Blue NRD will also provide a water sample analysis for nitrates to constituents upon request. These will not become a part of the annual sampling program, but is done as a public service.

All sampling results will be compiled and presented to the Groundwater Committee and to the Little Blue NRD Board of Directors. Information will be sought from, and compiled information will be shared with, the appropriate agencies.

3.1.2.4.1 Summary of Results of LBNRD Sampling Program

Of the approximately 1,200 wells sampled from 1985 to early 1994, about 650 were for domestic use, 515 were irrigation wells, 7 were public water supply wells and 19 were installed for site specific monitoring purposes. Some of the wells, particularly wells used for irrigation and public supplies, were sampled only one or two times. Many of the domestic wells were sampled several times during this period and about 220 of them were sampled annually, in either spring or fall, since 1985. The most recent analysis for each of the 1,200 wells is shown by symbol in Figure 13-16.

The staff made an evaluation of the results of monitoring domestic wells sampled in the LBNRD and analyzed for nitrate-N. The program was initiated in 1985 and the most recent available data is 1993 or, for a few wells, 1994. Some wells, mostly in 1986, were sampled in the spring and fall of the same year. A few wells were rechecked when unexpected high or low values were found. The spring and fall values were similar although in general the spring value was slightly higher. A summary of the results of the evaluation for each county is as follows:

Adams County - Thirty-five domestic wells of a total of 74 wells sampled in the county have been monitored, most annually. Since 1985 nitrate levels have remained nearly constant ranging from less than one to three ppm in the majority of the wells sampled. Seven of the wells had concentrations above five ppm and two had values in the range of 12 to more than 20 ppm. The lowest value obtained in 15 of the wells was in 1993, the most recent sampling date for most wells.

Clay County - Twenty-one domestic wells out of a total of 89 wells sampled have been monitored since 1985. No district trends are apparent although in 14 of the wells the 1993 or 1994 concentrations were the lowest of record. Most of the wells had values ranging from less than one to about three and one-half ppm. Four of the wells had concentrations of about five to six ppm, one well had about 13 ppm in 1994 and another had 18 ppm when last sampled in 1990. Eleven other wells that were sampled only one or two times, and have not been sampled in recent years, had values above 10 ppm.

Fillmore County - Twenty-one of the 43 domestic wells sampled were monitored 1985-1993. As in Adams and Clay counties no trends can be observed for the nine year period. Nitrate values from wells that were high in 1985 generally were high in 1992-1993 and, conversely, those having early low values continued to remain low. Concentrations were the lowest of record in 1993 in nine of the wells. Concentrations were quite low in 13 of the wells, from less than one ppm to two ppm; three wells had values from six to about eight ppm. Five wells had values ranging from 13 to 30 ppm. These wells were in the non-irrigated portion of southeastern Fillmore County, 5N-1W. Some wells nearby had very low concentrations suggesting that the high levels resulted from point source contamination.

Jefferson County - Twenty-four of the 71 domestic wells sampled were monitored 1985-1993. Sixteen of the wells had nitrate values ranging from less than one ppm to about 5 ppm; two had values from about six to 10 ppm. Six wells had values in 1993 of 15 to 25 ppm. No trend can be discerned. About eight of the wells had the lowest value in 1993. A few wells that had very high values in the early period of record may have been replaced by new wells since the most recent values for the same location now indicate very low values.

Nuckolls County - A total of 172 domestic wells have been sampled. Of these, 69 wells have been monitored either spring or fall since 1985-1986. Most were sampled in the winter period of 1993-1994. Twenty-two of the wells had nitrate concentrations ranging from 10 to 30 ppm in this most recent sampling period. No distinct trend can be observed although at sometime during the nine year period 34 of the monitored wells sampled had nitrates in this high range. In a few of these cases nitrates were lower in 1993-1994 than in 1985-1986. Possibly a few of the wells with high nitrates in the early part of the period were abandoned and replaced. An examination of the map showing nitrate concentrations (Figure 13-16) indicates that most of the wells with the highest concentrations of nitrates occur in the low-transmissivity, non-irrigated portion of Nuckolls County.

Seven additional monitored wells had concentrations near or above 7.5 ppm. Of the remaining 40 monitored wells, 34 had concentrations of less than five ppm. No trend of either increase or decrease in nitrate values are apparent during this nine year period.

Thayer County - Fifty-one domestic wells and one irrigation well have been monitored, most since 1985-1986. The total number of domestic wells sampled at least once (although some were sampled two or three times) is 164. Ten of the monitored wells had nitrate values above 10 ppm. Another four wells had concentrations between 7.5 and 10 ppm. The average value for the remaining 37 wells was about three ppm.

The one irrigation well monitored 4N-4W southeast of Davenport has been sampled since 1989. Prior to that a domestic well in the same quarter section had been monitored 1985-1988. Values of nitrate-N for both wells were relatively high, generally above 10 ppm and as high as 18 to 20 ppm in 1988 and 1989. The most recent value for the irrigation well was 10.1 ppm.

Webster County - Only the northern tier of four townships are in the LBNRD. Twenty-three domestic wells have been sampled in the county and of these six wells have been monitored annually 1985-1993. Nitrate levels have been consistently low, 0.1 to 4.4 ppm. The highest values, with one exception, were in 1985 or 1986. However, based on the data available, values appear to have remained constant.

3.10.3. Conclusions

The domestic well monitoring system will be continued by the District. The data over time will help determine trends in nitrate levels. To date these data suggest that nitrate levels have reached an equilibrium level in most wells. In general, the data obtained from the domestic wells suggest a point source of pollution in non-irrigated areas with limited aquifers. These data also support the study done in the eastern portion of the LBNRD by DEQ and the evidence that nonpoint source pollution has occurred and may be occurring in the Byron-Deshler area and in the Bruning area as suggested in the DEQ study.

From the LBRND sampling results and from the nitrate levels found in public water supply wells (Appendix D, Reference 24), some evidence exists that nitrate levels may have reached an equilibrium. In addition, there is no evidence of aquifer-wide contamination of the aquifers. Nevertheless, there is abundant evidence that point source and nonpoint source contamination has occurred locally and probably is still occurring.

Soil type, hydrology, geology and depth to water are factors in the occurrence of nonpoint contamination. Some evidence suggests that on-the-farm management of chemicals (ie. fertilizer) and water use may be major factors in the localized occurrence of nitrates in the irrigated areas. If the evidence suggesting some leveling off of nitrate levels is correct, credit may be due to the high degree of awareness of the problems as a result of the efforts of the LBNRD and other agencies in their programs of education and demonstrations. Undoubtedly economics has become a significant factor in the acceptance of farm operators in adopting best management practices in the use of both chemicals and water.

Nonpoint pollution, particularly for domestic wells in limited aquifer areas, is a widespread problem. Possibly the only solution in many cases will be the proper abandonment of old wells and replacement by properly sited and constructed new wells.

3.11. Pesticide Contamination

DEQ, in the SPA study for the eastern part of the LBNRD sampled, 19 wells for pesticides (Reference 24). A field test kit for triazine herbicides was used on wells where nitrates were approximately 10 ppm or greater. Pesticide samples were collected from wells showing a positive response to the triazine field test. A few other random samples were also taken. Results of the sampling are given in Table 8 and locations of sampled wells and the results are illustrated in Figure 14 of the study report. The maximum contaminant level (MCL) for atrazine is 3 micrograms per liter (ug/l or parts per billion). No samples were greater than the MCL for atrazine.

The samples were analyzed for other pesticides (Tables 6 and 8, Reference 24). Other than atrazine, only a detection (not quantifiable) of fonofos was found. DEQ (page 15, Reference 24) concluded that despite limited sampling, nonpoint source contamination from pesticides is not thought to be a concern in the study area.

DEQ also had available the results of other studies involving pesticide sampling in the LBNRD. The results of all available sampling done in Nebraska (including the LBNRD) prior to about 1990 were summarized by Exner and Spalding (Reference 14). Essentially the same pattern and concentrations of pesticide, as found by DEQ, were documented in that report.

The LBNRD tested all municipal wells within the district in 1986 and sampling was repeated in 1988 for those wells which showed a presence of pesticides. Samples were collected by NRD staff and protocol, as described by NDOH, was followed. Samples were analyzed within 24 hours by the NDOH laboratory. Fifteen domestic wells also were sampled and analyzed for pesticides and VOC's in 1987.

The parameters tested for in 1986 included:

Alachlor (Lasso)	Atrazine (Atrex)	Carbaryl (Sevin)
Carbofuran (Furadan)	Cyanazine (Bladex)	Chloropyrifos (Lorsban)
Dyphonate (Dyfonate)	Metaphos	Metolochlor (Dual)
Metribuzin (Sencor)	Parathion	Terbufos (Counter)
Trifluralin (Treflan)		

Tests in 1988 included those pesticides listed above (except Metaphos) and added Butylate (Sutan), Ethylparathion and Methylparathion.

Organochlorine Pesticides (EPA-505) were also tested for in 1988. They included:

Aldrin	Alpha-BHC	Beta-BHC
Delta-BHC	Gamma-BHC	Chlordane
4, 4'-DDD	4, 4'-DDE	4, 4'-DDT
Dieldrin	Endosulfan I	Endosulfan II
Endosulfan Sulfate	Endrin	Endrin Aldehyde
Heptachlor	Heptachlor Epoxide	Methoxychlor
Toxaphene	PCB-1016	PCB-1221
PCB-1232	PCB-1242	PCB-1248
PCB-1254	PCB-1260	

A summary of results of sampling and analysis are given in Tables 3.2-1 and 3.2-2.

TABLE 3.2-1
Summary of LBNRD Testing of
Municipal Wells - (1986)
Emphasis on Pesticides

County	Community	Date	Number Wells Sampled	Number Positive Samples	Pesticide Detected	Contamination Level(ppt
Adams	CMS	8/6/86	2	-		
Adams	Hastings	7/15-7/30/86	14	-		
Adams	Holstein	9/2/86	2	-		
Adams	Juniata	8/20/86	3	-		
Adams	Kenesaw	8/13/86	3	-		
Adams	Roseland	9/2/86	1	1	Atrazine	0.516
Adams	Roseland	9/6/88 (Res)	1	1	Atrazine	0.29
Adams	Roseland	9/2/86	1	1	Atrazine	0.156
Adams	Roseland	9/6/88 (Res)	1	1	Atrazine	0.29
Clay	Clay Center	7/9/86	2	Well #2	Atrazine	0.561
Clay	Clay Center	9/6/88 (Res)	1	Well #2	Atrazine	0.11
Clay	Deweese	9/9/86	1	-		
Clay	Edgar	7/9/86	1	So. Well	Atrazine	0.619
Clay	Edgar	9/6/88 (Res)	1	So. Well	Atrazine	0.41
Clay	Edgar	7/9/86	1	No. Well	Atrazine	0.561
Clay	Fairfield	9/9/86	2	-		
Clay	Glenvil	8/20/86	2	-		
Clay	Ong	8/13/86	1	-		
Fillmore	Ohiowa	9/30/86	2	-		
Fillmore	Shickley	9/24/86	2	-		
Jefferson	Endicott	10/21/86	1	-		
Jefferson	Fairbury	10/29/86	2	-		
Jefferson	Reynolds	11/10/86	1	-		
Jefferson	Steele City	11/10/86	1	-		
Nuckolls	Hardy	10/21/86	1	Well #1	Atrazine	2.13
Nuckolls	Hardy	10/21/86	1	Well #2	Atrazine	1.76
Nuckolls	Hardy	10/21/86	1	Well #3	Atrazine	11.75
Nuckolls	Lawrence	9/16/86	2	-		
Nuckolls	Nelson	9/16/86	2	-		
Nuckolls	Ruskin	10/14/86	2	-		
Thayer	Alexandria	10/15/86	2	-		
Thayer	Belvidere	10/8/86	1	-		
Thayer	Bruning	7/2/86	2	-		
Thayer	Byron	10/14/86	1	1	Atrazine	0.65
Thayer	Byron	9/16/88 (Res)	1	1	Atrazine	0.33
Thayer	Carleton	9/24/86	2	-		
Thayer	Chester	10/8/86	1	-		
Thayer	Davenport	7/2/86	2	-		
Thayer	Deshler	9/9/86	2	-		
Thayer	Hebron	10/1/86	3	Well #4	Atrazine	0.318
Thayer	Hebron	9/6/88 (Res)	1	Well #4	Atrazine	0.25
Thayer	Hubbell	10/8/86	1	-		
Webster	Bladen	8/6/86	1	-		
Webster	Blue Hill	8/26/86	3	-		

(Res) - A resample made in 1988 to compare with the 1986 sample.

TABLE 3.2-2

SUMMARY OF WATER SAMPLES
COLLECTED BY LITTLE BLUE NRD (1987-88)
PARTICULAR EMPHASIS-PESTICIDES

Date Sampled	Type of Well	Legal Description	County	Nitrates ppm	Pesticides NE Scan. & EPA-608	VOC's EPA-524
7/7/87	Domestic	SWSW 21-T7N-R9W	Adams	2.3	<MDL	<MDL
7/7/87	Domestic	SW 26-T7N-R9W	Adams	4.3	<MDL	<MDL
7/7/87	Domestic	SE 35-T7N-R9W	Adams	2.3	<MDL	<MDL
7/7/87	Domestic	NW 6-T6N-R8W	Clay	3.6	<MDL	<MDL
7/7/87	Domestic	NWSE 4-T6N-R8W	Clay	4.7	<MDL	<MDL
8/31/87	Domestic	SESW 13-T5N-R8W	Clay	8.2	Atrazine 0.12 ppb	<MDL
8/31/87	Domestic	SESW 14-T5N-R9W	Adams	10.2	Atrazine 0.17 ppb	<MDL
8/31/87	Domestic	SE 23-T6N-R8W	Clay	3.6	<MDL	<MDL
8/31/87	Domestic	SESE 31-T6N-R7W	Clay	5.9	<MDL	<MDL
8/31/87	Domestic	SWNW 27-T6N-R7W	Clay	3.2	<MDL	<MDL
8/16/88	Domestic	SW 36-T5N-R2W	Fillmore	3.6	<MDL	<MDL
8/16/88	Domestic	NWNW 1-T4N-R2W	Thayer	8.9	Atrazine 1.78 ppb Dual 2.32 ppb	<MDL
8/16/88	Domestic	NW 25-T2N-R2E	Jefferson	1.3	<MDL	<MDL
8/16/88	Domestic	SW 30-T2N-R3E	Jefferson	<0.1	<MDL	<MDL
8/16/88	Domestic	NE 8-T1N-R3E	Jefferson	0.2	<MDL	<MDL

NOTE: <MDL - Below Method of Detection Limits
ppm - Parts Per Million
ppb - Parts Per Billion

3.12. Water Quality in the Principal Aquifers

Most of the water quality data collected pertains to the principal aquifer of the area. A brief generalized explanation of the major chemical constituents in the LBNRD follows.

3.12.1. Dissolved Solids concentrations range from less than 200 to 1,000 mg/l within the regions of the LBNRD (Figure 13-17). Concentrations below 500 mg/l are generally considered favorable for aesthetic considerations and most crop tolerance. If leaching or drainage is adequate, concentrations up to 1,500 mg/l are not likely to be harmful. The vast majority of the LBNRD has concentrations below 500 mg/l.

3.12.2. Hardness of groundwater reported as calcium cabonate ($CaCO_3$) ranges from 60 to 360 mg/l (Figure 13-18). Hardness concentrations greater than 180 mg/l in groundwater relate to the term "very hard" water. Soft water is generally water with less than 60 mg/l hardness. The EPA has not set limits on hardness since no specific health threats are known. Hard water can cause scale formation on pipes, fixtures and boilers and often is treated prior to use.

3.12.3. Fluoride occurs naturally in Nebraska's groundwater. The EPA upper limit for fluoride is 1.7 mg/l. Concentrations greater than 1.7 mg/l are known to cause mottling of teeth (McKee and Wolf, 1963), however, lesser concentrations are beneficial in the prevention of tooth decay in children.

3.12.4. Selenium

The EPA drinking water regulation for selenium is 0.01 mg/l. Few cases of selenium poisoning from drinking water have been documented. The maladies "blind staggers" and "alkali disease" are caused by high concentrations of selenium and are common in grazing animals. These diseases are generally not caused from drinking water but from ingestion of selenium-accumulator plans such as grain and hay crops grown in selenium-bearing soils. While man is susceptible to these maladies, he is not likely to be affected by them because his food comes from a large variety of areas that may not be seleniferous. Furthermore, cooking volatilizes much of the selenium that would be consumed if the food were eaten raw.

3.12.5. Nitrate in the groundwater does present a hazard because it may cause methemoglobinemia (blue baby syndrome) in infant humans and animals. The Environmental Protection Agency has set a limit for nitrate in drinking water of 10.0 mg/l. There is some naturally occurring nitrate in groundwater, however, these concentrations are normally small (1-3 mg/l). Excessive concentrations may indicate contamination due to human activities. In recent years the concern over nitrate contamination has increased as the quantity of water fit for domestic uses has decreased. The need to protect groundwater from nitrate contamination is well documented. Nitrate in groundwater needs to be a continuing subject of study and monitoring so that areas with a high potential for contamination can be identified and protected.

Nitrate concentrations in the LBNRD's groundwater are shown on Figure 13-16 and have been discussed in detail in previous sections of this Chapter.

4.0 Land Use and Contamination Source Inventory

Land use practices can adversely affect both water quantity and quality. Large withdrawals of groundwater for irrigation, municipal, and industrial use can reduce the amount of groundwater in storage. Groundwater contamination can occur from either point or non-point sources. Point sources of groundwater contamination are many, including: private, community, and industrial type waste disposal systems; the improper use, storage and disposal of chemicals, and other industrial and petroleum products; improperly operated or abandoned livestock feed yards; and improperly sited, constructed and abandoned wells. Non-point sources in Nebraska are generally considered to be those associated with poorly managed agricultural practices such as improper timing and application of fertilizer (either commercial or manure) and farm chemicals in amounts greater than those generally recommended as best management practices. Elsewhere in the state, evidence clearly indicates that poor timing and over irrigation contributes significantly to the contamination of groundwater from agricultural chemicals.

4.1. Land Use

The LBNRD covers approximately 2,402 square miles in the south-central and south-eastern part of Nebraska, including all of Thayer County and portions of Jefferson, Fillmore, Nuckolls, Clay, Webster and Adams Counties. (The area is shown with an overlaying topographic quadrangle map index in Figure 13-19.) The area includes most of the drainage area of the Little Blue River Basin. A general Land Use Map of the LBNRD is shown in Figure 13-5.

4.1.1. Population Distribution

The population of the LBNRD, amounting to approximately 50,022 people, is concentrated in cities and small towns spread throughout the entire NRD area. Major population centers are Hastings (pop. 22,837) in the northwest region of the NRD and Fairbury (pop. 4,335) in the southeast region.

Table 4.1.1-1 presents the 1980 and 1990 populations of the incorporated cities, towns, and villages within the LBNRD boundaries. It can be seen from these figures that approximately 70% of the LBNRD population lives within the jurisdiction of the 39 cities or towns. The largest incorporated area is the Hastings area with a population of 22,837, which is 57.6% of the total town-dwelling population, or 45.7% of the entire LBNRD population.

The trend toward declining populations in the small cities and towns of Nebraska over the last ten years is also apparent in the LBNRD population figures. Only one town (Juniata) has shown a significant (over 10%) increase in population from 1980-1990, which may be due partly to its location close to the City of Hastings, while 34 of the other 38 incorporated cities and towns showed decreases of 0.9% to 46.4%. Overall, the town-dwelling population of the LBNRD has decreased 5.2% over the years 1980-1990.

4.1.2. <u>Soils</u>

The major soil associations in the LBNRD and their respective average permeability are listed on the general soil map of Nebraska revised by the Conservation and Survey Division (CSD) in 1990. A generalized soils map based on the Soil Conservation Service (SCS) STATSGO Associations is included in this plan as Figure 13-20. The potential for soil erosion from stream runoff, as determined by SCS, is shown on Figure 13-21.

TABLE 4.1.1-1
Population of Incorporated Cities and Towns in the LBNRD
(Reference: NNRC Data Bank)

		1980	1990	Percent Change
Alexandria		255	224	-12.2
Ayr	112	101		- 9.8
Belvidere		158	117	-25.9
Bladen		298	280	- 6.0
Blue Hill		883	810	- 8.3
Bruning	330	332		0.6
Byron		154	140	- 9.1
Carleton		160	144	-10.0
Chester	435	351		-19.3
Clay Center		962	825	-14.2
Davenport		445	383	-13.9
Deshler	997	892		-10.5
Deweese		69	74	7.2
Edgar		705	600	-14.9
Endicott		198	163	-17.7
Fairbury		4,885	4,335	-11.3
Fairfield		543	458	-15.7
Gilead		69	37	-46.4
Glenvil		363	304	-16.3
Hastings		23,045	22,837	- 0.9
Hebron		1,906	1,765	- 7.4
Holstein		241	207	-14.1
Hubbell	71	55		-22.5
Juniata		703	811	15.4
Kenesaw		854	818	- 4.2
Lawrence		350	323	- 7.7
Nelson		733	627	-14.5
Nora		24	24	0.0
Oak		79	68	-13.9
Ohiowa	135	146		8.1
Ong		104	69	-33.7
Prosser		98	77	-21.4
Reynolds		125	104	-16.8
Roseland		254	247	- 2.8
Ruskin		224	187	-16.5
Shickley		413	360	-12.8
Steele City		137	101	-26.3
Strang		59	42	-28.8
Totals		41,808	39,644	- 5.2

4.1.3. Industry

There are a number of light industries in the LBNRD such as manufacturing plastic or paper products, iron, steel, aluminum products, ethanol, beef packing, and other light items requiring high amounts of labor and small shipping costs. Much of the industry in the District is oriented toward supplying the needs of agriculture or marketing agricultural products.

4.1.4. Agriculture

Agricultural statistics are published broken down by county and are not subdivided to reflect NRD boundaries. Therefore, the figures reported here are for the entire seven counties which, in whole or in part, make up the LBNRD. For example, the statistics given for Adams County are for all of Adams County and not just for that portion which lies within the LBNRD boundaries.

Agriculture is the primary land-use activity in the LBNRD. According to the Agricultural Stabilization and Conservation Service at least 1,654,100 acres were cultivated in 1993 in the seven counties within which the LBNRD lies. Overall, Webster County had the smallest number of acres set aside for crop production in 1993 (about 9.7% of the total cropland acreage in the seven county area), whereas Filmore County has the largest number of acres set aside for crop production (17.9%). The main dryland crop was sorghum with wheat a close second (see Table 4.1.4-1). Jefferson County had the largest number of dry cropland acres in 1993 (about 18.5% of the total dryland acreage).

The main irrigated crops were corn, soybeans, alfalfa, and sorghum (see Table 4.1.4-1). Corn was by far the most heavily irrigated crop with over 80% of the total irrigated acres planted in corn. Of the 729,400 acres planted in corn, almost 90% was irrigated. Fillmore County had the largest number of irrigated acres while Webster County had the fewest. Clay County had the greatest percentage of irrigated acres with 69.3% of the cultivated acres in Clay County being irrigated.

TABLE 4.1.4-1
Crop Statistics for 1993
Number of Acres by County①
(Reference 49)

Crop	Adams	Webster	Clay	Fillmore	Jefferson	Nuckolls	Thayer	Total
Corn, dryland	13,600	10,200	10,400	15,300	8,400	6,600	10,800	75,300
Corn, irrigated	152,700	37,600	144,100	151,700	37,200	39,200	91,600	654,100
Wheat, dryland	34,900	47,900	14,800	20,900	32,900	51,700	46,500	249,600
Wheat, irrigated	100	1,100	200	100	100	300	500	2,400
Beans, dryland	6,700	1,800	10,000	22,600	24,500	5,300	18,400	89,300
Beans, irrigated	19,800	3,700	24,600	26,800	15,200	8,200	17,100	115,400
Alfalfa, dryland	4,400	7,300	4,000	4,100	11,500	6,900	7,100	45,300
Alfalfa, irrigated	3,800	1,000	1,300	900	800	600	1,000	9,400
Sorghum, dryland	22,900	30,800	36,000	45,800	66,200	61,200	50,700	313,600
Sorghum, irrigated	3,300	1,700	8,500	4,800	4,200	3,500	6,000	32,000
Other[2], dryland	7,300	17,700	4,100	3,500	12,200	12,600	10,300	67,700
Total dryland	89,800	115,700	79,300	112,200	155,700	144,300	143,800	840,800
Total irrigated	179,700	45,100	178,700	184,300	57,500	51,800	116,200	813,300
Total	269,500	160,800	258,000	296,500	213,200	196,100	260,000	1,654,100

[1]Acres are not restricted to areas within the NRD and include all acres within each county.
[2]Other crops may include oats, rye, sunflowers, barley, or hay.

4.1.4.1. Agricultural-Related Industry

Agricultural-related light industry in the LBNRD mainly consists of agricultural processing plants and livestock businesses. About 37 feedlots with overall total capacities of 104,825 head of cattle and 63,900 swine existed in 1994 in the LBNRD.

4.1.5. Wildlife Refuges

The rainwater Basins located in Adams, Clay, Fillmore, and Thayer Counties are considered some of the better waterfowl production areas in the State. The U.S. Fish & Wildlife Service and the Nebraska Game and Parks Commission have purchased a number of land tracts containing marshes and wetlands for production of waterfowl and for public utilization (hunting and wildlife observation).

Many of the rainwater basins in the flat uplands in the northern part of the District have been drained for agricultural use and their value for waterfowl has been destroyed. The remaining wetlands and marshes are important for waterfowl habitat and recreation and should be preserved in order to maintain the resource.

4.2. Contamination Sources

4.2.1. Nonpoint Sources

Nonpoint source (NPS) pollution is defined as pollution caused by diffuse sources that are not regulated as point sources. Normally, nonpoint sources are associated with agricultural, silvicultural, urban and construction site runoff. Such pollution results in the manmade or man-induced alteration of the chemical, physical, biological, and radiological integrity of water. In practical terms, NPS pollution does not result from a discharge at a specific, single location (such as a pipe) but generally results from land runoff, precipitation, atmospheric deposition, or percolation. It must be kept in mind that this definition is necessarily general. Legal and regulatory decisions have sometimes resulted in certain sources being assigned to either the point or nonpoint source categories because of considerations other than the manner of discharge. For example, irrigation return flows are designated as nonpoint sources by Section 402(1) of the Clean Water Act, even though the discharge is through a discrete conveyance. Releases from dams have similarly been defined as nonpoint sources in a federal court decision, even though the discharge is through a discrete conveyance.

Nonpoint sources may generate both conventional and toxic pollutants, just as point sources do. Although nonpoint and point sources may contribute many of the same kinds of pollutants, these pollutants are generated in different volumes, combinations, and concentrations. Pollutants from nonpoint sources are mobilized primarily during storm events and the application of irrigation water. Consequently, NPS pollution episodes are generally less frequent and shorter in duration than continuous point source discharges. However, they may contribute to long term problems.

In 1987 Congress amended and reauthorized the Clean Water Act to address current and future water quality problems. The Water Quality Act of 1987 amended the Clean Water Act's declaration of goals and policy by adding the following:

> "...it is the national policy that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of this Act to be met through the control of both point and nonpoint sources of pollution."

This policy focuses on the importance of controlling nonpoint sources of surface and groundwater pollution. With the enactment of Section 319 of the Clean Water Act (CWA), new direction with federal assistance for the implementation of state nonpoint source programs has been authorized.

The LBNRD plans to address the issue of NPS control through the establishment of a Groundwater Management Area and associated monitoring and control programs. (See Section 10.)

In the LBNRD, agricultural activities constitute the most widespread cause of water quality problems from nonpoint sources. Most problems are caused by the application of excessive amounts of fertilizers and/or pesticides and are often exacerbated by the subsequent over-application of supplemental water. Runoff leads to contamination of surface water, while the absorption of these chemicals into the soil leads to the much longer term contamination of the groundwater supply through the slow leaching of these chemicals through successive soil layers.

The 1994 Annual NPS Report (Reference 47) by the Nebraska Department of Environmental Quality identifies one area of the LBNRD (the area currently in the Hardy-Superior SPA) as a Priority One Area; that is, an area where NPS groundwater contamination has been documented and/or formal management programs (GWMA's, SPA's, etc.) have been initiated. In addition, the report identifies a large portion of the

LBNRD (essentially the area shown as the principal aquifer on Figure 13-6) as a Priority Two Area; that is, an area where NPS groundwater contamination is potentially or actually occurring, but no formal management programs have been initiated.

4.2.1.1. Fertilizers

The tonnage of commercial fertilizer sold in the seven counties which, in whole or in part, makeup the LBNRD from July 1992 through June 1993 is given in Table 4.2.1.1-1.

TABLE 4.2.1.1-1
Tonnage Report of Commercial Fertilizer Sold
By County, July 1, 1992 - June 30, 1993
(Reference 45)

County	Actual Nutrients Total N	Total P_2O_5	Total K_2O	Anhydrous Ammonia	Nitrogen Solutions	Phosphate Materials	Potash Materials	Single Nutrient Fertilizers	Multiple Nutrient Fertilizers	All Other Fertilizers	Total All Fertilizers	Lime Cal. Yr. 1991
Adams	9,677	1,238	13	8,456	6,853	0	42	18,182	2,872	4	21,057	—
Webster	3,888	958	8	2,511	4,780	0	0	8,077	2,264	84	10,425	—
Clay	31,282	5,032	47	29,932	11,540	0	71	46,472	12,659	565	59,696	52
Fillmore	21,039	4,837	37	18,048	14,524	92	56	33,531	13,505	35	47,072	2,484
Jefferson	9,213	2,457	94	6,858	8,565	0	126	17,075	4,698	21	21,794	4,612
Nuckolls	8,408	1,589	4	4,709	12,148	50	1	18,337	3,580	140	22,057	279
Thayer	16,344	2,663	21	9,154	24,767	0	27	36,272	6,961	116	43,350	20
Total	99,851	18,774	224	79,668	83,177	142	323	177,946	46,539	965	225,451	7,447

Application of chemical fertilizers in excessive amounts or at inappropriate times of the year, especially when combined with excess irrigation or rainfall, can result in high concentrations of these chemicals and of nitrogen-nitrates in surface water and/or groundwater supplies. Possible identified contamination locations in the LBNRD are discussed in Sections 3.0 and 6.0.

4.2.1.1.1 Chemigation Permits

Chemigation permits are issued by the Little Blue NRD. The following chart provides a summary of the number of active permits that have been granted by the LBNRD.

CHEMIGATION PERMITS ISSUED BY LBNRD

County	Number of Active Permits
ADAMS	113
CLAY	41
FILLMORE	38
JEFFERSON	19
NUCKOLLS	51
THAYER	172
WEBSTER	1
TOTAL PERMITS	435

4.2.1.2. Pesticides

Agricultural pesticides include herbicides for control of weeds and unwanted plants, insecticides for the control of insects, nematocides for the control of parasitic worms, and fungicides for the control of fungus.

Specific herbicide- and pesticide-use statistics in the LBNRD are not readily available. However, statistics for Nebraska indicate that herbicides were used on about 95% of corn cropland with atrazine (11%) being the most commonly used herbicide statewide (Reference 46).

Pesticide use in Nebraska was estimated to be 482 million pounds of active ingredients in 1992. Herbicides account for 84% of the total pesticide use. In Nebraska, approximately 90% of corn, soybean, and grain sorghum acreages are treated with herbicides, of which 57% is applied to corn (Reference 46).

In Nebraska, corn has the largest insecticide use followed by grain sorghum. Other crops receive relatively small quantities of insecticide. About 65% of the corn cropland in 1991 was treated with insecticides to combat corn rootworms. In Nebraska, the major insecticides used on corn in 1991 were carbonfuran, chlorpyrifos, and terbufos. Disulfoton was used on wheat, oats, barley, and rye. Carbofuran, chlorpyrifos, and malathion were used on alfalfa. In 1991, insecticide use on pasture and rangeland was almost totally absent in Nebraska (Reference 46).

In general, corn does not receive much fungicide application. Only an estimated 3.4% of Nebraska's corn acres were treated with fungicides in 1991; remaining fungicides were applied to special crops such as potatoes, sugar beets, and beans. Examples of nematocides are Telone and Temik. Nematocide use is limited to beets. Fumigants, such as aluminum phosphide, as well as protectants are used on stored grain. Other chemicals include rodenticides and bird repellents (Reference 46).

4.2.2. Point Source

Point sources are sources of groundwater or surface water contamination which can be identified as originating from a specific, small, confined location. Examples of point sources include wastewater treatment plants, feedlots, landfills, septic tanks, leaking underground storage tanks, and abandoned wells.

Nebraska state law gives regulatory control over point sources to the Department of Environmental Quality (DEQ). The Natural Resources Districts have no regulatory power in the point source area. However, the following listing of point source activity in the LBNRD is provided in order to increase awareness of potential problems. These lists are based on current information as of September 1995 and are not intended to be complete and exclusive lists. They are updated regularly by DEQ.

4.2.2.1. RCRA List

The RCRA list is a compilation of businesses that are required by the Resource Conservation and Recovery Act (RCRA) to report their activities to the Environmental Protection Agency (EPA). RCRA requires businesses that generate, store or transport hazardous waste to register their activities with the EPA.

HANDLER NAME	CITY
Alexandria Packing Co	Alexandria
Williams Drilling Co	Belvidere
Burge & Son	Blue Hill
Burlington Northern Railroad	Blue Hill
Duane Delay	Blue Hill
Bruning Motor Service	Bruning
Carleton Motors	Carleton
Chester, Village of	Chester
Clay County Weed Control Autho	Clay Center
Dahlsten Truck Line, Inc.	Clay Center
Dahlsten Truck Line, Inc.	Clay Center
Midwest Furnace Co	Clay Center
U. S. Meat Animal Research Cen	Clay Center
University of Nebraska-S Centr	Clay Center
Superior Deshler Co	Davenport
Deshler Rustler	Deshler
Deshler Tire Co	Deshler
E & J Clothing	Deshler
Reinke Mfg Co Inc	Deshler
Superior Deshler Co	Deshler
Superior Deshler Co	Edgar
American Microtrace Corporation	Fairbury
Consolidated Sand & Gravel	Fairbury
Endicott Clay Products Co	Fairbury
Engels Aircraft Inc	Fairbury
Fairbury Journal Inc	Fairbury
Fairbury Planing Mll	Fairbury
Fairbury Prnt & Supl	Fairbury
J D V Inc	Fairbury
Jefferson County Weed Control	Fairbury
KJ Chevrolet	Fairbury
Lofings Repair	Fairbury
Patrick Kujath	Fairbury
Wasserman Trucking/Virgil L	Fairbury
A-1 Fiberglass Inc	Hastings
Armour Food Company	Hastings
B G & S Transmission	Hastings
Carmichaels Construction	Hastings
Consolidated Motor Freight	Hastings
Consumers Service Company, Inc.	Hastings
Cooperative Producers Inc.	Hastings
Dana Corp. Perfect Circle Prd.	Hastings

HANDLER NAME	CITY
Dickerson Care Home	Hastings
Farm Air Spray Inc	Hastings
Frank's Paint & Body Shop Inc	Hastings
Gessford Machine Shop	Hastings
Great Plains Chrysler	Hastings
Hastings Battery & Electric In	Hastings
Hastings College	Hastings
Hastings Industries Inc	Hastings
Hastings Irrigation and Pipe C	Hastings
Hatten Electric	Hastings
Holt Truck & Trailer	Hastings
Industrial Irrigation Services	Hastings
Ingersoll-Rand/Wester Landrol	Hastings
Jerry Spady Pontiac Cadillac, Inc.	Hastings
Marshalltown Instruments Inc	Hastings
Modern Methods Inc	Hastings
Paul Spady Motors	Hastings
Pavelka Trucking Inc	Hastings
Pettit Auto Repair	Hastings
Sealey Body Shop	Hastings
Servi-Tech Laboratory	Hastings
Sherwin-Williams Co	Hastings
Stan's Radiator	Hastings
T-L Irrigation Co	Hastings
Tri City Fiberglass	Hastings
Werner Construction Inc	Hastings
Buchli and Son Implement	Hebron
George Virus Inc	Hebron
Haven Home of Kenesaw	Kenesaw
Himmelberg Service Inc	Nelson
Central Fiber	Prosser
Cornhusker Swine	Shickley
Johnson Feed Mill Inc	Shickley
Saltzman Inc	Shickley
Shickley Ag Service	Shickley
Shickley, Village of	Shickley

4.2.2.2. CERCLIS List

CERCLIS is an acronym for the Comprehensive Environmental Response, Compensation and Liability Information System. The sites listed on the CERCLIS list have been identified by EPA and DEQ as being potentially contaminated with a hazardous substance. EPA may investigate any site on the CERCLIS list in accordance with federal regulations.

SITE NAME	CITY	COUNTY
Belvidere Elevator	Belvidere	Thayer
Bruning Grain & Feed Co Inc	Bruning	Thayer
Bruning Form Gvrnmnt Grain Storage Bin	Bruning	Thayer
Bruning Public Water Supply	Bruning	Thayer
Bruning-Casper Service Station	Bruning	Thayer
Carleton Groundwater Contamination	Carleton	Thayer
Chester Flying Service	Chester	Thayer
Davenport Groundwater Contamination	Davenport	Thayer
Deshler Public Water Supply	Deshler	Thayer
Deshler Landfill	Deshler	Thayer
American Microtrace	Fairbury	Jefferson
Ohiowa Public Water Supply	Ohiowa	Fillmore
A-1 Fiberglass	Hastings	Adams
M & P Land Company	Hastings	Adams
EBKO Industries	Hastings	Adams
Dutton-Lainson Co	Hastings	Adams
Western Landroller	Hastings	Adams
McMurtry Marsh	Hastings	Adams
Bruckman Rubber Co	Hastings	Adams
Fleming Manufacturing Co Inc	Hastings	Adams
Eli Pest Control	Hastings	Adams
Dravo Industries	Hastings	Adams
Hastings Groundwater Contamination	Hastings	Adams
T-L Irrigation Co	Hastings	Adams
Army Guard Wet Site	Hastings	Adams
Perfect Circle Co-Dana Corp	Hastings	Adams
Ag-Tronics Inc	Hastings	Adams
Hastings City Landfill	Hastings	Adams
Hastings East Industrial Park	Hastings	Adams
Midstate Industrial Co	Hastings	Adams
T-L Irrigation Co	Hastings	Adams
Coop Grain & Supply - Blue Hill	Blue Hill	Webster
University of Nebraska-S Central Sta	Clay Center	Clay
Hruska Meat Animal Research Center	Clay Center	Clay
Clay Center Municipal Water Supply	Clay Center	Clay
Glenvil Township	Glenvil Township	Clay
Section 5 Impoundment	Glenvil Township	Clay
Section 8 Excavation Areas	Glenvil Township	Clay
Former NAD Sewage Treatment Plant	Glenvil Township	Clay
Inland Township-Clay County	Inland Township	Clay
Kenesaw Public Water Supply	Kenesaw	Adams
Coop Grain & Supply - Roseland	Roseland	Adams

SITE NAME	CITY	COUNTY
Ruskin Public Water Supply	Ruskin	Nuckolls
Ruskin Farmer's Union Coop	Ruskin	Nuckolls
Ruskin Filling Station	Ruskin	Nuckolls

4.2.2.3. NPDES Permits

This list includes applicants or holders of National Pollutant Discharge Elimination System (NPDES) permits for wastewater discharge. (WWTF indicates a wastewater treatment facility.)

NAME	CITY	COUNTY
Vontz Construction Co. Ayr	Ayr	Adams
Ayr WWTF	Ayr	Adams
Hastings Utilities Power Plant	Hastings	Adams
Dutton-Lainson Co. Hastings	Hastings	Adams
Ag Tronics	Hastings	Adams
Hastings Hide Company	Hastings	Adams
Comm& Muni Serv #2-Hastings	Hastings	Adams
Hastings Energy Center Unit #1	Hastings	Adams
Hastings Wet Site	Hastings	Adams
Hastings Regional Center	Hastings	Adams
Holstein WWTF	Holstein	Adams
Juniata WWTF	Juniata	Adams
Kenesaw WWTF	Kenesaw	Adams
Roseland WWTF	Roseland	Adams
Clay Center WWTF	Clay Center	Clay
Edgar WWTF	Edgar	Clay
Fairfield WWTF	Fairfield	Clay
Leverage Tool Inc.	Glenville	Clay
Glenville WWTF	Glenville	Clay
Ong WWTF	Ong	Clay
Ohiowa WWTF	Ohiowa	Fillmore
Shickley WWTF	Shickley	Fillmore
Endicott WTP	Endicott	Jefferson
Roode Packing Co. Fairbury	Fairbury	Jefferson
Fairbury Power Plant	Fairbury	Jefferson
Fairbury WWTF	Fairbury	Jefferson
Reynolds WWTF	Reynolds	Jefferson
Steele City WTP	Steele City	Jefferson
Hardy WWTF	Hardy	Nuckolls
Lawrence WWTF	Lawrence	Nuckolls
Nelson WWTF	Nelson	Nuckolls
Houtwed Sand and Gravel	Ruskin	Nuckolls
Ruskin WWTF	Ruskin	Nuckolls
Alexandria WWTF	Alexandria	Thayer
Bruning WWTF	Bruning	Thayer

NAME	CITY	COUNTY
Byron WWTF	Byron	Thayer
Carleton WWTF	Carleton	Thayer
Chester WWTF	Chester	Thayer
Davenport WWTF	Davenport	Thayer
Deshler WWTF	Deshler	Thayer
Gilead WWTF	Gilead	Thayer
Hebron WWTF	Hebron	Thayer
NPPD Hebron Gas Turbine	Hebron	Thayer
Hubbell WWTF	Hubbell	Thayer
Bladen WWTF	Bladen	Webster
Blue Hill	Blue Hill	Webster
Blue Hill Processing	Blue Hill	Webster

4.2.2.4. Feedlots

Following is a listing of feedlots in the LBNRD.

OPERATION NAME	COUNTY
Krable Land & Cattle	Adams
Juniata Feedyards	Adams
Juniata Feedyards	Adams
Snyder, Larry & Sheryl	Adams
Adams County Pork	Adams
Riverview Farms Inc.	Adams
Alvin Paus & Sons	Clay
Weyenberg, James	Clay
US MARC	Clay
R Lazy K Inc.	Clay
M & P Land Co.	Clay
US MARC	Clay
US MARC	Clay
Anderson, Steve	Clay
Husker Swine Inc.	Fillmore
Lichti Farms Inc.	Fillmore
Noel Bros. Ag Co.	Fillmore
Mosier, Darrel	Fillmore
Saltzman Bros.	Fillmore
Saltzman Bros.	Fillmore
Miller, Gordon	Fillmore
Houchin, Wayne Sr.	Fillmore
Roode Packing Co. Inc.	Jefferson
Starck, Roger	Jefferson
Knobel Farms Inc.	Jefferson
Knobel Farms Inc.	Jefferson
Grone, Dean	Jefferson

OPERATION NAME	**COUNTY**
Livingston, Bruce D.	Jefferson
Wehrman Feed Yards	Nuckolls
H. B. Wehrman & Son	Nuckolls
Pleasant View Fmy. Fm.	Nuckolls
Jones, Boyd	Nuckolls
Jones, Boyd	Nuckolls
Jones, Boyd	Nuckolls
Gebers, Steve	Nuckolls
Mid America Feed Yard	Thayer
Quality Pig Inc.	Thayer
J. L. Buchli & Sons	Thayer
Heinrichs, Rod	Thayer

4.2.2.5. <u>Landfills</u>

There are only two active licensed landfills in the LBNRD.

LANDFILL SITE	**COUNTY**
City of Hastings	Adams
City of Fairbury	Jefferson

4.2.2.6. <u>Compost Facilities</u>

There is only one active public compost facility in the LBNRD.

OPERATION NAME	**COUNTY**
Green Acres Compost	Adams

4.2.2.7. <u>LUST Sites</u>

LUST is an acronym for Leaking Underground Storage Tanks. The LUST report is a listing of all of the leaking underground storage tanks in the LBNRD reported to DEQ since 1981. The list identifies the type of release for each site. The LUST list is arranged by City, and is updated monthly.

CITY	**OWNER**	**SPILL LOCATION**
Ayr	Garvey Elevators Inc.	Main Street
Belvidere	Williamson Oil Co.	NE CRNR 4th & C St.
Bladen	Bladen Sand & Gravel	1 Blk E Main 1 Blk N Rt 6
Blue Hill	Marv's Service	Sinclair Sta on Hwy 281
	Unknown	410 Gage St.
Bruning	Casper Oil Co.	200 East Main, 4N-2W-50 CCA
	Four Star Service Inc.	200 E Main
	Bruning Pub School	In Town
Clay Center	Burklund Conoco	220 West Fairfield
	USDA Meat Animal Resh	6 mi. W 1.5 mi S
	Commercial State Bank	401 N Center-Former Serv. S
	Red Cloud Coop	404 N Center St.
	US Fish & Wildlife Serv.	Massie WPA
Clay Center	USDA Meat Animal Resh Ctr	State Spur 18D
	USDA Meat Animal Resh Ctr	State Spur 18D

CITY	OWNER	SPILL LOCATION
Davenport	Peterson Oil Co.	SW CRNR 3rd & B St.
	Peterson Oil Co. Inc.	2NE and B St.
	GSE & Associates	Railroad & B St.
	Krueger Enterprises	Jct. E Hwy. 4 & B St.
Deshler	Ervin Fangmeyer	Behind E&J Clothing
	Steidley Oil Co.	4th & Hebron
	Ervin Faugmier Cleaners	E&J Clothing
Deweese	Deweese Agri Services	NE CRNR Main & RR Spur
	Deweese Sand & Gravel Inc.	SE CRNR Liberty & Spur C18
Edgar	Shuck Engineering Co.	1/2 mi West on Spur
	Mikes Service Station	108 N Center
	Shuck Engineering	1/2 mi West of Edgar
Fairbury	Jefferson Co. Hospital	2200 N. "H" St.
	Unknown	1st & Railyard
	UPRR - Fairbury	2nd & I St.
	Southwick Oil Inc.	1402 C St.
	Southwick Oil Inc.	4th St. near RR Tracks
Fairfield	Woods Farms	Woods Farms-NE of Fairfield
	Unknown	1 mi E of Main & Hwy 74 Inters
Glenvil	Ken & Al's Service	Ken & Al's Service
Hastings	Foote Oil Company	102 East Second St.
	Hastings Utilities Dept.	1228 N. Denver Ave.
	Ingersoll-Rand	1342 W 2nd St.
	Thomsen Oil Co.	806 East South St.
	Chris's Car Wash	907 So. Burlington
	UNK Hwy 6 Hastings	SE Corner Burlington & Hwy 6
	UNK 2nd & St. Joseph Ave	131 N. St. Joseph Ave.
	Unknown (TL Irrigation)	Hastings IND Pk E Hwy 6
	Unknown	Hwy 6 & Burlington
	Unknown	5 miles SSE of Hastings
	Dilly's Truck Stop	1206 East J
	Goodrows 66	702 West B St.
	Handi-Stop/Hutchson	309 S Elm St.
	Bernie Beckest	1100 West J St.
	City of Hastings	1313 No. Hastings Ave.
	City of Hastings	1010 West A St.
	Edwards Oil/Blue Diamond	1407 E South St.
	FAA	Hastings RCAG
	Farmland Industries	3 mi E of Hastings Hwy 6
	Gas N Shop	848 South Burlington
	Great Plains Packaging	2000 Summit
	Imperial Mall Auto Serv	2815 Park Ln.

CITY	OWNER	SPILL LOCATION
Hastings	Kmart Corporation	123 No. Marian Rd.
	Linweld, Inc.	1120 S. Burlington
	NC+ Hybrids	RR2 Box 190
	Nebr Dept. of Roads	5 mi East of Hastings
	Offutt AFB - Detachment HA	Hastings Det, Bldg 500
	Patterson Well Drilling	143 North Maple
	Sealey Body Shop	201 S Hastings
	Taylor Quik Pik	Taylor Quik Pik Inc.
	Union Pacific RR	18th & Burlington
	Quick N Easy	1725 W 2nd St.
	Texaco Inc.	1102 W 2nd (SW 2nd & Bellevue)
	Theis Service Center	302 Denver (3rd & Denver NE)
Hebron	McLaughlin Ent. Hebron	5th & Lincoln St. Ave.
	Nebr Dept. of Roads	East Side of Hwy 81
Juniata	Cenex Inc.	11th & Depot St.
	Farmers Union Gas & Oil	Farmers Union Gas & Oil
Kenesaw	Bettfield, Steven	1.5 S 1.0 W of Kenesaw
Lawrence	Ken & Al's Service Inc.	Hwy 4 & Calvert
	Coop, Farmers-Red Cloud	Hwy 4
Prosser	Coop-Prosser	So. 40-D & Virginia Ave.
	Farmers Union Gas & Oil	S 121' Fo. Sub Lot 1
Ruskin	C & M Supply, Inc.	3 mi S of Ruskin
Steele City	Bud & Bills Ready Mix Inc.	Main Street

4.2.2.8. Septic Tanks

Septic tanks are a known point source of groundwater contamination and are a growing concern, especially in rural subdivisions. However, since registration of septic tanks is not required, no data on locations or density of septic tanks in the LBNRD is currently available.

4.2.3. Wellhead Protection Areas

The following communities in the LBNRD have DEQ delineated Wellhead Protection Areas (WPA) around their drinking water wells:

Blue Hill	Hastings
Bruning	Hebron
Bryon	Kenesaw
Chester	Nelson
Davenport	Ong
Deshler	Reynolds
Edgar	Shickley

Of these communities, only Hastings is taking aggressive action in establishing and enforcing a Wellhead Protection Area. The Village of Deshler has also indicated an interest in establishing a WPA.

5.0 Water Use and Demand

Demands are made on the groundwater reservoir within the Little Blue drainage basin for many purposes. Among these are demands for rural domestic uses, municipal uses, livestock, crops, industries, cooling water for power generation, sub-irrigation of wetlands vegetation, and stream flow for fish and wildlife habitat. Comments on the projected uses of each are based on information from the 1985 Policy Issue Study on Water and Energy by the NRC.

Water use statistics are available by county but not by NRD boundaries. Therefore, the figures reported here are for the entire county and not just for the portion of that county that lies within the borders of the LBNRD.

Table 5.0-1 lists the total withdrawals from groundwater sources for public water supplies in the seven county area and breaks down the usage of that water into Domestic, Commercial, and Industrial categories.

Table 5.0-1
WITHDRAWALS FOR PUBLIC WATER SUPPLY AND DELIVERIES TO WATER-USE CATEGORIES - 1985
(Reference 49)

(Mgal/d - Million gallons per day)

County Name	Withdrawals for public supply[1] (Mgal/d)	Deliveries		
		Domestic (Mgal/d)	Commercial (Mgal/d)	Industrial (Mgal/d)
Adams	5.89	3.08	1.35	1.31
Clay	1.26	1.10	.14	.02
Fillmore	1.32	1.18	.13	.01
Jefferson	1.55	1.35	.14	.02
Nuckolls	.86	.76	.09	.01
Thayer	1.13	1.03	.09	.01
Webster	.51	.43	.06	.01
Total:	**12.52**	**8.93**	**2.00**	**1.39**

[1] Public water supply all from ground water unless noted otherwise.

5.1. Domestic Use

Rural domestic and livestock groundwater demands are made by rural residents to serve the daily needs of their families and livestock. Groundwater is normally supplied for these purposes by small capacity wells ranging from 5 to 20 gpm. Rural domestic and livestock demands do not represent a large portion of the total groundwater demand, but they are very important because of health and economic concerns. If nitrate or bacterial contamination occurs, the health of both residents and livestock is threatened.

Municipal groundwater demands include use of water for domestic purposes, sanitation, fire protection, commercial and industrial purposes, gardening, etc. As seen in Table 5.0-1, the major portion (71%) of the groundwater withdrawn for public water supplies is provided to domestic users. Progressive development in almost all municipal systems is projected to occur.

The quality of groundwater for municipal purposes must meet the chemical requirements for public water supplies as prescribed by the Nebraska Department of Health. Currently the most serious quality concern of most communities is excessive nitrate concentrations in water supplies. Nitrate concentrations exceeding 10 parts per million (ppm) are dangerous to infant children and infant animals. The total annual municipal demand of approximately 14,000 acre-feet is small compared to the total overall demand, but the quality of municipal supplies is critical for the health and economic well being of the residents of the Little Blue NRD.

Tables 5.1-1 through 5.1-3 list 1985 estimates of total domestic water use in the LBNRD seven county area, both from public-supplied and from self-supplied groundwater sources.

TABLE 5.1-1
ESTIMATE OF TOTAL DOMESTIC WATER USE - 1985
(Reference 49)

County Name	Population served	Total Domestic Water Use: Average use (Mgal/d)	GPD per capita[1]/	Annual volume[2]/ (acre-ft)
Adams	31,100	3.33	107	3,730
Clay	7,800	1.29	165	1,440
Fillmore	7,600	1.40	184	1,570
Jefferson	9,500	1.55	163	1,730
Nuckolls	6,700	.92	137	1,030
Thayer	7,300	1.21	166	1,350
Webster	4,600	.68	148	760
Total:	**74,600**	**10.38**	**139**	**11,610**

[1]/ Average use, in Mgal/d divided by population served.
[2]/ Rounded to nearest 10 acre-ft.

TABLE 5.1-2
ESTIMATE OF PUBLIC-SUPPLIED DOMESTIC WATER USE - 1985
(Reference 49)

County Name	Population served	Public-Supplied Domestic Water Use: Average use (Mgal/d)	GPD per capita[1]/	Annual volume[2]/ (acre-ft)
Adams	28,000	3.08	110	3,450
Clay	5,400	1.10	204	1,230
Fillmore	5,000	1.18	236	1,320
Jefferson	6,900	1.35	196	1,510
Nuckolls	4,700	.76	162	850
Thayer	5,300	1.03	194	1,150
Webster	2,500	.51	204	570
Total:	**57,800**	**9.01**	**156**	**10,080**

[1]/ Average use in Mgal/d divided by population served.
[2]/ Rounded to nearest 10 acre-ft.

TABLE 5.1-3
ESTIMATE OF SELF-SUPPLIED DOMESTIC WATER USE - 1985
(Reference 49)

County Name	Self-Supplied Population	Self-Supplied Domestic Water Use: Average use (Mgal/d)[1]	GPD per capita	Annual volume[2] (acre-ft)
Adams	3,100	.25	80	280
Clay	2,400	.19	80	210
Fillmore	2,600	.22	85	250
Jefferson	2,600	.20	85	220
Nuckolls	2,000	.16	80	180
Thayer	2,000	.18	80	200
Webster	2,100	.17	80	190
Total:	**16,800**	**1.37**	**82**	**1,530**

[1] Self-supplied population times GPD per capita divided by 10^6.
[2] Rounded to nearest 10 acre-ft.

5.2. Agricultural Use

5.2.1. Groundwater

Crop groundwater demand is the quantity of irrigation water needed to supplement natural precipitation in raising a crop. Irrigation groundwater demand varies from year to year depending on the amount of rainfall received. Depending on crop requirements and the number of acres of each type crop planted in the basin, current annual groundwater irrigation requirements in the seven county area are approximately 510,000 acre-feet per year assuming normal precipitation occurs. A lesser amount of irrigation water in this area comes from surface water. Surface water irrigation requirements total approximately 60,000 acre-feet per year in this seven county area. Surface water irrigation is discussed in Section 5.2.2.

A 1985 estimate of the total water used for irrigation in these seven counties is shown in Table 5.2.1-1. The number of registered irrigation wells in the seven county area as of 1985 is listed in Table 5.2.1-2. The amount of groundwater withdrawn by these wells, further broken down into center pivot distribution systems and gravity distribution systems is listed in Tables 5.2.1-3 and 5.2.1-4, respectively. Locations of registered irrigation wells in the LBNRD are shown on Figure 13-11. Locations of registered non-irrigation wells in the LBNRD are shown on Figure 13-22.

TABLE 5.2.1-1
ESTIMATE OF TOTAL WATER USED FOR IRRIGATION
1985
(Reference 49)

County Name	Estimated acres irrigated	Average seasonal application (in/acre)[1]	Average use rate (Mgal/d)	Annual volume (acre-ft)[2]
Adams	164,960	7.5	93.45	104,760
Clay	176,950	8.0	102.18	114,540
Fillmore	186,080	8.5	117.01	131,170
Jefferson	53,650	9.0	36.09	40,460
Nuckolls	58,870	11.0	47.76	53,540
Thayer	115,950	7.5	63.30	70,960
Webster	50,360	12.5	47.62	53,380
Total:	**806,820**	**9.1**	**507.41**	**568,810**

[1] Rounded to nearest 0.5 in.
[2] Rounded to nearest 10 acre-ft.

TABLE 5.2.1-2
NUMBER OF REGISTERED IRRIGATION WELLS, METHOD OF DISTRIBUTION, AND ESTIMATED ACTIVE IRRIGATION SYSTEMS - 1985
(Reference 49)

County Name	Registered irrigation wells	Method of distribution		Estimated active systems 1985		
		Gravity	Center Pivot	Gravity	Center Pivot	Total
Adams	1,909	1,454	455	1,235	428	1,663
Clay	2,045	1,623	422	1,379	400	1,779
Fillmore	1,944	1,172	772	996	721	1,717
Jefferson	537	298	239	253	214	467
Nuckolls	576	471	105	401	92	493
Thayer	1,259	854	405	726	386	1,112
Webster	451	264	187	225	166	391
Total:	**8,721**	**6,136**	**2,585**	**5,215**	**2,407**	**7,622**

TABLE 5.2.1-3
ESTIMATED GROUNDWATER WITHDRAWAL FOR IRRIGATION BY CENTER-PIVOT DISTRIBUTION SYSTEMS - 1985
(Reference 49)

County Name	Active center-pivot systems 1985	Estimated acres irrigated	Groundwater used by center pivots		
			Season application (in/acre)[1]	Average use rate (Mgal/d)	Annual volume (acre-ft)[2]
Adams	428	56,920	6.0	25.57	28,660
Clay	400	53,200	6.0	24.40	27,350
Fillmore	721	95,890	7.5	53.95	60,480
Jefferson	214	28,460	8.0	17.18	19,260
Nuckolls	92	12,240	7.0	6.24	7,000
Thayer	386	51,340	6.0	22.94	25,720
Webster	166	22,080	9.5	15.21	17,050
Total:	**2,407**	**320,130**	**7.1**	**165.49**	**185,520**

[1]/ Rounded to nearest 0.5 in.
[2]/ Rounded to nearest 10 acre-ft.

TABLE 5.2.1-4
ESTIMATED GROUNDWATER WITHDRAWAL FOR IRRIGATION BY GRAVITY DISTRIBUTION SYSTEMS - 1985
(Reference 49)

County Name	Active gravity systems	Estimated acres irrigated	Groundwater use by gravity systems		
			Season application (in/acre)[1]	Average use rate (Mgal/d)	Annual volume (acre-ft)[2]
Adams	1,235	104,000	8.5	65.34	73,250
Clay	1,379	117,220	8.5	73.69	82,610
Fillmore	996	84,660	9.5	59.06	66,210
Jefferson	253	21,520	10.5	16.40	18,390
Nuckolls	401	34,080	9.0	22.21	24,900
Thayer	726	61,710	8.5	38.55	43,210
Webster	225	19,130	11.0	15.63	17,520
Total:	**5,215**	**442,320**	**9.4**	**290.88**	**326,090**

[1]/ Rounded to nearest 0.5 in.
[2]/ Rounded to nearest 10 acre-ft.

Table 5.2.1-5 lists the cumulative number of registered irrigation wells in the LBNRD by county by year. Prior to 1955 there were only 128 registered irrigation wells in the Little Blue NRD. The number of irrigation wells registered increased rather dramatically in the five years 1954 to 1959 and again in the five-year period from 1974 to 1979. The locations of registered irrigation wells are shown in Figure 13-11. The total number of registered irrigation wells in the Little Blue NRD at the end of 1994 is 5,671.

Table 5.2.1-5
Registered Irrigation Wells in The Little Blue NRD[1]

Year	Adams	Clay	Fillmore	Jefferson	Nuckolls	Thayer	Webster	Cumm[2] Total
1942	0	1	0	0	0	0	0	1
1949	5	4	0	1	8	6	2	26
1954	35	34	13	1	21	21	3	128
1959	490	373	210	32	206	445	26	1,782
1964	563	432	237	36	242	486	33	2,029
1969	807	624	311	75	330	716	55	2,918
1974	1,035	770	361	83	376	858	78	3,561
1979	1,390	984	454	127	482	1,107	100	4,644
1984	1,557	1,057	506	153	522	1,249	107	5,151
1989	1,619	1,096	522	156	543	1,305	109	5,350
1994	1,727	1,141	546	163	585	1,390	119	5,671

1 Include registered irrigation wells located within the LBNRD boundaries and not throughout the entire county.
2 Number of well registrations are cumulative to the end of that year.

Sub-irrigation groundwater demands include groundwater which is withdrawn directly from the water table by vegetation. Sub-irrigation occurs in the wetland areas where the depth to the water table is quite shallow. Sub-irrigation areas produce lush native grass for hay and also support trees and other vegetation all of which use significant quantities of groundwater. In some areas where the water table is not too shallow (5 to 20 feet deep) cropping of sub-irrigated areas can be accomplished. Sub-irrigation groundwater demand in the LBNRD has not been quantified.

The quality of water used for irrigation must be good in order for profitable yields to be obtained. Groundwater irrigation is projected to increase very gradually. Increases may be dependent on the degree of profitability realized.

5.2.2. Surface Water

The amount of surface water used for irrigation in the LBNRD is approximately one-eighth the amount of groundwater used for that purpose. Tables 5.2.2-1 and 5.2.2-2 list the estimated use of surface water for irrigation in the seven county area based on withdrawal permits issued by DWR in 1985.

TABLE 5.2.2-1
ESTIMATED USE OF SURFACE WATER
FOR IRRIGATION - 1985
(Reference 49)

County Name	Number of withdrawal permits	Acres registered for permits	Estimated acres irrigated in 1985	Surface water used for irrigation: Average seasonal withdrawal (in/acre)[1]	Surface water used for irrigation: Average use rate (Mgal/d)	Surface water used for irrigation: Annual volume (acre-ft)[2]
Adams	118	6,475	4,040	8.5	2.54	2,850
Clay	148	12,931	6,530	8.5	4.09	4,580
Fillmore	128	10,706	5,530	9.5	4.00	4,480
Jefferson	97	6,343	3,670	9.0	2.51	2,810
Nuckolls	92	7,170	12,550	20.5	19.31	21,640
Thayer	102	5,199	2,900	8.5	1.81	2,030
Webster	65	11,745	9,150	24.5	16.78	18,810
Total:	**750**	**60,569**	**44,370**	**12.7**	**51.04**	**57,200**

[1] Rounded to nearest 0.5 in.
[2] Rounded to nearest 10 acre-ft.

TABLE 5.2.2-2
SURFACE WATER DIVERTED FOR IRRIGATION PROJECTS
1985
(Reference 49)

County Name	Acres irrigated	Acre-feet diverted to canals	Average diversion rate (Mgal/d)	Average annual diversion (in/acre)[1]	Acre-feet delivered to farm headgates	Average delivery rate to farm headgates (Mgal/d)	Average seasonal application (in/acre)[1]
Nuckolls	6,800	17,000	15.17	30.0	10,200	9.10	18.0
Webster	6,440	16,100	14.36	30.0	9,660	8.62	18.0
Total:	**13,240**	**33,100**	**29.53**	**30.0**	**19,860**	**17.72**	**18.0**

(No Diversions Reported in Adams, Clay, Fillmore, Jefferson or Thayer Counties.)

[1] Rounded to nearest 0.5 inch.

Surface water rights may be obtained from the Department of Water Resources. The role of the LBNRD with respect to surface water diversion is limited. However, the district could be an applicant to obtain a surface water right for various purposes. The district can adopt rules and regulations with respect to groundwater withdrawal and groundwater protection. Chapter 46, Section 666.01 is specific in requiring a Natural Resources District to consult with holders of any permits for intentional or incidental groundwater storage and recovery pursuant to Section 46-226.02, 46-233, 46-240, 46-241, 46-242, or 46-297 prior to adopting or amending any rules or regulations for a management area pursuant to Section 46-673.09. Provisions of Section 46-673.-09, which authorize a district to manage the use of water in a management area, include a provision for requiring best management practices.

State law would appear to permit an NRD to apply for a surface water right for storage and/or other facilities to intentionally recharge groundwater. In this regard, the NRD could cooperate with other water suppliers in water management efforts involving either incidental or intentional groundwater recharge including the recovery of water.

5.3. Industrial Use

Industrial groundwater demands include water which is public-supplied or self-supplied by industry for processing, sanitation, raw material, etc. Good water quality is critical to the success of many manufacturing processes. Poor quality water can damage manufacturing equipment and may increase production costs to a point where production is economically unfeasible. Industrial growth is continually being pursued and such growth will increase water demand.

Power generation groundwater demands include water which is used to cool generating equipment and aid in the efficient production of power. Total estimated use of water for power generation in 1985 in the seven counties area was 1.10 Mgl/d or approximately 1,230 acre-feet per year.

Table 5.3-1 lists 1985 estimates of water use for commercial, industrial, and mining purposes in the seven counties which, in whole or in part, make up the LBNRD.

TABLE 5.3-1
ESTIMATES OF WATER USE FOR COMMERCIAL, INDUSTRIAL, AND MINING PURPOSES - 1985
(Reference 49)

	Commercial		Industrial		Mining
County Name	**Self-supplied (Mgal/d)**	**Public supplied (Mgal/d)**	**Self-supplied (Mgal/d)**	**Public supplied (Mgal/d)**	**All self-supplied (Mgal/d)**
Adams	.01	1.35	.80	1.31	.00
Clay	.00	.14	.00	.02	.88
Fillmore	.00	.13	.00	.01	.00
Jefferson	.00	.14	.30	.02	3.09
Nuckolls	.00	.09	.20	.01	3.61
Thayer	.00	.09	.00	.01	1.32
Webster	.00	.06	.00	.01	1.32
Total:	**0.01**	**2.00**	**1.30**	**1.39**	**10.22**

5.3.1. Agricultural Industrial Use

The greatest agricultural industrial demand for water is in the livestock production industry. Here again, the need for good quality water is obvious. The estimated water usage (both groundwater and surface water) for livestock production in 1985 for the seven county area is given in Table 5.3.1-1.

TABLE 5.3.1-1
ESTIMATES OF LIVESTOCK WATER USE - 1985
(Reference 49)

	Water use in Mgal/d			Annual volume used in acre-feet		
County Name	**Ground-water**	**Surface water**	**irrigated Total**	**Ground-water**	**Surface water**	**Total**
Adams	1.19	.25	1.44	1,330	280	1,610
Clay	1.87	.22	2.09	2,100	240	2,340
Fillmore	.96	.14	1.10	1,080	160	1,240
Jefferson	.83	.13	.96	930	150	1,080
Nuckolls	.78	.12	.90	870	130	1,000
Thayer	.75	.13	.88	840	150	990
Webster	.76	.16	.92	850	180	1,030
Total:	**7.14**	**1.15**	**8.29**	**8,000**	**1,290**	**9,290**

5.4. Fish and Wildlife Needs

The Little Blue River Valley provides habitats for a number of species of fish, mammals, water fowl, and birds. Stream flow in the river and the interrelated groundwater supply has a significant impact on these habitats.

The Policy Issue Study on Instream Flows, 1982, (Reference 52), contains a table of recommended fishery flows for the 51 mile reach of the Little Blue River from the confluence with Pawnee Creek (near Deweese) to the confluence with Big Sandy Creek (near Alexandria). The flows vary each month of the year. The study also includes a map of the state with a legend identifying the reach of the Little Blue River from Hebron to the state line as a stream with continuous flow throughout the year, significant instream flow values, and base flows that are not entirely committed to existing water rights. The reach of the river from Hebron to the headwaters is identified as a stream that does not exhibit continuous flow throughout the year.

The rainwater Basins located in Adams, Clay, Fillmore, and Thayer Counties are considered some of the better waterfowl production areas in the state. The U.S. Fish & Wildlife Service and the Nebraska Game and Parks Commission have purchased a number of land tracts containing marshes and wetlands for production of waterfowl and for public utilization (hunting and wildlife observation).

The Little Blue NRD is aware of the impact their actions may have on fish and wildlife and their habitats. The NRD Board of Directors is committed to providing for the needs of fish and wildlife in their district. The LBNRD's position on the protection of threatened or endangered species in the district is presented in Section 10.10.

5.5. Economic Value of Water

In order to prioritize the uses of water for purposes of better management, the relative economic value of alternative uses needs to be evaluated. As competition for available water increases in the future, the economic value of the use will likely be an important factor in managing development of facilities which have higher water demands.

Groundwater is the economic lifeblood of the Little Blue NRD. If the groundwater supply were to deteriorate substantially in either quantity or quality, competition for the remaining usable supply would likely be fierce. In some states where usable water is in short supply, allocation of water is made largely on an economic basis. In Colorado, water rights are bought and sold in a manner similar to mineral rights. Water rights do not necessarily transfer with ownership of real estate.

Fortunately, water of suitable quality is not in short supply in most areas of the Little Blue NRD. The economic value of water is not determined by the highest bidder. The economic value of groundwater could be estimated from the use which is made of it. It follows that good quality water which is suitable for many uses has a greater economic value than poorer quality water which has limited use. Water which is usable for some purpose may have little value for other purposes. For example, water which is high in nitrates has diminished value for domestic purposes, but may be more valuable for irrigation than water with low nitrates.

Poor quality water which has little value in a water rich area may have high economic value in other areas where water is in short supply.

In summary, all water is invaluable, but the economic value of water at any place or time depends on many aspects and can change rapidly depending on general economic conditions in the area where it is used. Ironically, a change in quantity or quality of water supply can also rapidly change the overall economy of an area. The economic value of water is a moving target, which probably can only be accurately measured in dollars if the value is assigned in an open market.

6.0 Identification of Problem Areas

Water quantity and water quality problems have been described in the previous chapters. Some problems are naturally occurring and are related to the geology of the area. For example, groundwater is in short supply over the buried and outcropping bedrock ridges (see Figures 13-3, 13-4, 13-7, 13-9, and 13-12). Water of poor to very poor quality is known to occur in the Dakota Sandstone Formation in the areas generally west of a north-south line through Fairbury. Little is known about the natural levels of radionuclides, but evidence elsewhere in the state suggests that they may be present above MCLs in wells developed in some of the cretaceous bedrock units.

Other problems of water quality and quantity have developed as the result of human activities. These problems include: Water level declines and reduction in groundwater storage; elevated levels of nitrate-nitrogen; and leaky underground storage tanks and improper disposal of hazardous wastes.

6.1. Water Quantity Problem Areas

Groundwater declines have occurred and a significant quantity of groundwater has been removed from storage over the past 50 years. Although there is little direct evidence, it can be assumed that well interference and lowered water levels have resulted in reduced yields of wells during the irrigation season in some areas. Water withdrawal for irrigation accounts for most of the water level declines and reduction in storage. However, the withdrawal of water for public supply has also contributed. Notably, the City of Hastings is a major contributor to water level declines in northeast Adams County due to withdrawal of water for municipal use and cooling purposes (see Figure 13-14).

Concern about water level declines led to the creation of a Groundwater Control Area in 1979 (Figure 13-23). The Groundwater Control Area was dissolved in 1993 after a hearing (Sec. 1.1.2). Testimony presented at the hearing indicated that water levels appear to have stabilized.

The LBNRD continues to have concern about management practices that include excessive withdrawal and application of water for irrigation. The concern is based not only upon declines in water levels, but also upon the likelihood that excessive application of water leaches chemicals to the groundwater reservoir.

Water levels have been monitored since the late 1940's and early 1950's through the cooperative efforts of the USGS and CSD (see Location of Observation Wells, Figure 13-24). The LBNRD has continued and expanded that program and is storing the data electronically. Data verification is a continuing effort including well identification and determination of ground altitudes for each well. Plans for implementation and criteria for creating a GWMA for quantity controls are described in Section 10.6.1.

Areas where problems of declines and reduction in storage appear to be the most severe are depicted in Figure 13-14. They include the Hastings-Glenville-Fairfield area and the Shickley-Bruning area. Because the southwest to northeast trending paleovalley in western Thayer County and the paleovalley from Chester to Fairbury in southern Thayer and Jefferson Counties are somewhat restricted in width of the cross section, these areas may deserve close scrutiny. The Chester to Fairbury paleovalley is contiguous with an irrigation area in Kansas. The LBNRD is cooperating with their counterpart in Kansas in sharing information about water levels and water use across the state line.

In addition to other efforts of the LBNRD to address problems of water level declines, two recharge structures on Big Sandy Creek were constructed. The MARC site near Fairfield in Clay County was completed in 1980 and the other near Bruning in 1984. Both sites have contributed significantly to groundwater recharge and have provided excellent habitat for wildlife and in particular for migratory water fowl. Quantification of recharge was studied for a number of years at the MARC site (References 54 and 55). Water levels in the aquifer in the area are still being monitored by the LBNRD.

6.1.1. Rural Water Systems

Large areas south of the Little Blue River in Webster, Nuckolls, Thayer, Jefferson and Southeast Fillmore Counties have limited groundwater supplies for municipal, stock, or domestic wells (Figure 13-4). Poor water quality, either naturally occurring or due to nitrate-nitrogen contamination (Figure 13-16) further exacerbates water supply problems in these areas. The LBNRD has responded to concerns in parts of Jefferson and Thayer Counties by creating rural water systems (Figure 13-13) since 1979. Planning is ongoing to create another rural water district in southwestern Jefferson County. The source of the supply to date has been from the City of Fairbury.

6.2. Water Quality Problem Areas

The overall vulnerability of the groundwater in the LBNRD is indicated on the DRASTIC map (Figure 13-25).

6.2.1. Nitrate-Nitrogen Contamination

The occurrence and problems related to contamination of nitrates is discussed in Chapter 3 and illustrated in Figure 13-16. Elevated levels of nitrate-nitrogen are attributed to both point and non-point sources. High levels of nitrate-nitrogen in domestic wells in the non-irrigated portions of the NRD are generally considered to be due primarily to well siting and construction. Contributing to the problem may be the age of wells and proximity to local sources of contamination such as septic tanks, abandoned wells, cess pools, animal wastes and fertilizer application. The LBNRD will continue to analyze domestic wells for nitrate-nitrogen, investigate for non-point sources and help provide case-by-case evaluation. One of the solutions to water quality problems of this nature has been for the NRD to explore and develop the potential for rural water districts.

Nitrate-nitrogen levels above 3 ppm in the irrigated portion of the LBNRD are generally believed to result from excessive application of fertilizer and water. Non-point sources of contamination may also account for levels of nitrate-nitrogen in some domestic wells. Evidence available to date suggests that nitrate-nitrogen contamination is not aquifer wide and that localized areas with elevated levels occur along side or near other areas or sampled wells with relatively low levels of nitrates. This evidence suggests that individual fertilizer and water management practices may account for apparent differences. Some evidence (see 3.1.2.4.1 and 3.1.3) suggests that nitrate levels may have approached equilibrium conditions. If this is the case, elevated contamination levels may be largely due to farming practices prior to the last two to fifteen years. However, elevated levels of nitrate-nitrogen is a concern to the district and the LBNRD requested DEQ to study the eastern portion of the NRD (3.1.2.2).

The DEQ study identified six subareas where the potential for contamination was considered to be at high risk because of the geology. Two of the subareas, Byron-Deshler and the Bruning area had relatively high average nitrate levels. The procedures the LBNRD plans to implement to address non-point contamination problems are described in Section 10.5.

Nitrate-nitrogen levels in a few wells sampled in the shallow water table area of extreme northwest Adams County are high (Figure 13-16). Areas with sandy soils and shallow depths to water, as is the case there, are susceptible to leaching of agricultural chemicals to the aquifer.

6.2.2. Superior - Hardy Area

The LBNRD and Lower Republican NRD (LRNRD) jointly requested a study from DEQ for an SPA in southeastern Nuckolls County (Figure 13-23). After investigation, the area was designed an SPA in February 1990. An action plan jointly prepared by the two NRDs was approved by DEQ in January 1991. The USGS, in cooperation with the NRDs, installed and sampled 20 dedicated monitoring wells at 16 locations. Progress has been summarized in DEQ and USGS interim reports. A final report evaluating and describing results of the USGS study, "Groundwater and Vadose Zone Monitoring of the Superior-Hardy SPA, Nuckolls County, Nebraska," has been completed and is now being reviewed prior to publication.

The Superior-Hardy area was the first SPA designated in Nebraska. The LBNRD and the LRNRD are jointly funding sample collection, analyses and implementing the action plan.

6.2.2.1. Hazardous Wastes

The LBNRD does not have primary responsibility for contamination resulting from leaky underground storage tanks (LUST), (see 4.2.2.7), hazardous chemical spills, use of grain fumigants, land fills or other potential point sources of contamination. The district has cooperated with NDEQ and NDOH in this regard and have been involved in educational programs and as public participants.

In addition to the LUST sites, which have been identified at a number of places in the NRD (generally near towns or cities), water contamination by hazardous substances from several sources has been identified at the Hastings Groundwater Contamination Site. Initial investigation was done in 1983 and NDOH and NDEQ sampled wells or contracted for sampling and evaluation of the contaminated area. Since 1983, the City of Hastings has taken three municipal wells out of service and placed others on standby (Reference 48).

After the initial investigation, EPA evaluated the site and determined that the site warranted its placement on EPA's Superfund National Priority List of hazardous waste sites. Seven subsites have been identified within or east of Hastings. Monitoring, investigation and clean-up activities are ongoing.

A study to appraise the effects of artificial recharge on groundwater at the Bruning site (Structure 35-5-2) in the Big Sandy Creek watershed was made by CSD under contract with the LBNRD (References 3 and 4). Monitoring wells were installed and samples from them, nearby domestic wells, and surface water were analyzed for nitrates and several pesticides. Runoff into the reservoir did not appear to contribute nitrates to the regional groundwater reservoir. Pesticides were found to be relatively high in the surface water after runoff events. Several pesticides were detected in shallow monitoring wells and at very low levels in household wells around the structure. Levels of pesticides from wells sampled in the regional aquifer were well below MCLs. The LBNRD is continuing to monitor water quality at and around the site at three-year intervals.

6.2.3. Radionuclides

Samples from seven public water supply wells were analyzed for Radon by NDOH in 1991. All were below 300 pCi/l with the exception of a well at Lawrence, which had 2,334 pCi/l of Radon. The source of the Radon may be the Niobrara Chalk Formation. Some domestic wells, stock wells, and a few irrigation wells obtain water from the Niobrara. The City of Nelson also has wells developed from the Niobrara. Generally, radionuclides are probably not a problem elsewhere in the district.

7.0 Groundwater Goals and Objectives

As a whole, the entire Little Blue River Basin is fortunate to have an abundance of good quality groundwater. It is the intention of the Little Blue Natural Resources District Board to maintain this high quality supply for uses by their constituents both now and in the future. For this purpose, the LBNRD has adopted a Groundwater Reservoir Life Goal, which is as follows:

"Maintain an adequate supply of acceptable quality and quantity groundwater to forever fulfill the reasonable groundwater demands within the Little Blue NRD."

This goal is a combined and reworded version of the quantity and quality goals stated in the 1986 GWMP. The Groundwater Reservoir Life Goal is the major goal of the LBNRD in its groundwater planning efforts. All of the other efforts described here, including the following objectives, the programs and policies presented in Section 8.0, and the groundwater management area implementation plans presented in Section 10.0, are LBNRD plans intended to achieve the Groundwater Reservoir Life Goal.

The following objectives have been established by the LBNRD Board to achieve the Groundwater Reservoir Life Goal. Actual programs in support of these objectives are described in Section 8.0. These objectives are also supported by the groundwater management area implementation plans presented in Section 10.0.

8. <u>Groundwater Quantity Objectives</u>

   The following objectives have been updated and expanded from the 1986 GWMP.

   1. Work toward elimination of excessive and inefficient use of groundwater through education, technical assistance, and cost share incentives.
   2. Enforce Rules and Regulations for improper irrigation runoff.
   3. Work closely with adjoining NRDs in monitoring static water levels and if declines occur, develop a uniform program of corrective measures with neighboring Districts.
   4. Establish an expanded well monitoring program.

5. Closely follow the results of the well monitoring program and take the actions described in Section 10. as problems are recognized.
6. Obtain funding for groundwater quantity conservation programs.

8.1. Groundwater Quality Objectives

The following objectives have been updated and expanded from the 1986 GWMP.

1. Keep the public informed on current water quality conditions and educate the public on the hazards of potential contaminants.
2. Educate the public in the use of best management practices and other methods of reducing groundwater contamination.
3. Work closely with adjoining NRDs in monitoring water quality conditions and if problems occur, develop a uniform program of corrective and further preventive measures with neighboring Districts.
4. Establish an expanded water quality monitoring program for domestic and irrigation wells.
5. Closely follow the results of the well monitoring program and take the actions described in Section 10 as problems are recognized.
6. Obtain funding for groundwater quality improvement and conservation programs.

8.0 Groundwater Programs and Practices

The following programs are established to support the objectives presented in Section 7.0 in order to achieve or maintain the stated Groundwater Reservoir Life Goal for the District. Most of these programs are currently in effect while others will be expanded or enacted in the future. It should be understood that full development of all the programs will be dependent on their individual priority and the available economic resources. Unidentified programs and priority ratings may evolve as further understanding of the groundwater system and future development indicates it prudent.

Full details on current programs, services, and cost-share programs offered by LBNRD are available at the LBNRD's offices. This listing is only a partial brief listing of NRD programs pertaining to groundwater and surface water quality and quantity.

8.1. <u>Programs</u>

8.1.1. <u>Educational Programs</u>

LBNRD education programs serve schools, youth groups, organizations and the general public. The goal is to help develop positive environmental ideas for future generations. Conserving and preserving starts at a young age, with the responsibility growing throughout the years.

Materials/Activities

*Environmental resource materials, information and curriculum are available for photocopying or to check out on a variety of subjects, such as water, plants, wetlands, wildlife, soil, recycling and legislation.

*Curriculum Guides are available for use at LBNRD recreational areas, outdoor classrooms or in the classroom.

*Environmental comic books are available upon request - water, wildlife and plants.

*Videos can be loaned out on several topics.

*Soil and Stewardship materials are available for churches.

*Newsletters for special projects and the District's Heritage Newsletter are sent to NRD residents.

*Scholarships are given to Seniors in High School and Juniors in College who are pursuing a career in Natural Resources. (Six per year.)

*Scholarships are available for 4-H, FFA and Scouts to attend state and local camps. (4-H Expro-visions, Halsey 4-H Camp, Range Camp and others.)

*Outdoor classrooms can be pursued by schools that offer a plan, work schedule and adopt curriculum addressing the area. A grant for materials is available along with technical assistance and curriculum.

*Recreational Areas throughout the District offer an excellent outdoor classroom.

*Land and Range Judging contests, Envirothon and other special projects are supported by the NRD.

*Groundwater Models can relate the groundwater flow and possible contamination to individuals. The District has two models and will demonstrate them within a program about groundwater. They may also be loaned out on a case by case basis.

*Classroom Presentations by NRD staff can complement curriculum topics ranging from the environment to professional.

*Assistance is offered to students needing information for studies and papers about the environment, etc.

Special Events

*Arbor Day hosts many possibilities for groups, schools and organizations. Free trees are available with a short program.

*Teacher Workshops for Project Wild, Stop Look and Learn, Aquatic Wild and other curriculum are available if there is enough interest.

*Southeast Nebraska Environmental Education Seminar is a two week course for college credit that awakens new ideas for hands on activities in the classroom. Held at Camp Jefferson near Fairbury.

*Water Jamboree at Liberty Cove near Lawrence enlightens over 1,000 5th and 6th graders from six south central counties about water quality, wildlife, plants and their interaction. The two day festival is held in early September.

*Water Adventure Days creates new ways for students to learn about the environment around them. The two day event at Camp Jefferson near Fairbury hosts 400 5th and 6th graders from three southeastern counties.

*Contests are occasionally organized for special projects and events.

8.1.2. Water Quality Sampling Program

The LBNRD will expand its water quality sampling and monitoring network by adding additional monitoring wells, both irrigation and domestic. Sampling protocol is also being revised. Full details have been presented in Section 3.1.2.4.0.1 of this plan.

8.1.3. Groundwater Nitrate Testing Service

The Little Blue Natural Resources District offers a free testing service for nitrates to any District resident. Testing for other water contaminants can be done by the Department of Health, Nebraska State Health Lab, 3701 South 17th, Lincoln, NE 68502, (402) 471-2122, or by any private laboratory. A current list of private labs can be obtained at the NRD office.

8.1.4. Technical Assistance Programs

In addition to the education programs described above, the LBNRD will:

1. Provide voluntary training sessions on water management techniques, pumping plant efficiency, new technologies and research, fertilizer management, etc.
2. Sponsor and participate in demonstration projects which stress items above.
3. Provide public information and education programs through newsletters, articles, pamphlets, TV, radio, magazine and public forums.
4. Establish water conservation, lawn care and management programs in cooperation with cities and villages.
5. Encourage the use of BMP's, such as:
   a. Irrigation scheduling
   b. Water measurement devices
   c. Irrigation recycle systems
   d. Land leveling
   e. Fertilizer management
   f. Integrated pest management
   g. Tillage practices
   h. Conservation practices
6. Provide technical assistance in developing efficient irrigation systems and management schemes.
   a. Use of Ultrasonic Flow Meter on an individual basis
   b. Center pivot adjustments and new technologies
   c. Automatic rainfall shutoffs for wells
   d. Gravity field irrigation management practices
   e. Conservation practice design, layout and cost share

8.1.5. Well Abandonment Assistance Program

This program provides cost-share for proper decommissioning of abandoned wells according to Title 178, Chapter 12 of the Department of Health regulations governing water well abandonment standards. All decommissioning activities must be conducted by a LICENSED WELL DRILLER OR PUMP INSTALLER. Certain requirements must be met and procedures followed. Full details are available at the LBNRD office.

8.1.6. Chemigation Permits

The Nebraska Chemigation Act was adopted by the Legislature in 1986 which provided the Natural Resources Districts and the Department of Environmental Quality (DEQ) with the authority to document, monitor, regulate, and enforce chemigation practices in Nebraska. This Act requires NRD's to inspect chemigation safety equipment and issue permits to potential chemigators or applicators. The Act also requires chemical applicators to be certified by the DEQ through a testing procedure. This requires attending a training session and passing an examination by the Extension Service. Certifications for chemigators are good for a duration of four years.

Permit Requirements: Any landowner or operator who desires to use chemigation must first obtain a permit for each chemigation injection site from the NRD. After the NRD inspects the required safety equipment and finds such equipment in proper working order a permit can be issued. All permit renewals must be submitted before June 1st of each calendar year. The costs are thirty dollars for a new permit and ten dollars for each renewal. These costs are payable to the Little Blue Natural Resources District.

8.1.7. Assistance For 404 Permits

The Little Blue NRD provides site inspection and consultation to District residents interested in stream and wetland alteration projects.

Such activities as altering or changing water courses, stream bank stabilization, and dredging or filling in water courses or wetlands all require federal permission.

The District has applied for and received a General Pemit to streamline the process for construction of select bank protection methods in the District.

The District staff will provide assistance in obtaining and completing 404 Permit applications to file with the Army Corps of Engineers for such projects.

8.1.8. Irrigation Runoff Complaint Assistance Program

The Little Blue NRD started its irrigation water runoff control program in 1976. State statutes declare that any irrigation runoff which causes or contributes to the accumulation of water upon or beneath the surface of the lands of any other person(s) is illegal. Any landowner, tenant or resident of the District may file a complaint with the NRD if irrigation water is running onto his/her property from adjacent lands. An inspection will be conducted to determine if a violation of the District's rules and regulations has in fact occurred. If found in violation, the irrigator must take appropriate action to stop the runoff situation.

If voluntary measures are not pursued by a violator, a strict regulatory procedure will be initiated by the District. This involves formal hearings, cease and desist orders, and eventually court proceedings. The Little Blue NRD strongly encourages the parties involved in runoff complaints to resolve their conflict before pursuing District intervention or court proceedings.

8.1.9. Erosion and Sediment Control Program

In 1986 the Nebraska Legislature adopted the Erosion and Sediment Control Act. The Act represents a commitment by the State of Nebraska to reduce soil erosion, sedimentation and other problems that result from that erosion. Part of that commitment required each NRD in the State to develop a local program to address soil erosion and sediment problems. This was completed in 1987. The program also provides a complaint process by which sediment complaints may be filed with local NRD's.

8.1.10. Land Treatment Program

This program provides soil and water conservation incentives in the Little Blue Natural Resources District. The NRD administers State of Nebraska Soil and Water Conservation Program (NSWCP) funds and local Little Blue Soil and Water Conservation Program (LBSWCP) funds to eligible landowners for land treatment practices to help control soil erosion and sedimentation, and to conserve water resources in the District. The District prefers to use federal funds (ACP) first, state funds next (NSWCP) and district funds last. The NRD distributes funds to each county within the District based on percent of the land area each county contributes to the makeup of the Little Blue NRD.

Full details on eligible projects, requirements, limitations, and cost-share amount are available at the LBNRD office.

8.1.11. Urban Conservation Assistance Program

This program provides assistance to citizen groups and governmental agencies in their efforts to reduce and prevent soil erosion, flooding and related resource problems in urbanized areas. The District will provide technical and financial assistance on eligible projects sponsored by citizen groups, private organizations or governmental agencies.

1. Acceptable Projects:

   *Development and Improvement of Recreation and Public Use Lakes
   *Permanent Grade Stabilization Structures
   *Stormwater Management Facilities (e.g. detention structures, improved channels)
   *Diversions and Terraces
   *Permanent Critical Area Seeding and Mulching ($100/acre maximum)
   *Grassed Waterways

8.1.12. Special Projects Cost-Share Program

This program provides cost-sharing for special projects toward the enhancement of natural resources. Special projects may be established by the Board of Directors by majority vote if it is considered within the statutory authorities and responsibilities of the NRD. Special projects are considered on a case by case basis, each on its own merit. The percentage of District cost-share or project participation shall be determined by the Board.

8.1.13. Wildlife Habitat Improvement Program

A cooperative Wildlife Habitat Improvement Program (WHIP) between the Little Blue NRD and the Game and Parks Commission has been created to enhance or protect existing wildlife habitat on private land through contracts with landowners. Cooperation landowners are offered financial assistance for establishing new wildlife habitat or improving existing habitat. Full details on this program are available at the LBNRD office.

9.0 Groundwater Management And Protection Act Authorities

9.1. Legal Background

The State of Nebraska passed the Groundwater Management Act in 1975, in response to the growing concern over the depletion of the groundwater through mining of the aquifers occurring in the state. This act provided the means by which groundwater depletion could be controlled and regulated. The original Act did not address groundwater quality issues.

In 1982, the Nebraska state legislature revised the Groundwater Management Act to allow creation of groundwater management areas, but the focus of the Act was still on water quantity. The title of the Act was changed to the Groundwater Management and Protection Act (GWMPA). A 1984 revision to this Act called for each of the twenty-three NRDs to develop a groundwater management plan, which would inventory the groundwater resources within each district. Further revisions, included in the 1986 update of the Act, defined the role of the Natural Resources Districts and provided the means by which they could address non-point source groundwater contamination. Even more emphasis was placed on water quality when, in 1991, legislation was passed that required revision of the groundwater management plans to address water quality concerns in detail.

With these revisions, the state has given primary responsibility to the NRDs for administering non-point source regulations through the ability to implement Groundwater Management Areas (GWMA's).

Additional responsibilities and authorities were given Districts in the Act with the passage of LB 962 in 2004. Amendments to the Act are intended to provide procedures and tools to address conflicts between surface and groundwater users when integrated management of the ground and surface water resources is necessary.

For a more complete summary of groundwater management legislation see Appendix 12.1.

9.2. Groundwater Management Areas

The NRDs are the primary entity responsible for the areas of groundwater quantity issues and non-point source water quality contamination concerns. Through the Groundwater Management and Protection Act (GWMPA), there are two options available for dealing with non-point source groundwater contamination: 1) The establishment of Special Protection Areas (SPA's) by DEQ and (2) the establishment of Groundwater Management Areas (GWMA's) by the NRD. Special Protection Areas can be established by DEQ after a study, hearing and determination that non-point source contamination is occurring within a definable area. The NRD must then prepare an "action plan" designed to stabilize or reduce the level and prevent the increase or spread of groundwater contamination. The action plan must be approved by DEQ. DEQ will adopt and enforce protective measures in an SPA if the local NRD does not. A Management Area may be established by the local NRD after preparation of a groundwater management plan and a public hearing conducted by the NRD. While the plan must be reviewed by state agencies, it can be implemented even without their approval. A pre-existing problem with groundwater quantity or quality is not required to establish a GWMA. The purpose of a GWMA is to protect groundwater quantity and/or quality.

Through the GWMPA there are also two options available for dealing with groundwater quantity problems. The first option, available to NRD's, is the establishment of a GWMA as discussed above. The second option is the establishment of a Control Area (CA). Control areas involve actions by DWR after a hearing requested by the NRD, and are established mainly for groundwater quantity protection in areas where there is an inadequate supply of groundwater for present and reasonably foreseeable use.

SPA's are somewhat reactive in nature, in that contamination must be occurring or be likely to occur before the program goes into effect. A management area, on the other hand, can be more proactive -- actions can be taken to prevent a problem before it occurs (and even before there is hard evidence that it is likely to occur) and a data base can be built upon which to base future action. In addition, under a GWMA, control remains under the exclusive jurisdiction of a more localized government entity (the NRD), which is in close touch with the people who are affected by the controls and the effects of any groundwater contamination.

9.2.1. Consequences of GWMA Formation

When a GWMA is established, the following actions by the NRD are required or permitted, as noted:

1. Require permits for all new water wells, except test holes, dewatering wells with intended use of ninety days or less, and water wells which are designed and constructed to pump 50 gallons per minute or less.
2. A district may manage the use of water in a management area for water quantity or quality purposes or both by any of the following means: (46-673.09)
   a. Allocating the total permissible withdrawal of groundwater;
   b. Rotation of use of groundwater;
   c. Well-spacing requirements pursuant to section 46-673.12;
   d. Reduction of irrigated acres;
   e. Requiring the use of flow meters on wells;
   f. Best management practices;
   g. Requiring the analysis of water or deep soils for fertilizer and chemical content; or
   h. Education programs designed to protect water quality.
3. The NRD must determine the total amount of water to be withdrawn from the aquifer consistent with the ground water reservoir life goal and must adopt controls to allow the beneficial use of that amount of water. The NRD must take these actions even if the GWMA was established for water quality purposes.
4. The NRD may levy tax up to an additional 1.8 cents per $100 valuation in the management area.*

*NOTE: It is the intent of the LBNRD to utilize its general taxing authority for implementation of the initial activities of the GWMA. A public hearing and action of the LBNRD Board will be required before a GWMA tax could be levied.

9.2.1.1. Enforcement of Controls

In a GWMA, the primary enforcement tool is the issuance of cease and desist orders and suits against alleged violators who fail to abide by cease and desist orders. Violation of cease and desist orders is a Class IV misdemeanor. In addition, the district may bring an action in District Court to obtain a court order to enforce the cease and desist order. Failure to follow a court order subjects an individual to contempt of court proceedings.

10.0 Implementation of the LBNRD Groundwater Management Plan

10.1. LBNRD Groundwater Reservoir Life Goal

The Groundwater Reservoir Life Goal of the LBNRD is to: "Maintain an adequate supply of acceptable quality and quantity groundwater to forever fulfill the reasonable groundwater demands within the LBNRD".

10.2. Initiation of a Groundwater Management Area Formation

In support of the Groundwater Reservoir Life Goal, the LBNRD Board will establish a GWMA over the entire LBNRD after approving a Groundwater Management Plan (GWMP), obtaining the approval of that plan by DWR (or explaining how the LBNRD has addressed the DWR objections), and holding a public hearing on creating a GWMA. Upon establishment of a GWMA, the entire LBNRD will be under Level I Quality and Quantity controls. (See Sections 10.5 and 10.6.)

The Groundwater Management Area will overlay the LBNRD's existing Special Protection Area (SPA), however the current SPA program will remain in effect and all SPA requirements will continue as designed in that area.

10.3. Establishment of Sub-Areas and Higher Levels of Control in the LBNRD

Particular areas in the LBNRD have specific needs because of varying groundwater uses, different irrigation distribution systems, different cropland uses, different recharge rates, or varying climatic, hydrologic, geologic, or soil conditions that exist. Thus, uniform application of controls throughout the district would fail to provide flexibility for any higher levels of management listed in this plan.

It is the intention of the LBNRD to establish groundwater management sub-areas, as needed, in specific areas of the LBNRD with actual or potential problems of groundwater quality or quantity. The purpose of establishing sub-areas is so that different controls and/or levels of controls may be applied over a specific area of the LBNRD as required by the conditions in that area, without having to apply those controls or levels over the entire LBNRD. The authority for different controls is Nebraska State Statute 46-666(4). The relevant bases for applying different controls is varying ground water uses, different irrigation distribution systems, or varying climatic, hydrologic, geologic, or soil conditions. The LBNRD Board will use these bases when determining boundaries for sub-areas. As an example, an area with high nitrate concentrations in the groundwater would have different hydrologic conditions than surrounding areas without high nitrate concentrations. After establishment, individual sub-areas have the same legal status as an individual management area would have. As the need arises, the LBNRD Board will delineate and establish these sub-areas in regions where the potential for groundwater quantity or quality problems exists or where actual problems have been identified. The procedure the LBNRD will follow in determining when and where sub-areas are required is as follows:

The LBNRD Board will review the results of their groundwater monitoring program at least annually. When the data show that the triggering levels for either Quality or Quantity (which are presented in Section 10.5.2 and 10.6.2, respectively) have been reached or exceeded, the LBNRD will take the following actions:

1) Conduct further studies (review existing data and gather additional data), taking from two to five years to determine the extent and seriousness of the problem or potential problem. If it is determined that non-point source pollution is not occurring, that the problem area does not meet the size requirement of a sub-area or that the levels needed to trigger a higher level of control have not been met, the LBNRD shall take no further action to establish a groundwater management sub-area or to increase the level of controls in an existing sub-area.
2) If a problem has been identified, characterized by non-point pollution with an area of adequate size to meet the criteria for a sub-area, and/or the trigger for a higher level of controls has been reached, the LBNRD will:
    a. Identify the boundaries of the proposed sub-area within which the problem is occurring. The sub-area shall be an area containing at least 5 monitored wells within the LBNRD's monitoring network and a minimum of sixteen (16) square miles with legally definable boundaries (following township or section or quarter-section lines, roadways, rivers, etc.).
    b. Determine the controls which will be applied in the proposed sub-area in order to address the problem. Controls for quality and quantity problems are identified in Sections 10.5.2 and 10.6.2, respectively.
    c. Hold a public hearing at which groundwater conditions, proposed sub-area

boundaries and controls are presented to local residents of the proposed sub-area.

d. Take LBNRD Board action to set the boundaries of the sub-area and the controls to be implemented.
e. Enact the next Level of controls in the sub-area in the following year.

In no event will the LBNRD skip over one level of control to activate a higher level of control. Controls must be in place in a given level for at least one year before action is taken by the LBNRD Board to initiate the next higher level of controls.

10.4. Implementation of Controls in Management Areas and Sub-Areas

In every established management area and sub-area the level of controls applied will depend on the severity of the problems identified in that area. The entire LBNRD begins with Level I Quality and Quantity controls. As certain "triggering levels" are reached in an area, as determined from the results of the LBNRD's well monitoring program, then additional levels of controls are applied in that sub-area after action by the LBNRD Board (See Section 10.3). Triggering levels may be defined as a percentage of the Primary Maximum Contaminant Level (PMCL's) or of the Secondary Maximum Contaminant Level (SMCL's) for quality or as declines in the water table for quantity.

Lists of Maximum Contaminant Levels (MCL's) are issued by DEQ and DOH and are based on lists published by the U.S. Environmental Protection Agency (EPA). Current lists of PMCL's and SMCL's from the EPA Safe Drinking Water Standards are included in Appendix 12.3. PMCL's are for contaminants which have a proven negative effect on human health when the 100% level is reached. SMCL's are for contaminants which give water a poor taste or color and may be injurious to humans at higher concentrations.

The LBNRD strategy for the protection of groundwater quality stresses prevention of groundwater contamination, recognizing that it is much more expensive to clean up a problem than it is to prevent one. The quality controls imposed by the LBNRD in a GWMA will be determined by the extent of the problem. The LBNRD is concerned mainly with nitrates and other contaminants that are a result of non-point source pollution. The LBNRD will field sample wells for nitrates, and where levels equal or exceed 100% of MCL, a field sample will be taken from that well and tested for triazine herbicides. If the field sample shows a positive occurrence of triazines, another sample will be collected from that well and sent to a lab for verification and quantification. In addition, blind sampling on a random 2% of the wells sampled each year will be analyzed by a laboratory for triazines. Analysis for all the contaminants listed in Table 10.4-1 will also be done as deemed necessary by the LBNRD Board and based on results of field samples for nitrates, atrazine (as stated above) and data collected from other sources.

If pesticides or PCB's listed in Table 10.4-1 are found at triggering levels, during annual sampling, the LBNRD Board will consult with the appropriate state agency before proceeding with the actions outlined in Section 10.3.

TABLE 10.4-1
GROUNDWATER CONTAMINANTS
MONITORED BY THE LBNRD

Contaminant	MCL	
Inorganic Chemicals:		
Nitrate	10.	mg/l
Nitrite	1.	mg/l
Total nitrate and nitrite	10.	mg/l
Organic Chemicals:		
Pesticides & PCB:		
Alachlor (Lasso Herbicide)	0.002	mg/l
Aldicarb (Temik Insecticide)	0.003	mg/l
Aldicarb sulfoxide (Temik Insecticide)	0.004	mg/l
Aldicarb sulfone (Temik 1/4 Strength)	0.003	mg/1
Atrazine	0.003	mg/l
Carbofuran (Furadan)	0.04	mg/l
Chlordane	0.002	mg/l
Dibromochloropropane	0.0002	mg/l
2, 4-D	0.07	mg/l
Endrin (No longer produced)	0.0002	mg/l
Ethylene dibromide (EDB, Pestmaster)	0.00005	mg/l
Heptachlor	0.0004	mg/l

Heptachlor epoxide		0.0002	mg/l
Lindane	0.0002	mg/l	
Methoxychlor (Dual)		0.04	mg/l
Pentachlorophenol (PCP)		0.001	mg/l
Polychlorinated biphenyls		0.0005	mg/l
Toxaphene		0.003	mg/l
2,4,5-TP (Silvex)		0.05	mg/l

The Level I controls listed in Sections 10.5.1 and 10.6.1 will be applied over the entire LBNRD upon adoption of this plan. Additional or stricter controls will be applied over individual sub-areas as problems are identified and LBNRD action is initiated by established triggering mechanisms (see Section 10.3). Separate levels of controls are established for quality and quantity problems. Thus, one area or sub-area may have Level III Quality controls and Level I Quantity controls applied concurrently as required by the specific problems occurring in that sub-area.

10.5. Quality Controls

10.5.1. Level I Quality

The following actions will be taken and/or controls implemented upon establishment of a groundwater management area over the entire LBNRD. The establishment of a GWMA requires action by the LBNRD Board in accordance with the procedures outlined in Nebraska Statutes Section 46-673.05.

A. Establish the following education and technical assistance programs in accordance with the LBNRD's annual education planning and budget process:

1. Provide voluntary training sessions on water management techniques, pumping plant efficiency, new technologies and research, fertilizer management, etc.
2. Sponsor and participate in demonstration projects which stress items above.
3. Provide public information and education programs through newsletters, articles, pamphlets, TV, radio, magazine or public forums.
4. Establish water conservation, lawn care and management programs in cooperation with cities and villages.
5. Encourage the use of BMP's, such as:

a. Irrigation scheduling methods.

b. Water measurement devices.

c. Irrigation recycle systems.

d. Land leveling.

e. Fertilizer management, including: soil sampling, yield goals, irrigation water nitrate analysis, and recommended application rates.

f. Chemical and pesticide management, including: application calibrations, timing, storage and disposal.

g. Integrated pest management, including field scouting.

h. Conservation tillage practices.

i. Conservation structural practices.

j. Crop rotation.

k. Other practices which the industry may identify as beneficial.

    1. Computerized fertilizer monitors.

    2. Computerized spray monitors.

6. Provide technical assistance in developing efficient irrigation systems and management schemes.

    a. Flow meter use training.

    b. Use of Ultrasonic Flow Meter as an in-field water management education tool.

    c. Center pivot adjustments and new technologies.

    d. Rainfall activated engine shutoffs for wells.

    e. Gravity field irrigation management practices.

    f. Conservation practice design, layout, cost share.

B. Maintain an ongoing program of sampling wells for groundwater quality throughout the area. Identify any obvious sources of pollution. Identify any deficiencies in data. The water quality sampling program will include the following:

   1. Establish a well sampling program and associated protocol for field samples.
   2. Develop and maintain a well sampling record, well condition record and site assessment for each sampled well.
   3. Collect samples on 1/3 of program wells annually and test for nitrates.
      a. Collect duplicate samples on a random 5% of the wells sampled each year with these sent to an EPA certified lab for verification.
   4. Offer in-house nitrate analysis with Hach Spectrophotometer.
   5. Field triazine screening will be done on wells which test at or above 100% MCL for nitrates. If screening shows a positive occurrence of triazines, a second sample will be taken and sent to the lab for verification and quantification.
   6. Acquire nitrate, pesticide, and other contaminant analysis data for all municipal wells annually.
   7. Obtain water quality sample data, gathered from within the LBNRD, from other local, state, or federal agencies.
   8. Conduct urban runoff water monitoring study to determine overland pollution potential.
   9. If possible, sample streams 3 years prior to development of flood control, recharge or recreation projects.

C. Establish the following controls and program requirements:

   1. Require permits for all new water wells, except test holes, dewatering wells with intended use of ninety days or less, and water wells which are designed and constructed to pump 50 gallons per minute or less in accordance with Nebraska Statutes Section 46-459.
   2. Encourage all new non-domestic water wells designed to pump 50 GPM or more to be constructed with adequate free space in the pump discharge to accommodate a flow device if required in the future.

3. Require a water sample to be drawn at completion of test pump from all new water wells to establish a benchmark groundwater nitrate condition record. Sample will be analyzed by the LBNRD and at the LBNRD's expense.
4. Enforcement of water well abandonment laws in accordance with the Nebraska Water Well Standards and Contractors' Licensing Act.
5. Enforce existing chemigation rules for prevention of groundwater pollution under LBNRD jurisdiction in accordance with Nebraska State Statutes 46-1101 - 46-1148.
6. Share information and seek cooperation in solving problems where applicable.

10.5.2. Higher Level Quality Controls

10.5.2.1. Level II Trigger And Controls

When sampling results show that 70% of MCL has been reached for any constituent in Table 10.4-1 in 60% or more of at least 5 sampled wells within an area, the LBNRD Board will take the actions outlined in Section 10.3. to further identify the problem area, establish sub-area boundaries and determine the controls to be implemented. A sub-area for Quality Controls is defined as an area containing at least five sampled wells within the LBNRD's well sampling program around which a logical boundary can be drawn. The minimum size of a sub-area shall be sixteen (16) square miles.

Level II actions will include the following requirements in addition to the Level I Quality requirements:

A. Increase information and education efforts for the target area.
B. Prohibit fall applications of anhydrous and liquid fertilizer before November 1 on crop land for the ensuing crop year unless an inhibitor is used. This requirement applies only to sub-areas so declared as a result of nitrate contamination.

C. Require initial operator reports of pertinent farm and practice information as a means of establishing a benchmark for management practice implementation, educational needs and future program progress.

D. Require a Best Management Practice (BMP) Plan from each landowner/operator in the sub-area. The plan will require the landowner/operator to identify at least one new BMP which will be implemented on the lands he/she controls within the next two year period. The BMP must be selected from a menu of practices kept current by the LBNRD and must be tailored to address the problem identified in the sub-area. The landowner/operator may request an exemption from the BMP implementation plan if he/she can document that sufficient BMPs are being practiced in their operation to address the problem. A request for exemption shall be made in writing to the LBNRD Board. The LBNRD Board shall review the request and either grant or deny the request.

E. Require year end annual reports tailored to crop and farming practices from the landowner/operator. The reports will consist of one or more of the following:

1. Available soil sample results and location where samples are taken.
2. Irrigation water sample results from each well.
3. Year-end report on amount of fertilizer/chemical applied to each specific field for all crops.
4. Flow meter readings or best available pumpage data for the irrigation season, the crops grown and acres irrigated from each well.
5. BMPs being implemented by the producer.
6. Other measures deemed appropriate by the LBNRD Board.

F. Provide one on one assistance to operators (as available).

G. Provide or secure through outside sources, funding for short term incentive programs to encourage producers to adopt BMP's.

The LBNRD may also include one or more of the following actions under Level II Quality, as deemed necessary by the LBNRD Board:

A. Training and certification of operators.
B. Conduct studies in cooperation with experts in the field to determine movement and travel time of the contaminants.
C. Deep soil and irrigation water samples for use in fertilizer or chemical application determinations.
D. Approved irrigation water measuring devices.
E. Implementation of additional BMP's by operators.
F. Other measures deemed appropriate.

10.5.2.2. Level III Trigger And Controls

When sampling results show that 85% of MCL has been reached for any constituent in Table 10.4-1 in 60% or more of the sampled wells in a sub-area, further action by the LBNRD is required.

Level III Quality actions, in the sub-area will include the following in addition to all previous level requirements:

A. Require the operator to establish a demonstration field for implementation of Level III actions. A demonstration field shall mean an operator's largest irrigated field, as delineated in the Consolidated Farm Services Agency (CFSA, formerly the ASCS) cropping plans records, in which the operator intends to plant any crop in the ensuing crop year. If the operator does not have any irrigated crop fields, the demonstration field shall mean the largest dryland field in which the operator intends to plant a crop in the ensuing year.
B. Require annual soil samples on the operator's demonstration field.
C. Require operator adherence to the certified laboratory fertilizer recommendations on the demonstration field.
D. Require irrigation scheduling on the demonstration field if the field is an

irrigated-tract.

10.5.2.3. Level IV Trigger And Controls

When sampling results show that 100% MCL has been reached for any constituent in Table 10.4-1 in 60% or more of the sampled wells in a sub-area, further action by the LBNRD is required.

Level IV Quality actions in the sub-area will include the following requirements in addition to previous requirements:

A. Operator training and certification.
B. Require soil samples on all fields.
C. No greater than the certified laboratory Nitrogen Fertilizer Recommendation followed, on all fields, with all credits figured.
D. Irrigation scheduling on all fields.
E. Fall fertilizing on all fields will require an inhibitor.
F. Annual reporting of activities on all fields.

When sampled wells indicate that contaminant levels have exceeded the next highest triggering level immediately adjacent to an already operable sub-area, the LBNRD will sample additional surrounding wells to determine if the sub-area boundaries should be expanded to include such wells. If evidence proves a problem exists in the adjacent wells, the LBNRD Board will enact the next higher level of controls within the extended sub-area in the following calendar year.

10.6. Quantity Controls

10.6.1. Level I Quantity

These controls are applicable upon establishment of a groundwater management area over the entire LBNRD.

A. Provide information and education programs on water conservation and use to water users. A list of such programs is included in Section 10.5.1 under Level I Quality, paragraph A.

B. Maintain a monitoring well network for water levels to provide sufficient coverage of all aquifers in the LBNRD. Monitored wells may include the same wells used for water quality monitoring. The water quantity sampling program will include the following:

   1. Measure established monitoring network wells twice each year, spring and fall.
   2. Develop and maintain a water well log file, including elevations, predevelopment levels, and pertinent information.
   3. Develop a visual hydrograph of each well.
   4. Develop a LBNRD-wide annual water contour map based on water levels.
   5. Examine water level contour maps to document trends and identify problem areas.

C. Implementation of Level I Quality controls listed in Section 10.5.1, paragraph C, will also support the Level I Quantity efforts. The following additional actions will also be implemented under Level I Quantity:

   1. Require season end irrigation pumpage reports from owners/operators with flow meters as a condition of meter maintenance.
   2. Provide meter maintenance to non-reporting cooperators on a "cost of parts" basis.
   3. Aggressive enforcement against irrigation runoff, center pivot end guns shutoffs and water wastefulness.

10.6.2. Higher Level Quantity Controls

10.6.2.1. Level II Trigger And Controls

When spring groundwater levels decline below, and remain below, the lowest level of record (pre-1994) for three consecutive years in any of the monitored wells, further action by the LBNRD Board is required. Following the outline in Section 10.3, the LBNRD Board will initiate a study during which water levels in surrounding wells will be measured to determine the severity, the geographical extent, and the boundaries of the affected area. A sub-area will be established and Level II Quantity activities will be enacted in the calendar year immediately after the following trigger has been satisfied: When the percentage established in Table 10.6.2.2-1 and Figure 10.1 below, or greater percentage, of the monitored wells in the sub-area which are included in the study, show a spring water level decline of 50% or more of the "Reasonable Acceptable Decline" set forth on the Table, as measured from the lowest level of record for that well and remains below that level for two consecutive years.

A sub-area is an area containing at least five monitored wells within the district's well monitoring program around which a logical boundary can be drawn. The minimum size of a sub-area shall be sixteen (16) square miles. A public hearing will be conducted to establish the boundaries of the sub-area and the practices to be implemented.

For additional wells acquired in the LBNRD's well monitoring network that do not have a pre-1994 level established, the LBNRD will gather water level data for the well for a five (5) year period of time and will use the lowest level of that period as its lowest level of record. The level will not be included in average groundwater levels until five (5) years of water levels have been collected.

Level II Quantity actions will include the following requirements in addition to the Level I Quantity requirements:

A. Provide information and education on water conservation and use to water users, both rural and urban.

B. Require all non-domestic water users to report annual water usage. Reports will be generated by using the best available procedures, as approved by the LBNRD Board.

C. Require every operator to establish a demonstration field for implementation of Level II actions. On the demonstration field an operator shall:
   - Report on the use of irrigation scheduling
   - Install an irrigation flow meter(s) to record groundwater use.

D. Provide technical assistance to water users in order to increase water use efficiency.

E. Provide or secure through outside sources, funding for incentive programs to encourage water conservation practices.

F. Certify all acres irrigated with each groundwater well within a Level II sub-area.

The LBNRD may also include one or more of the following actions under Level II Quantity:

A. Training and certification of operators.

B. Conduct a detailed study of the area to gather information to make informed predictions of trends and impacts. Additional recording devices may be necessary.

C. Require flow meters for irrigation water use.

D. An increase in the number of monitoring wells.

E. Expand well spacing requirements.

If, during the initial study, investigation determines that the quantity problem is most probably due to interfering wells and is limited in area or extent involving only a few wells or owners, then the LBNRD Board may attempt to act as a mediator or arbitrator between the parties affected. The LBNRD Board may suggest solutions and/or voluntary controls, mutually agreed upon by the parties involved, by which the problem may be addressed. This would be in lieu of formally establishing a groundwater management sub-area and mandatory controls.

10.6.2.2. <u>Level III Trigger And Controls</u>

Level III Quantity controls will be enacted when the percentage established in Table 10.6.2.2.-1, and associates Figure 10.1, or greater percentage, of the monitored wells in the sub-area which are included in the study show a spring water level decline equal to or greater than the "Reasonable Acceptable Declines" set forth on the Table, as measured for the lower level of record for that well, and remain below those levels for two consecutive years. Along with the controls enacted in Levels I and II, these stringent controls will include:

A. Requiring the use of flow meters on water wells.

B. Allocating the total permissible withdrawal of groundwater.

The Little Blue NRD may also include the following action in Level III Quantity:

C. Close all or a portion of the sub-area to the issuance of additional well permits; this may be selective to use.

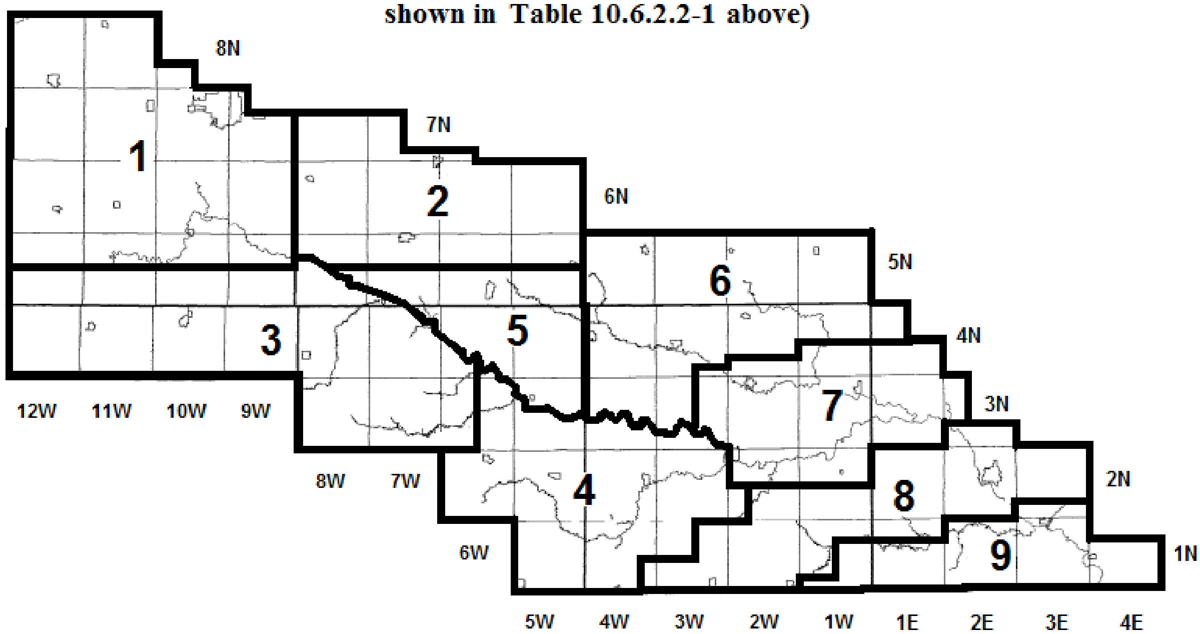
TABLE 10.6.2.2-1
LITTLE BLUE NRD
EXPLANATION OF DETERMINATION
FOR REASONABLE ACCEPTABLE DECLINES BASED
ON HYDROGEOLOGICAL CHARACTERISTICS
PRE-1994

Hydro Unit	Average Pre-Devel. Sat. Aquifer	Average 1992 Sat. Aquifer	Approximate Average Ft. of Pump Drawdown	NRD Allowable Percent Usage	Reasonable Acceptable Ft. of Decline *	Percent of Wells Allowed to Decline
1	155 ft.	148 ft.	-14 ft.	10%	15 ft	80%
2	135	121	-21	10%	12 ft	80%
3	90	86	-30	10%	9 ft	80%
4	70	64	-20	10%	7 ft	80%
5	92	80	-27	10%	8 ft	80%
6	125	110	-21	10%	11 ft	80%
7	135	130	-17	10%	13 ft	80%
8	70	65	-15	5%	3 ft	40%
9	N.A. **					

* Values rounded to nearest foot.
** N. A. indicates data Not Applicable due to absence of aquifer.

FIGURE 10.1- HYDROGEOLOGIC UNITS

(Unit delineations below correspond to the Hydrogeologic Units shown in Table 10.6.2.2-1 above)



10.7. Relaxation of Controls

If the results of the LBNRD's monitoring well sampling program for a sub-area indicate that a triggering level for a level of controls lower than that level which is currently being enforced in that sub-area is met for three consecutive years, then controls in that sub-area will decrease to that level, unless specific action by the LBNRD Board maintains the current level. This relaxation of controls applies to both quality and quantity controls.

Quality Example: An established sub-area is currently under Level II Quality controls due to nitrate readings in monitoring wells equal to or greater than 70% of MCL. If nitrate level readings in monitoring wells in that sub-area are below 70% of MCL for three consecutive years (and no other Level II triggering levels are met for other contaminants), then that sub-area will revert to Level I Quality controls after the third year, unless the LBNRD Board determines a problem still exists and acts to maintain Level II Quality controls in that sub-area.

Quantity Example: An established sub-area is currently under Level II Quantity controls. If 80% of the measured wells in that sub-area show a spring water level above the 50% of the "Reasonable Acceptable Decline" level, and that water level has been maintained for three consecutive years, then that sub-area will revert to Level I Quantity controls after the third year, unless the LBNRD Board determines a problem still exists and acts to maintain Level II Quantity controls in that sub-area.

This relaxation of controls is an acknowledgement that the problem which had existed in that sub-area has been remediated and that the lessons and practices learned during the remediation process, employed by the residents of that sub-area, will continue to maintain an improved water quality or quantity without the burdens and restrictions imposed by a higher level of controls.

If, however, in any subsequent year, in a sub-area in which controls have previously been relaxed, a higher triggering level for the same problem (ie: water quantity or the same contaminant if controls were for water quality) is reached, the controls in that sub-area will be re-instated at that higher level and will remain there until the following conditions are met:

1) The monitored problem level (ie: water quantity or contaminant level) in the sub-area has dropped to a lower triggering level and remained there for at least seven subsequent years; and
2) The LBNRD Board acts to remove the higher level controls and reinstate a lower level of controls as appropriate for the existing triggering level.

Example: Four years after the controls in the sub-area in the example above were relaxed to Level I Quality, well sampling in that sub-area indicates nitrate readings equal to or greater than 70% of MCL. The controls in that sub-area will immediately revert to Level II Quality controls and will remain there until both conditions mentioned above are met, even if the nitrate readings return to the 70% level or lower, and remain there. This would not require specific action of the LBNRD Board nor an amendment to the GWMP. (If a different contaminant besides nitrate, should reach Level II triggering levels, the sub-area would also go to Level II Quality controls, but would still be eligible for later relaxation of controls for that contaminant.)

This "anti yo-yo" clause acknowledges that it was the presence of the higher level controls themselves that was improving the water quality or quantity in the sub-area and that these controls must remain in place to continue or maintain improvements. Thus, the higher level controls must be reinstated and maintained in that sub-area.

10.8. Variances

The LBNRD Board may grant variances from the strict application of this plan upon good cause shown.

10.9. Amendments to Plan

According to Nebraska State Statute 46-673.13, the Groundwater Management Plan can be formally amended no more than once per year.

10.10. Impact of NRD Actions on Threatened or Endangered Species

According to a letter dated August 10, 1992, from Mary Clausen (Nongame Heritage Zoologist, Nebraska Game and Parks Commission) to Michael D. Onnen (Manager, LBNRD), there are "no confirmed records of endangered or threatened species that could be impacted by groundwater management activities within the jurisdictional boundaries of Little Blue NRD. However, potential habitat for the western prairie-fringed orchid may occur within your district."

The LBNRD recognizes:

1) That potential habitat for the western prairie fringed orchid may possibly exist in some parts of the district, and
2) that general protection of groundwater quantity and quality has many benefits including protection of the habitats of threatened or endangered species, and
3) that any groundwater management activities proposed in this plan may have some impact (positive or negative) on these potential habitats of the western prairie fringed orchid.

Therefore, if the existence of any western prairie fringed orchid habitats are confirmed within the boundaries of the LBNRD and if those habitats are identified specifically as being adversely affected by changing groundwater levels, then the LBNRD acknowledges the potential need to modify this groundwater management plan to include such actions consistent with the Nebraska Groundwater Management and Protection Act that could be taken by the NRD to reduce adverse effects on this species by maintaining a groundwater level that will help sustain the orchid's habitat.

In support of this commitment, the LBNRD staff have been familiarized with the characteristics and appearance of the orchid by reading the Nebraska Game and Parks brochure "Nebraska Threatened and Endangered Species -- Western Prairie Fringed Orchid." If, during the course of his or her field work, a staff member observes an actual (or a suspected) western prairie fringed orchid plant, its specific location will be noted and reported to the Nebraska Game and Parks Commission for further investigation and identification.

11.00 Plan Evaluation and Assessment

This plan has been written and submitted in fulfillment of the requirements of LB51. As such, it has been reviewed by a number of interested parties

11.1. Preliminary Reviews

Before the final adoption of this plan, it was reviewed by the following entities and modified accordingly.

11.1.1. LBNRD Staff and Board

This document represents the intentions of the Little Blue Natural Resources District Board of Directors in regards to the administration of a groundwater management program. As such, the contents herein have been extensively reviewed and discussed by the LBNRD Board and staff members. The plan as presented here reflects the wishes of a consensus of the board members. The implementation plan was approved by the board at the Board of Directors meeting on May 30, 1995.

11.1.2. State And Local Agencies

A preliminary copy of this plan was submitted to the following state and local agencies for an unofficial preliminary review: Department of Water Resources (DWR), Department of Environmental Quality (DEQ), Natural Resources Commission (NRC), the Clay County Groundwater Management District, and the Blue River Association of Groundwater Districts.

Although state statute does not require a formal approval by any state or local agency before the plan can be adopted and put into effect by the LBNRD, an attempt was made to address any comments or concerns presented by the responding agencies in the final draft of this plan.

The final draft of this plan was submitted to the Department of Natural Resources, as the coordinating state agency. DNR comments were received on November 16, 2005, and the final plan approved by the Little Blue NRD Board of Directors of December 13, 2005.

11.1.3. Public Review and Comment

Public review and input was an integral part of the formulation of this plan. A local advisory group participated in all meetings where the plan was discussed.

After approval of the draft plan by the LBNRD Board, an outline of the implementation portion of the plan was published in six newspapers of general circulation in the district. Public questions and comments were solicited through these publications. An attempt was made to address questions and comments presented by the public and to reflect any changes made in the final draft of the plan.