

FIGURE 1-1 LINCOLN-PIPESTONE RURAL SYSTEM AND CONSTRUCTION PHASES

Source: Dewild Grant Reckert and Associates Company, 1994

Cretaceous shale formations are present throughout much of southwestern Minnesota, however, Cretaceous aquifers of adequate production capacity and good water quality are difficult to locate and develop. This difficulty is due to great depths; low permeability of aquifer materials; and variable geochemical compositions of aquifer materials, which can produce poor water quality. Cretaceous aquifers are usually investigated only if the overlying glacial deposits yield little water or water of poor quality.

In the southwest corner of the state, Rock County and parts of Pipestone and Nobles Counties, the Sioux Quartzite formation is used as a water source (see Figure 1-2). The Sioux Quartzite is used where it directly underlies thin glacial drift. In areas of Rock and Pipestone Counties, where the Sioux Quartzite forms a bedrock high, this formation may be the only available aquifer. Yields from these wells reportedly range from 1 - 450 gpm. The yield of water from the quartzite depends on the number and size of joints and the degree of cementation of aquifer materials. Generally, the joints or crevices are small and the beds are only slightly pervious. It is, therefore, necessary to drill relatively deep wells to penetrate enough water-bearing openings to obtain an adequate supply of water.

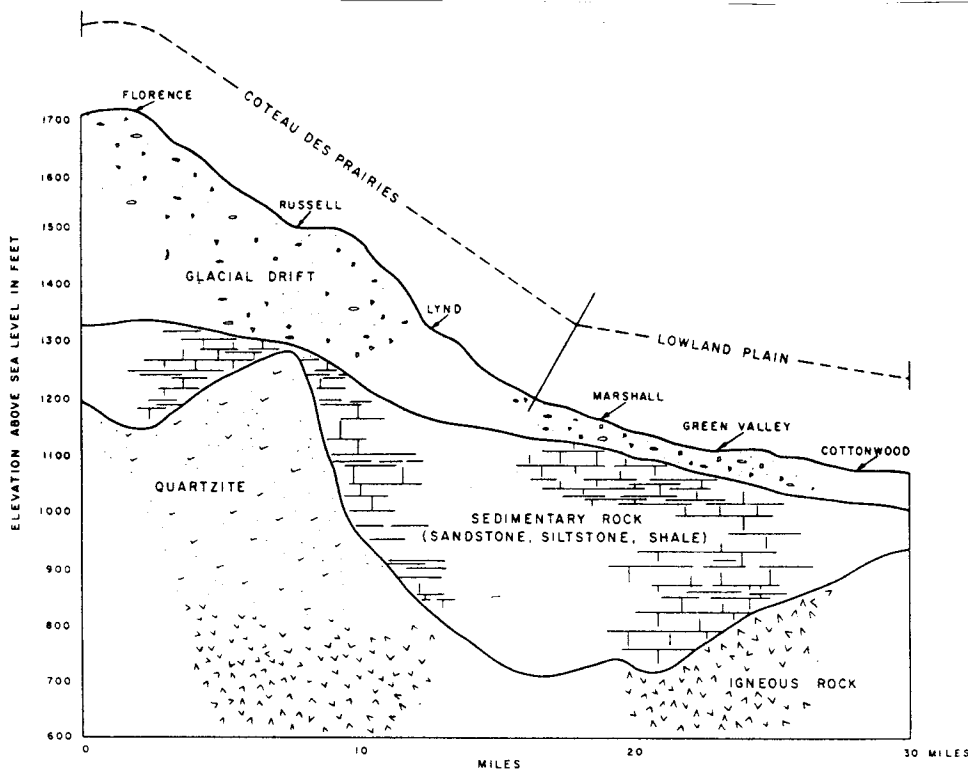


FIGURE 1-2 GENERALIZED CROSS SECTION OF GEOLOGY IN STUDY AREA

Source: USDA, Soil Conservation Service,

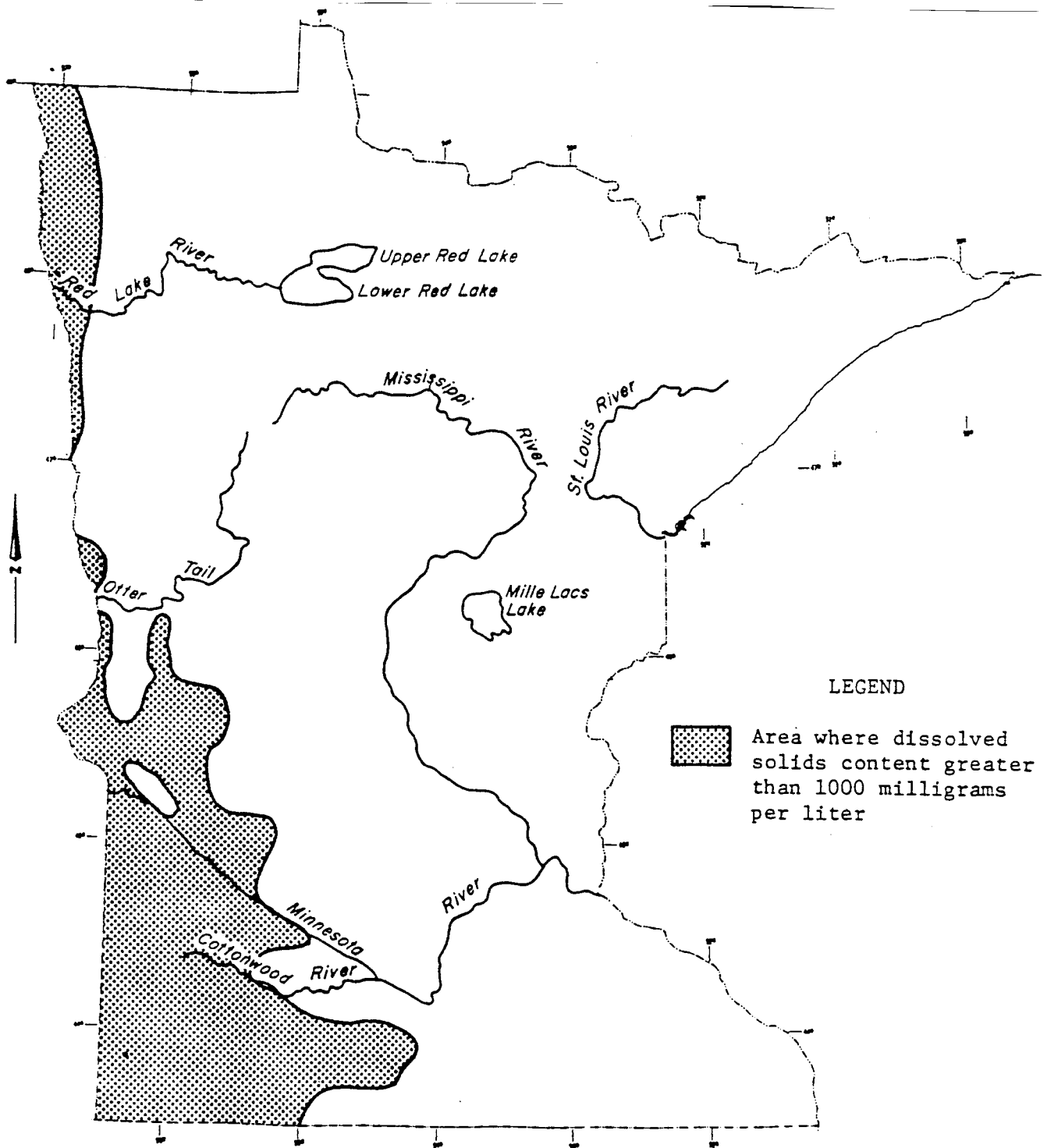
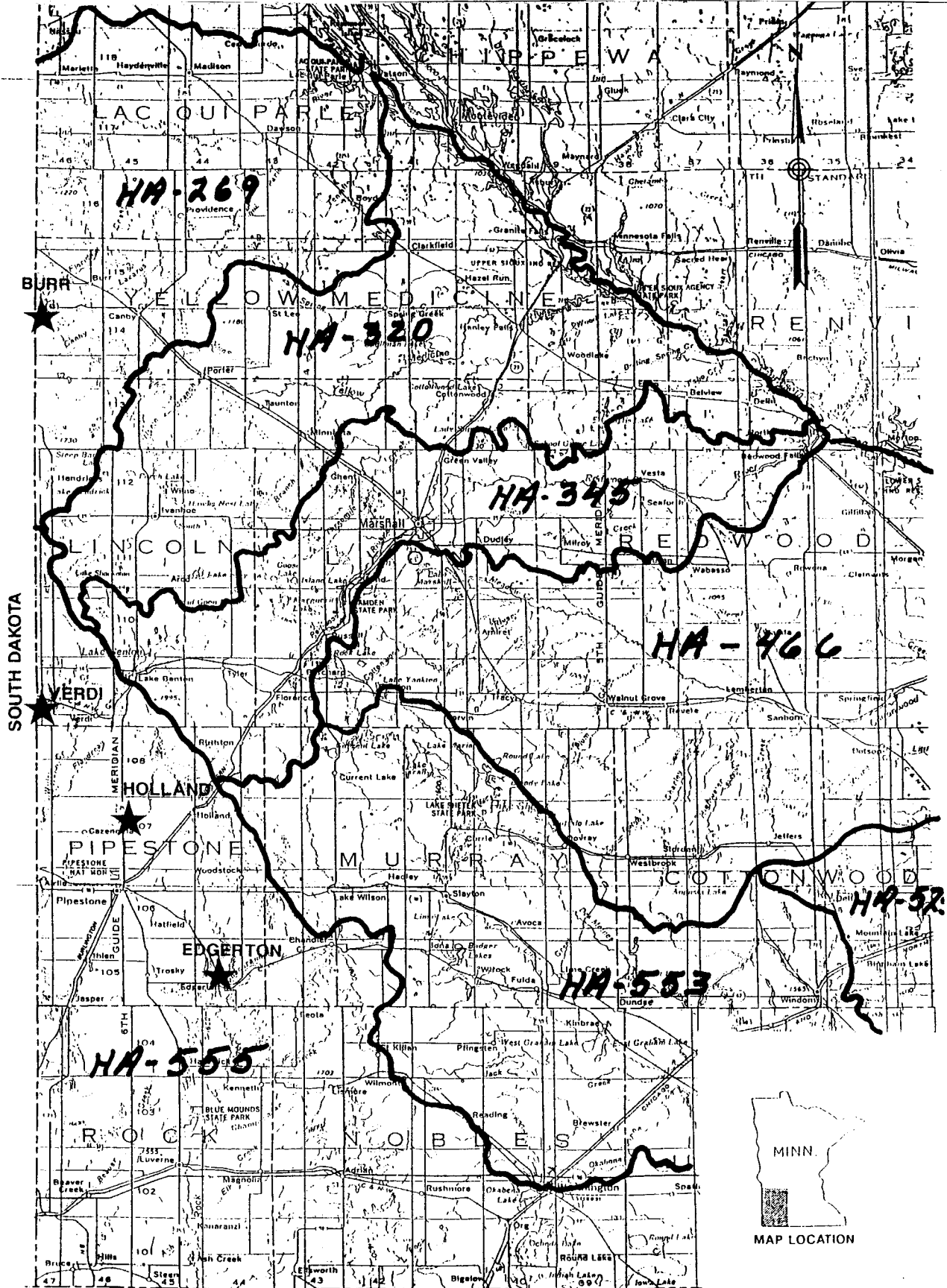


FIGURE 1-3 AREAS OF HIGHLY MINERALIZED GROUNDWATER

Source: MNDNR, Bulletin 26, The Natural Quality of Groundwater in Minnesota



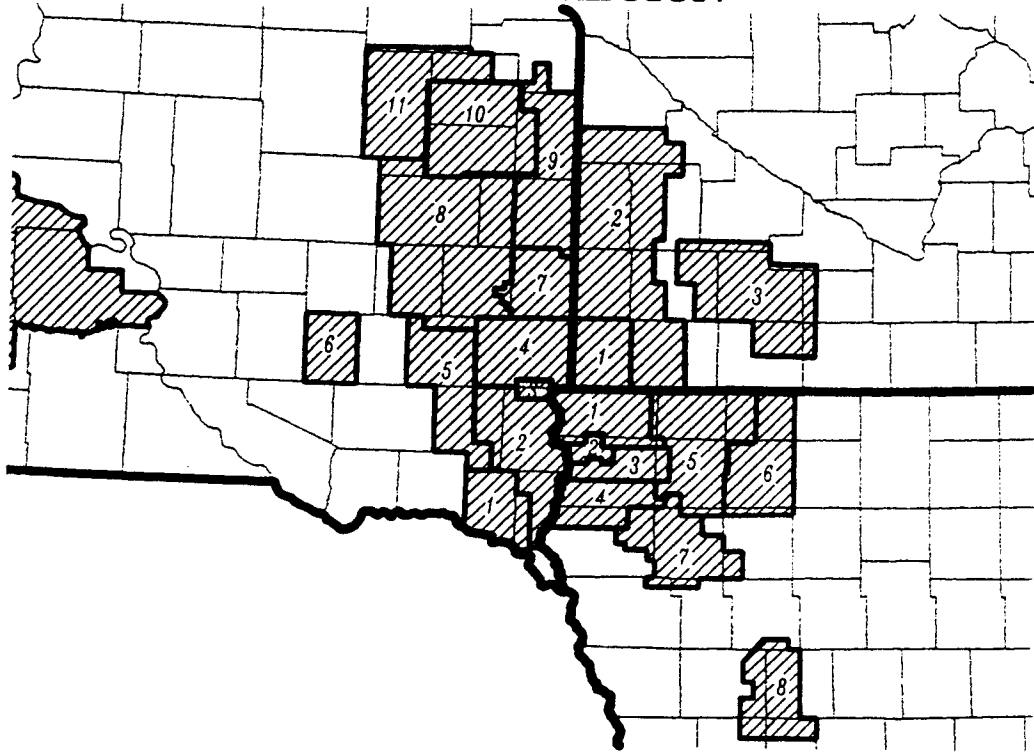
IOWA

FIGURE 1-4 WATERSHEDS WITHIN LPRW SERVICE AREA

NOT TO SCALE

Source: USGS, Hydrologic Atlas

RURAL WATER SYSTEM DEVELOPMENT IN THE REGION



RURAL WATER SYSTEM AND DATE INITIAL CONSTRUCTION WAS COMPLETED:

IOWA

1. LYON AND SIOUX RURAL WATER SYSTEM; 1974
2. ROCK VALLEY RURAL WATER DISTRICT; 1984
3. RURAL WATER SYSTEM NO. 1; 1975
4. SOUTHERN SIOUX COUNTY RURAL WATER SYSTEM; 1980
5. OSCEOLA COUNTY RURAL WATER SYSTEM; 1982
6. CLAY COUNTY RURAL WATER DISTRICT; 1982
7. CHEROKEE COUNTY RURAL WATER DISTRICT; 1975
8. WEST CENTRAL IOWA RURAL WATER ASSOCIATION; 1976

MINNESOTA

1. ROCK COUNTY RURAL WATER DISTRICT; 1980
2. LINCOLN PIPESTONE RURAL WATER SYSTEM; 1980
3. RED ROCK RURAL WATER SYSTEM; 1986

SOUTH DAKOTA

1. CLAY RURAL WATER SYSTEM; 1980
2. SOUTH LINCOLN RURAL WATER SYSTEM; 1982
3. LINCOLN COUNTY RURAL WATER SYSTEM; 1973
4. MINNEHAHA COMMUNITY WATER SYSTEM; 1986
5. TM RURAL WATER DISTRICT; 1985
6. DAVISON RURAL WATER SYSTEM; 1986
7. BIG SIOUX COMMUNITY WATER SYSTEM; 1976
8. KINGBROOK RURAL WATER SYSTEM; 1978
9. BROOKINGS DEUEL RURAL WATER SYSTEM; 1977
10. SIOUX RURAL WATER SYSTEM; 1976
11. CLARK RURAL WATER SYSTEM; 1984

FIGURE 1-5 RURAL WATER SYSTEM DEVELOPMENT IN THE REGION

Source: Dewild Grant Reckert and Associates Company, 1997

knobs, kettles, ice-block basins, and disintegration ridges. Locally, a stagnation moraine lies in contact along the eastern edge of the Altamont Moraine (see Figure 3-2).

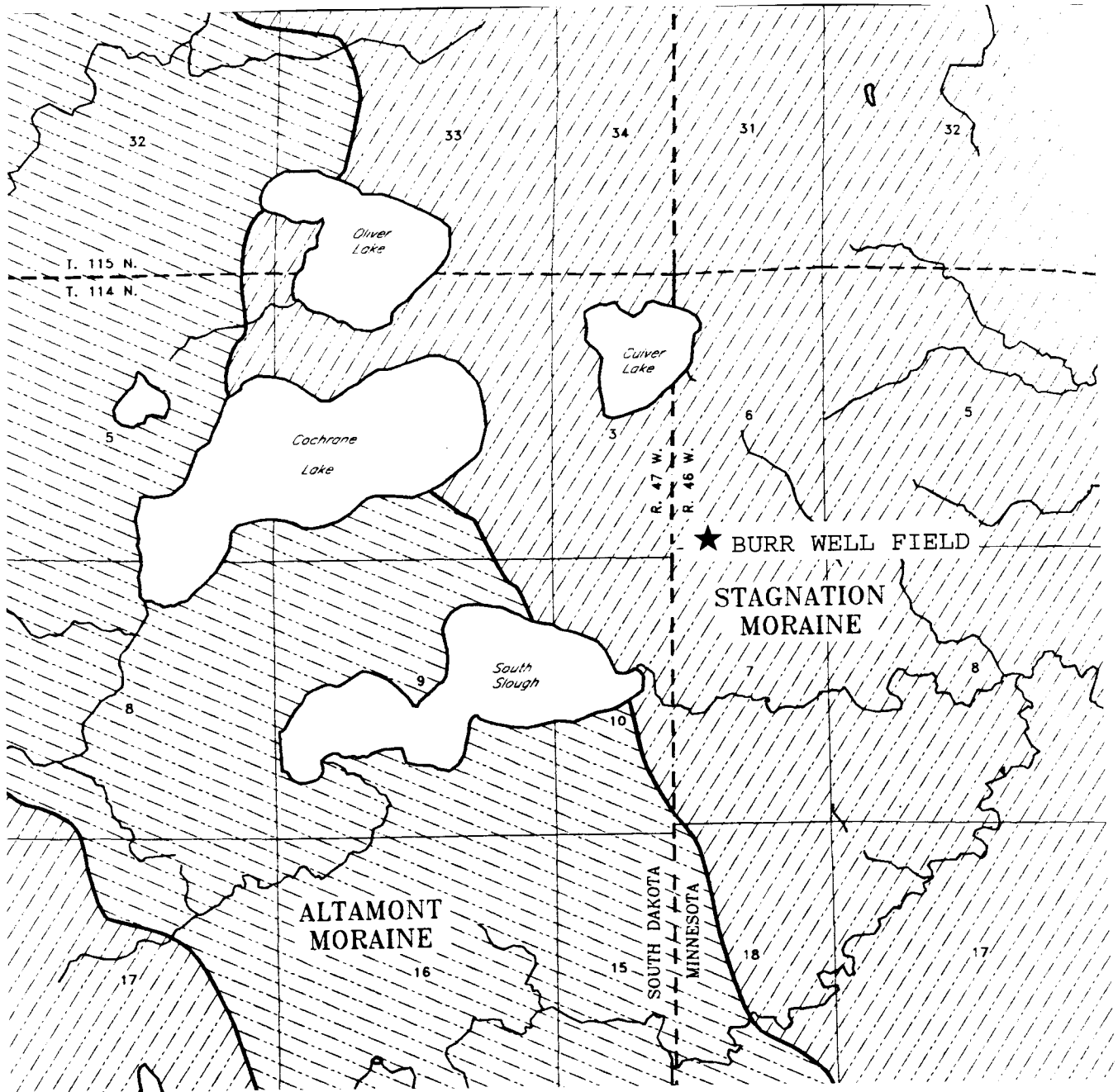
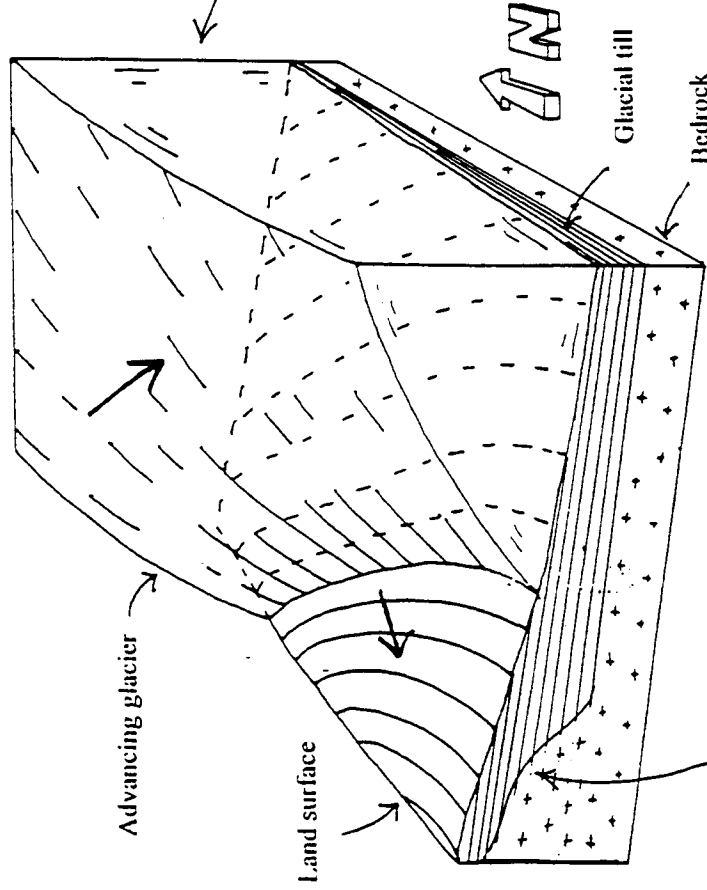


FIGURE 3-2 LOCAL GLACIAL GEOLOGY

Source: MNDNR, Burr Well Field
Aquifer Test Analysis, April 1994

1) Advancing glacier
Arrows show southwestern and lateral ice movement



Coteau Des Prairie

2) Receding glacier
Arrows show meltwater drainage from the glacier forming an outwash channel between the lateral glacial edge and the higher southwestern land surface

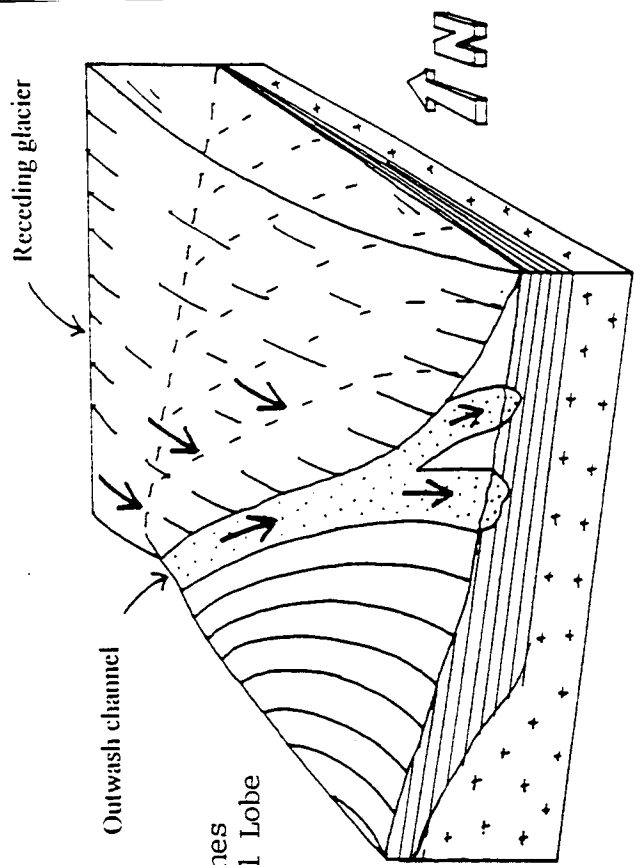


FIGURE 3-3 DEPOSITION OF NORTHWEST-SOUTHEAST ORIENTED BURIED GLACIAL OUTWASH CHANNEL (BURR UNIT)

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-97, Progress Report 1

Approximate ground water and surface water elevations are shown for August 23, 1994.

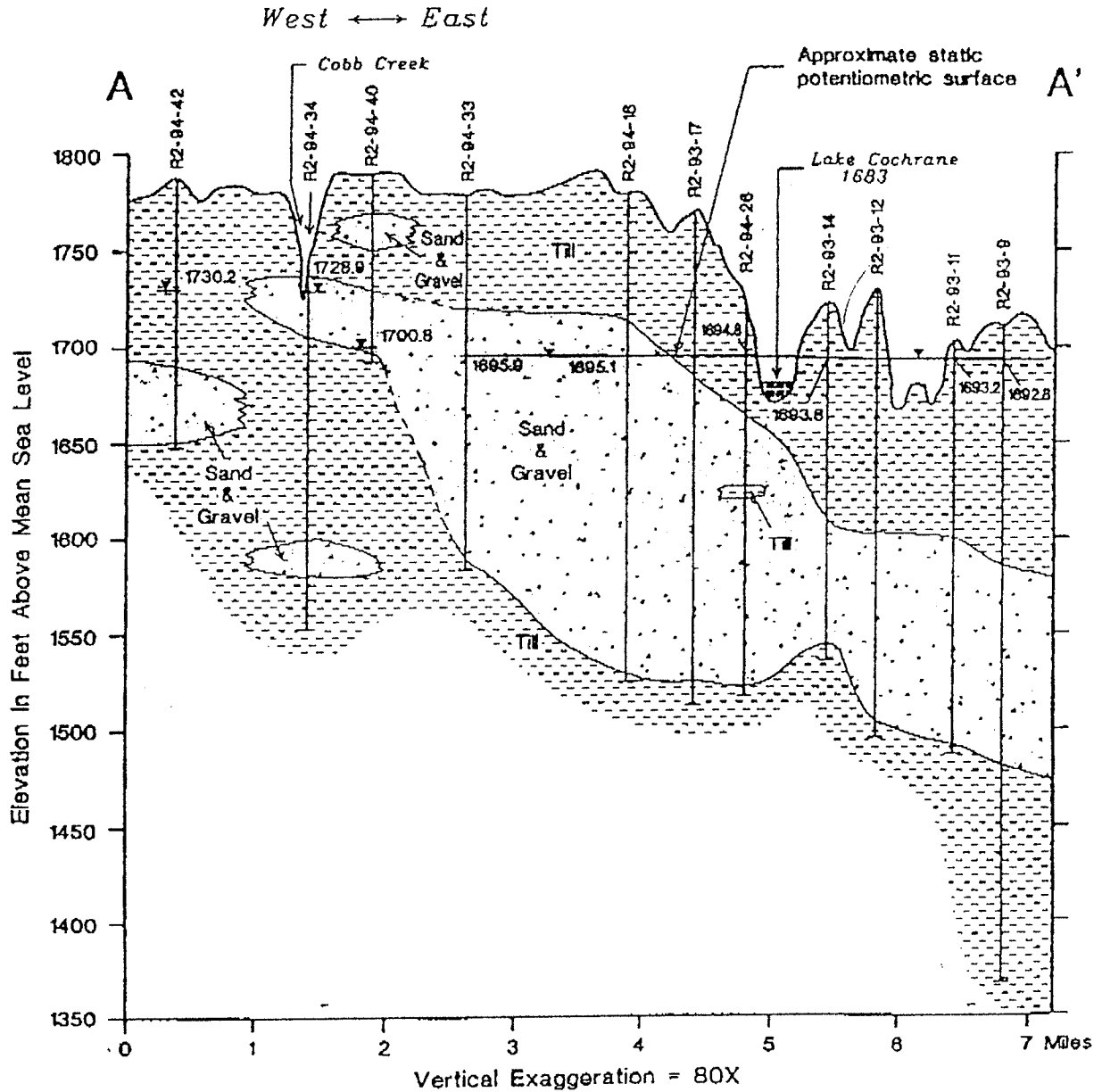


FIGURE 3-4 GENERALIZED GEOLOGIC WEST TO EAST CROSS-SECTION OF GLACIAL TILL AND OUTWASH ALONG CANBY-LAKE COCHRANE ROAD

Source: Pence, South Dakota Geologic Survey
Hydrologic Study of the lake Cochrane Area, 1995

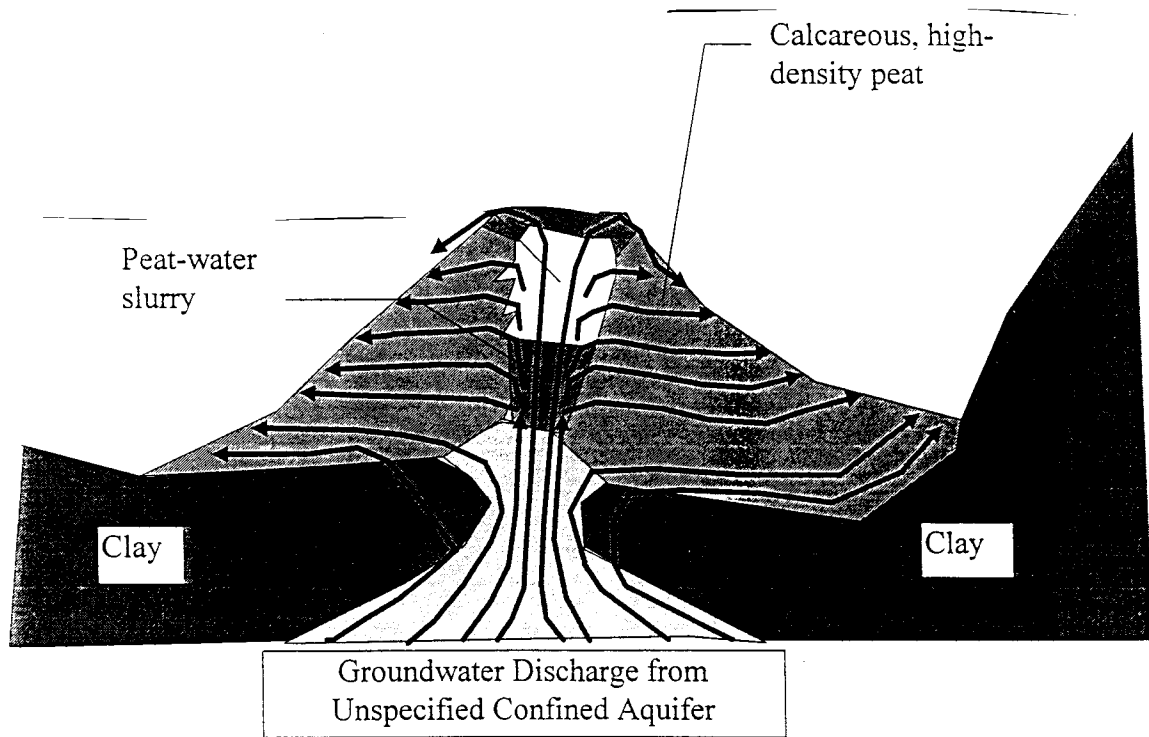


FIGURE 3-5 GENERALIZED SCHEMATIC OF CALCAREOUS FENS

Source: Peterson, Field Evaluation of Known and Proposed Calcareous Fens, Yellow Medicine County, Minnesota., 1995

Monitoring wells and piezometers have been installed adjacent to and in the Sioux Nation Fen. Figure 3-6 shows the locations of three piezometers installed directly in the top of the Sioux Nation Fen dome. These piezometers are numbered as Sioux Nation Fen Dome 1 (water table); Sioux Nation Fen Dome 2 (intermediate); and USGS Dome (deep). These piezometers have been installed at various depths in the fen dome in order to evaluate changes in the hydraulic gradients within the peat mass. Data has been collected using both data loggers and hand measurements. Figure 3-7 is a plot collected in all three piezometers from the Spring - Summer, 1991 to April 1994.the Fall, 1996. Dates vary because the installation dates of the piezometers differed. Figures 3- 8 to10 show individual plots of the data from each of the piezometers; the period of observation extend from Spring – Summer, 1991 and Summer 1992 - Fall 1997. The dates of the three most recent pump tests and surface elevations of the fen dome at the piezometer locations have been plotted on the Figures.

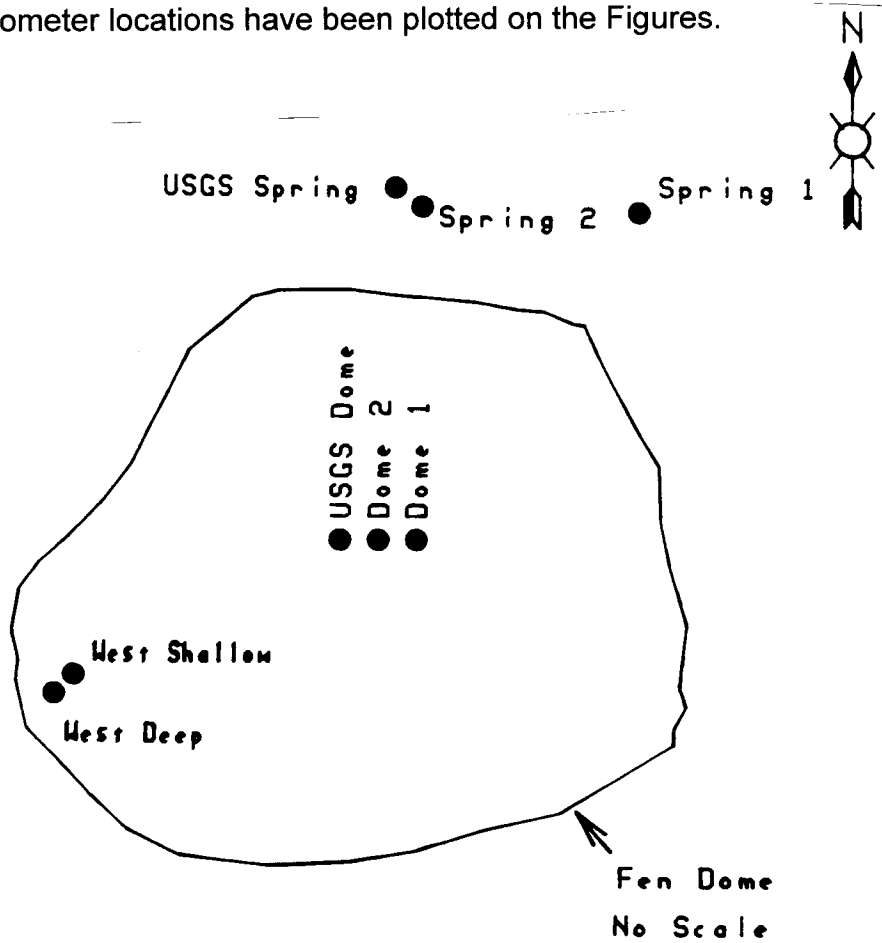


FIGURE 3-6 SIOUX NATION FEN DOME WELL AND PIEZOMETER LOCATIONS

Source: MNDNR, Burr Well Field
 Aquifer Test Analysis, 1994

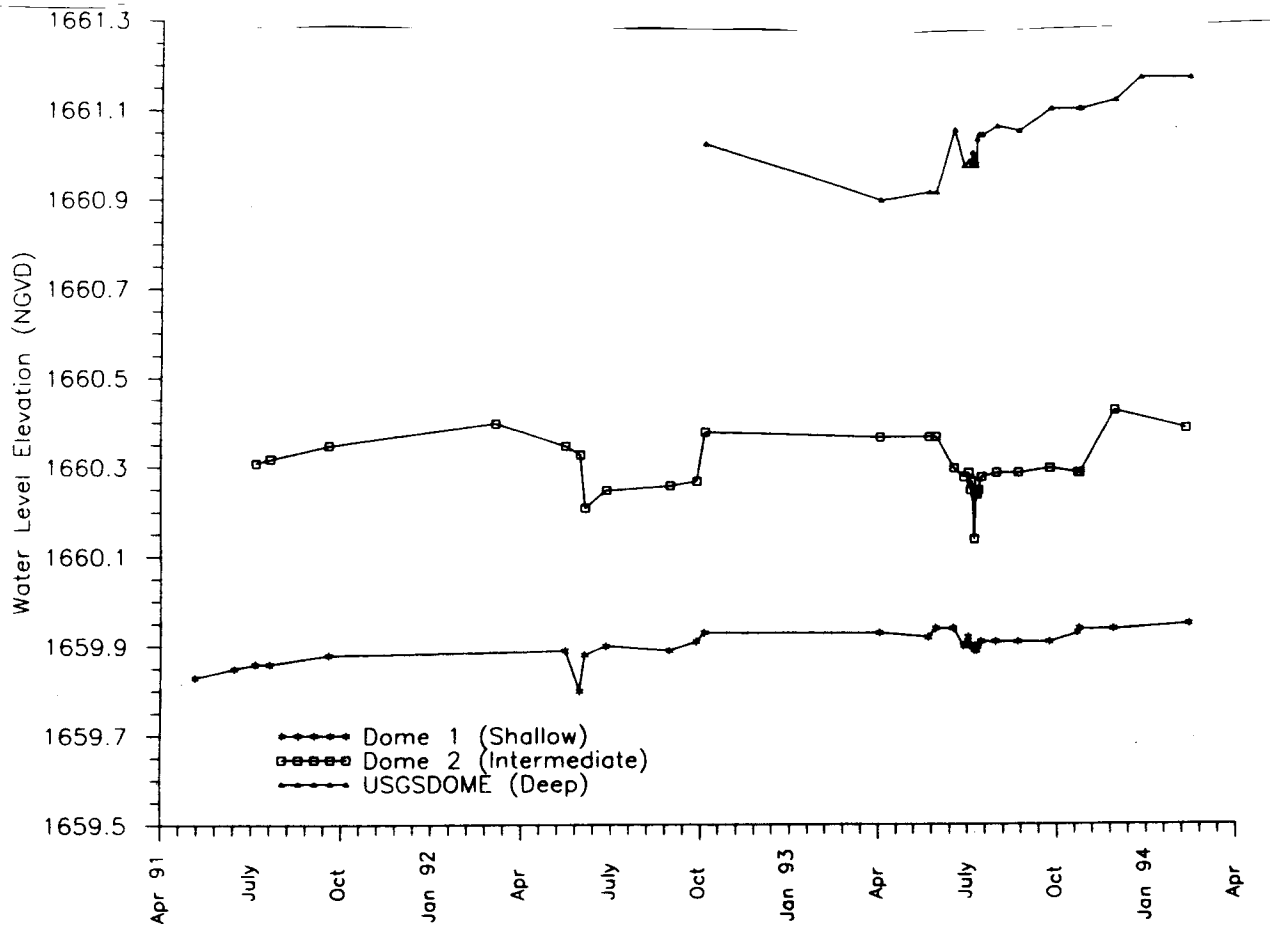


FIGURE 3-7 SIOUX NATION FEN HISTORIC WATER LEVELS IN PIEZOMETERS

Source: MNDNR, Burr Well Field
Aquifer Test Analysis, 1994

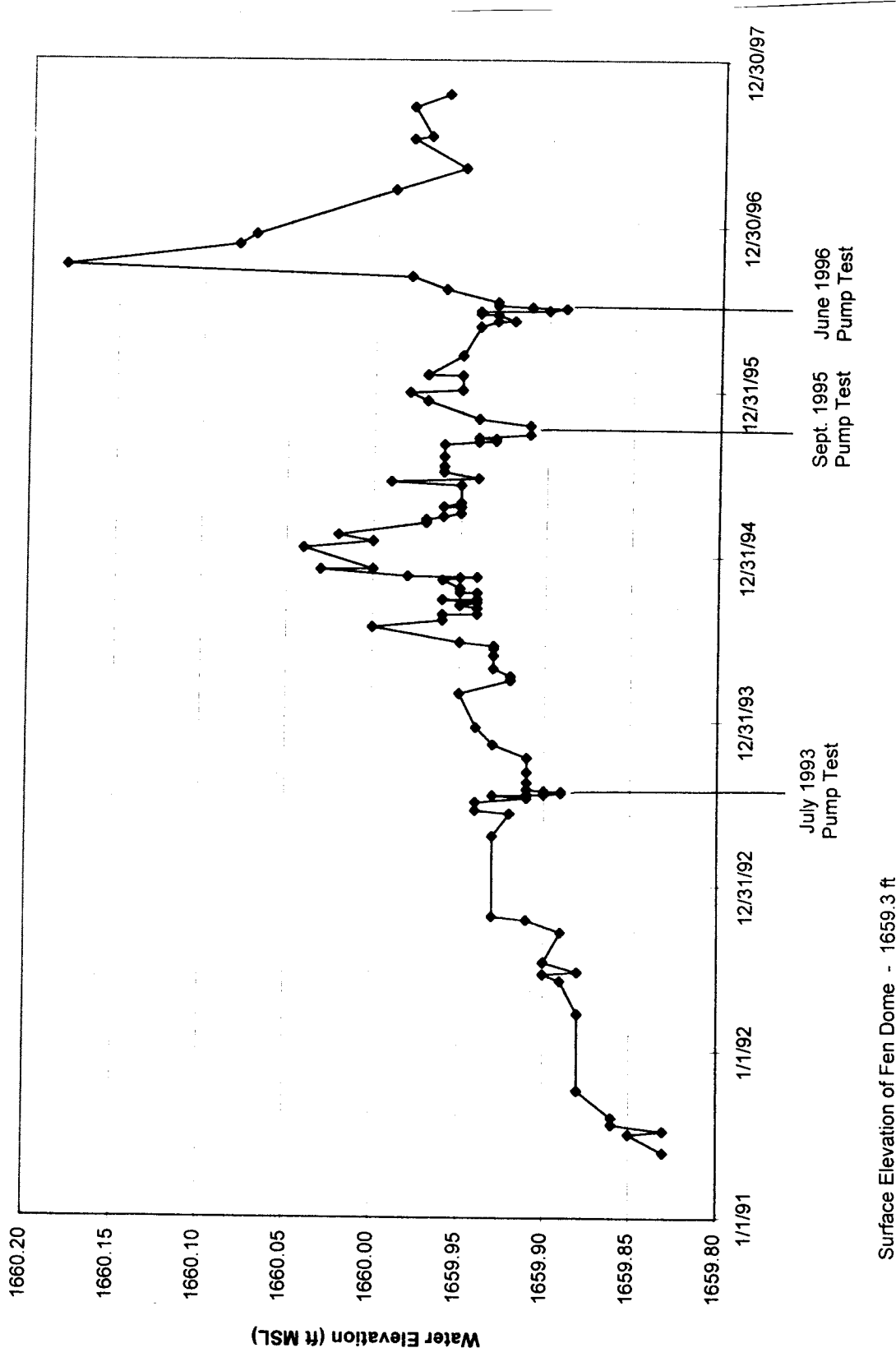


FIGURE 3-8 SIOUX NATION FEN DOME 1 PIEZOMETER (WATER TABLE)

Source: MNDNR, 1997, Attachment 39

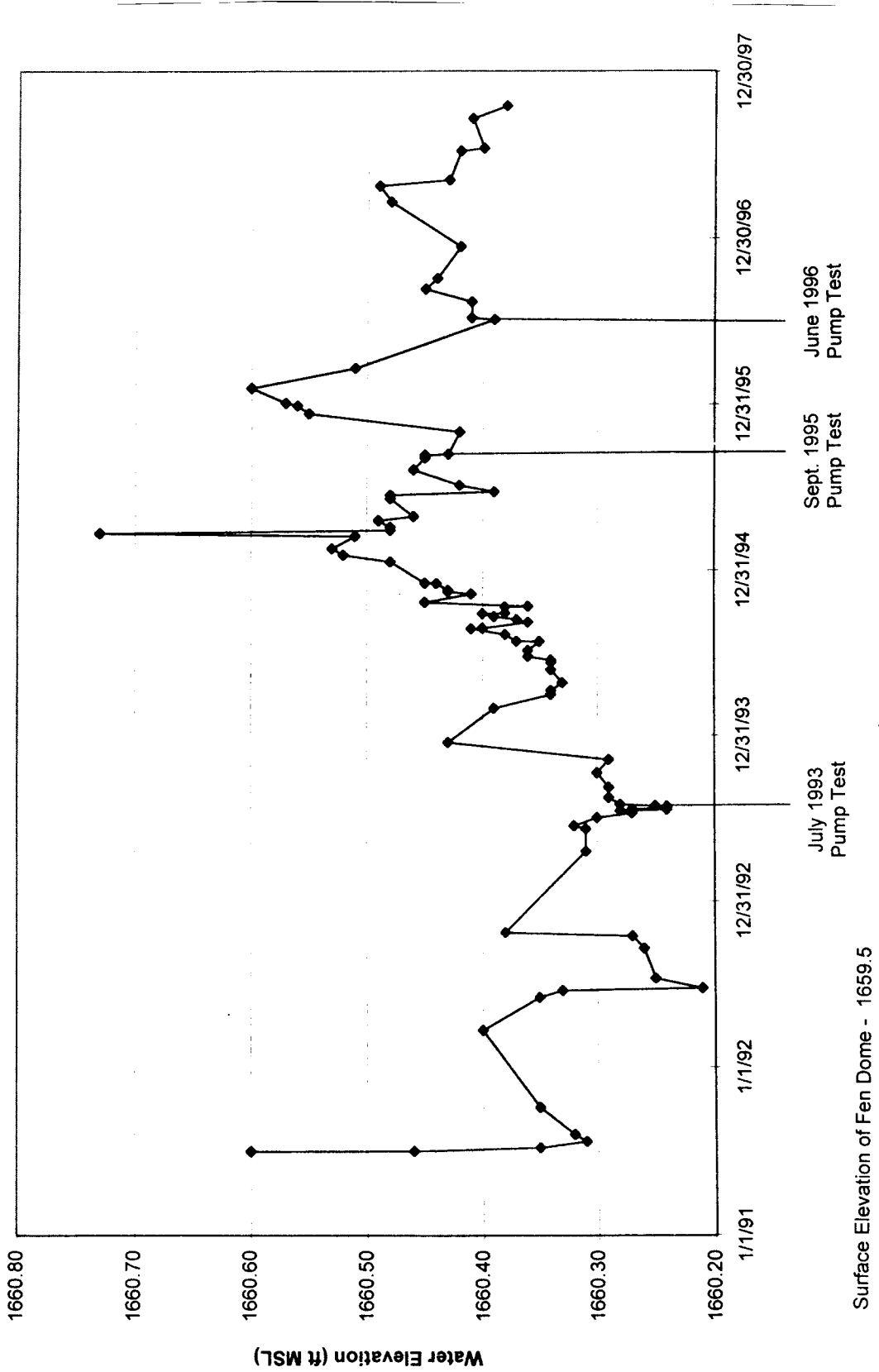


FIGURE 3-9 SIOUX NATION FEN DOME 2 PIEZOMETER (INTERMEDIATE)

Source: MNDNR, 1997, Attachment 39

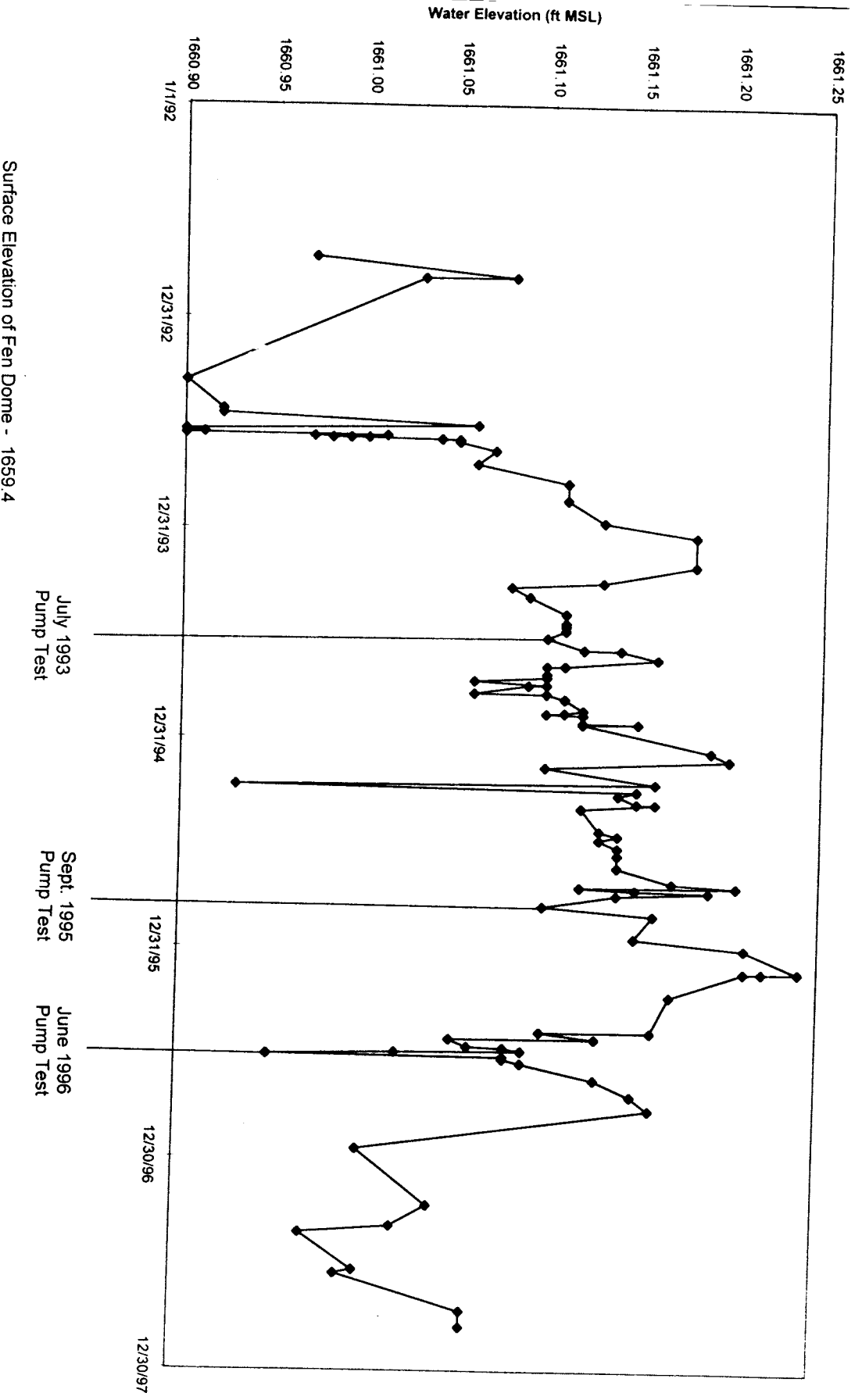


FIGURE 3-10 SIOUX NATION FEN USGS DOME PIEZOMETER (DEEP)

Source: MNDNR, 1997, Attachment 39

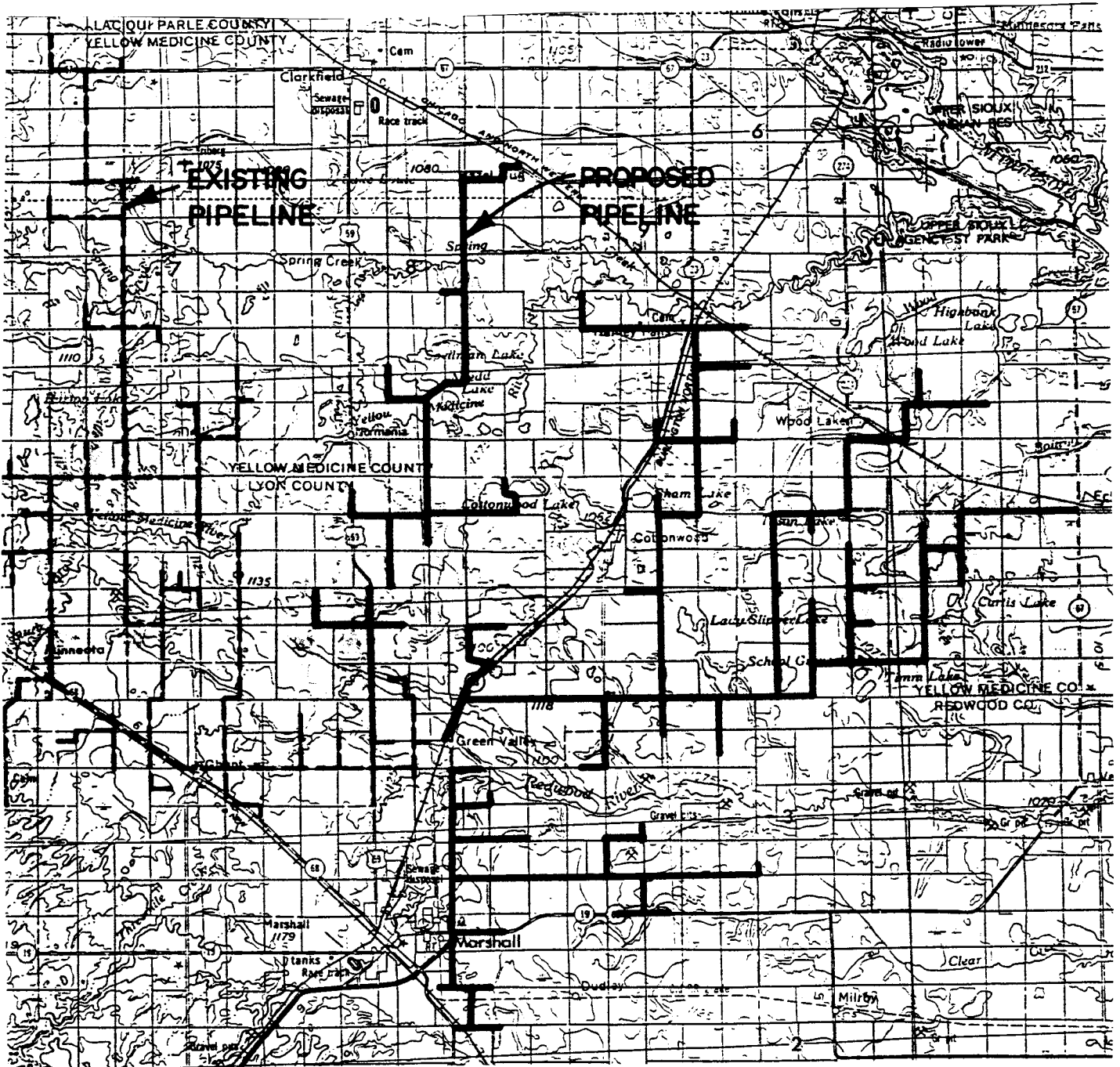


FIGURE 3-11 NORTHEAST PHASE EXPANSION PROPOSED PIPELINE ROUTES

3.3.1 Geology and Soils

Affected Environment

The geology and soil types in the proposed service area for the Northeast Phase are generally very uniform. The entire service area is proposed to be

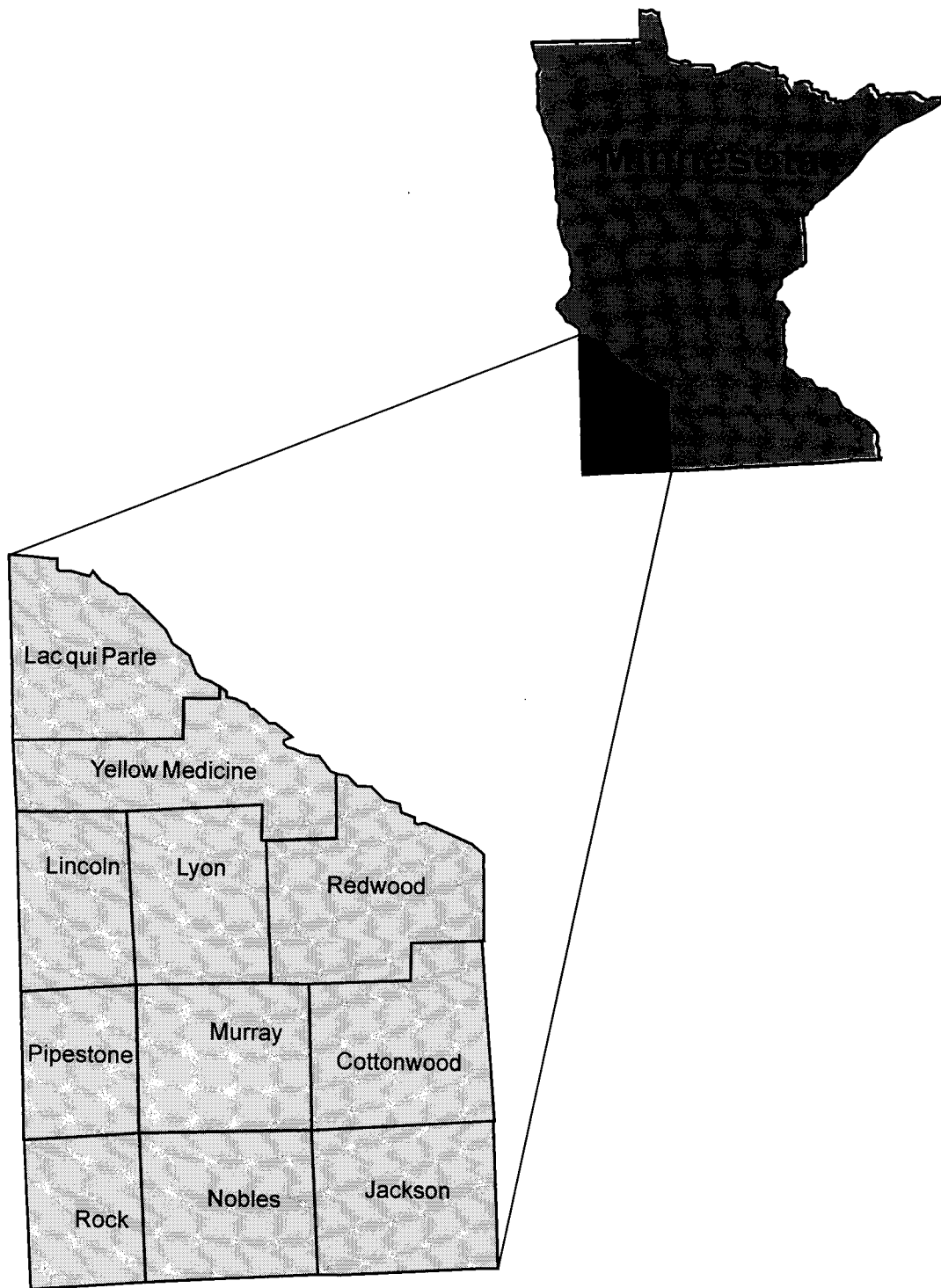


FIGURE 3-12 MINNESOTA STUDY AREA

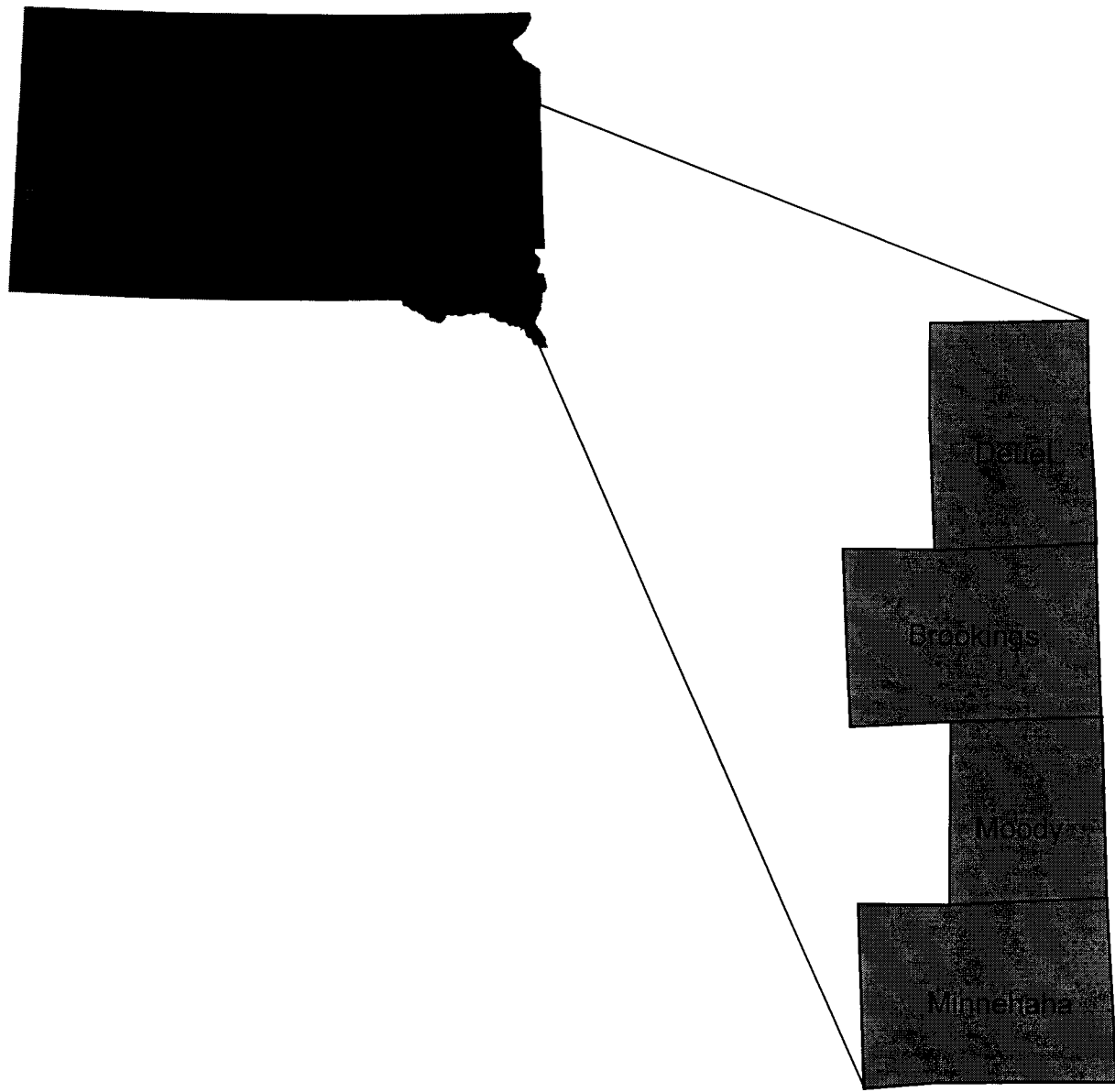


FIGURE 3-13 SOUTH DAKOTA STUDY AREA

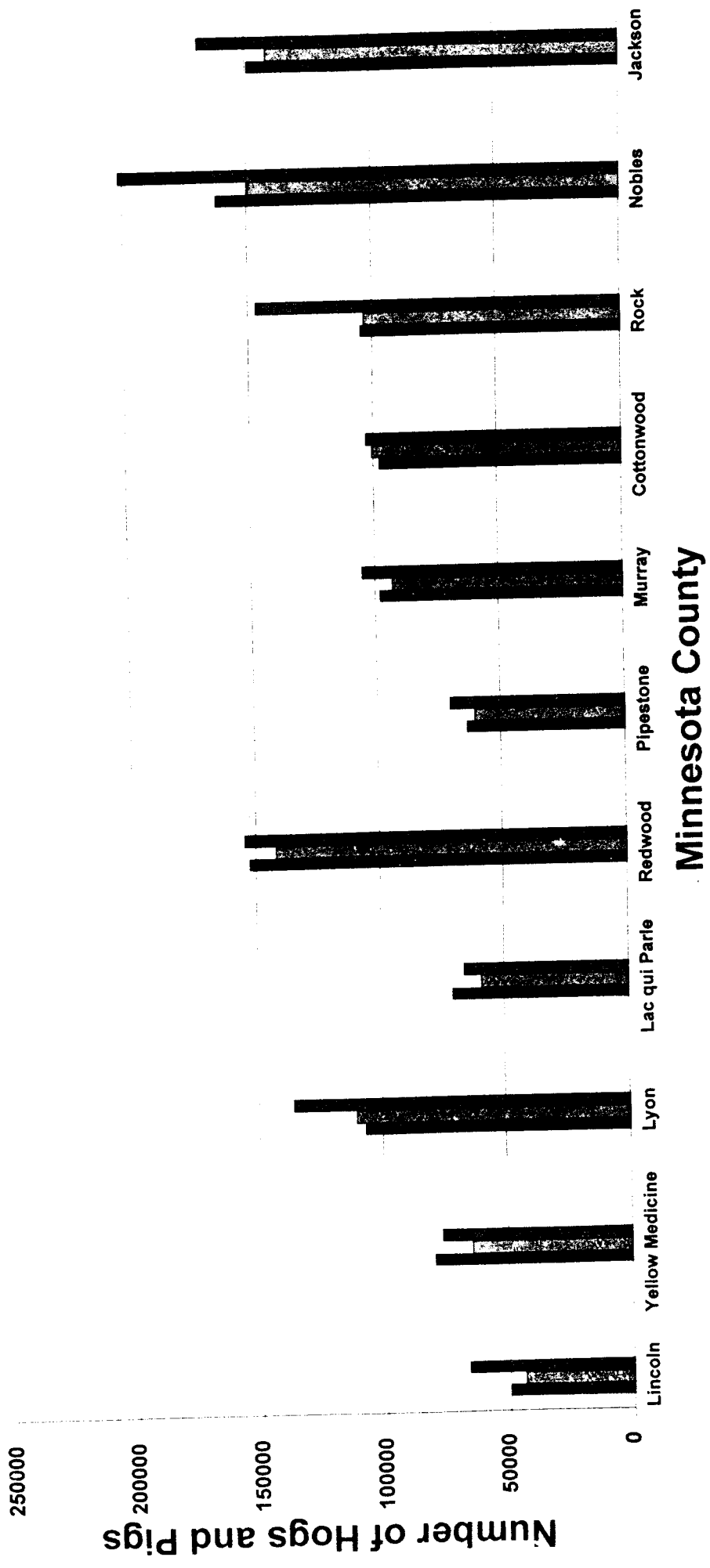


FIGURE 3-14 COMPARISON OF HOG AND PIG CENSUS FOR YEARS 1982, 1987, 1992

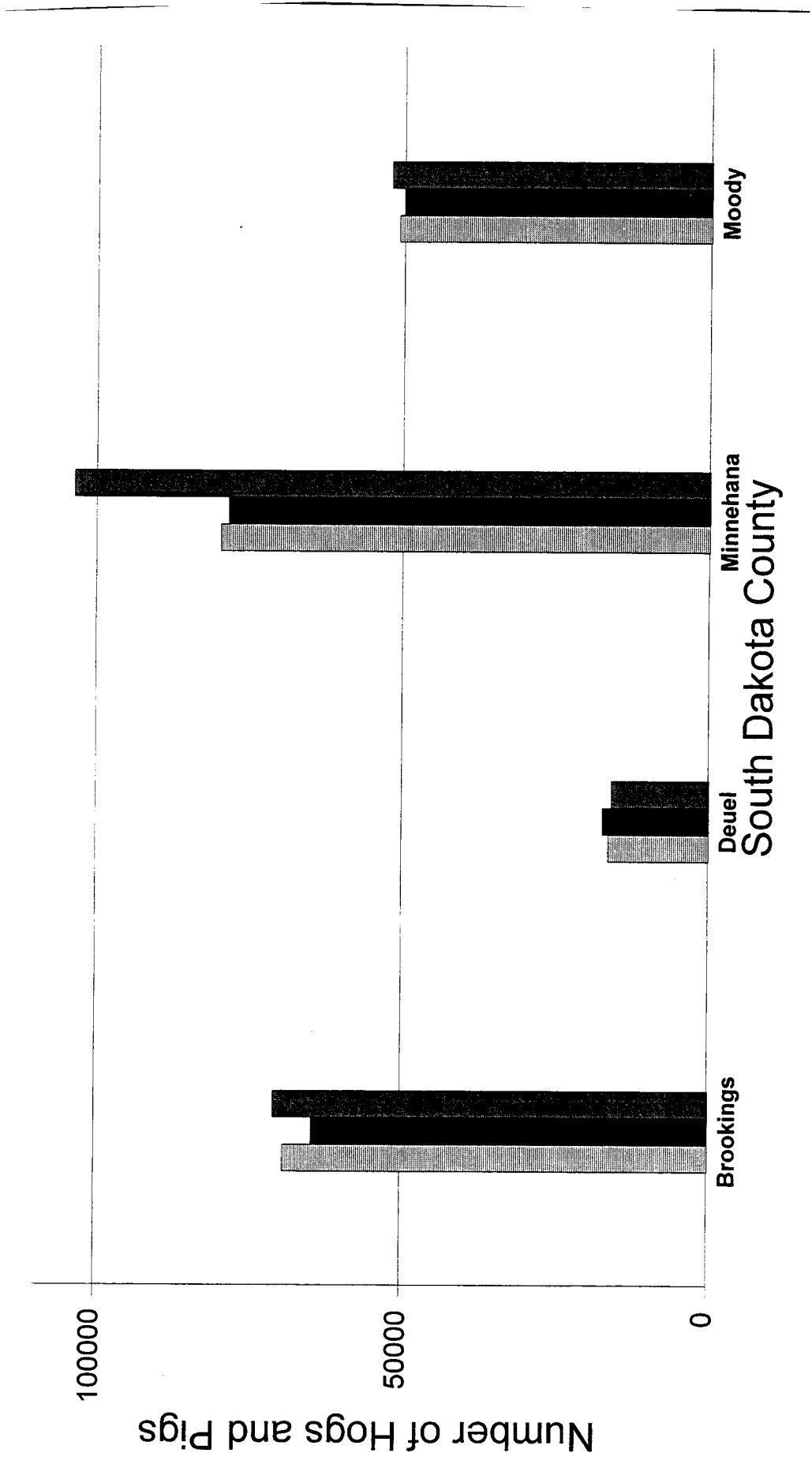


FIGURE 3-15 COMPARISON OF HOG AND PIG CENSUS FOR YEARS 1982, 1987, 1992

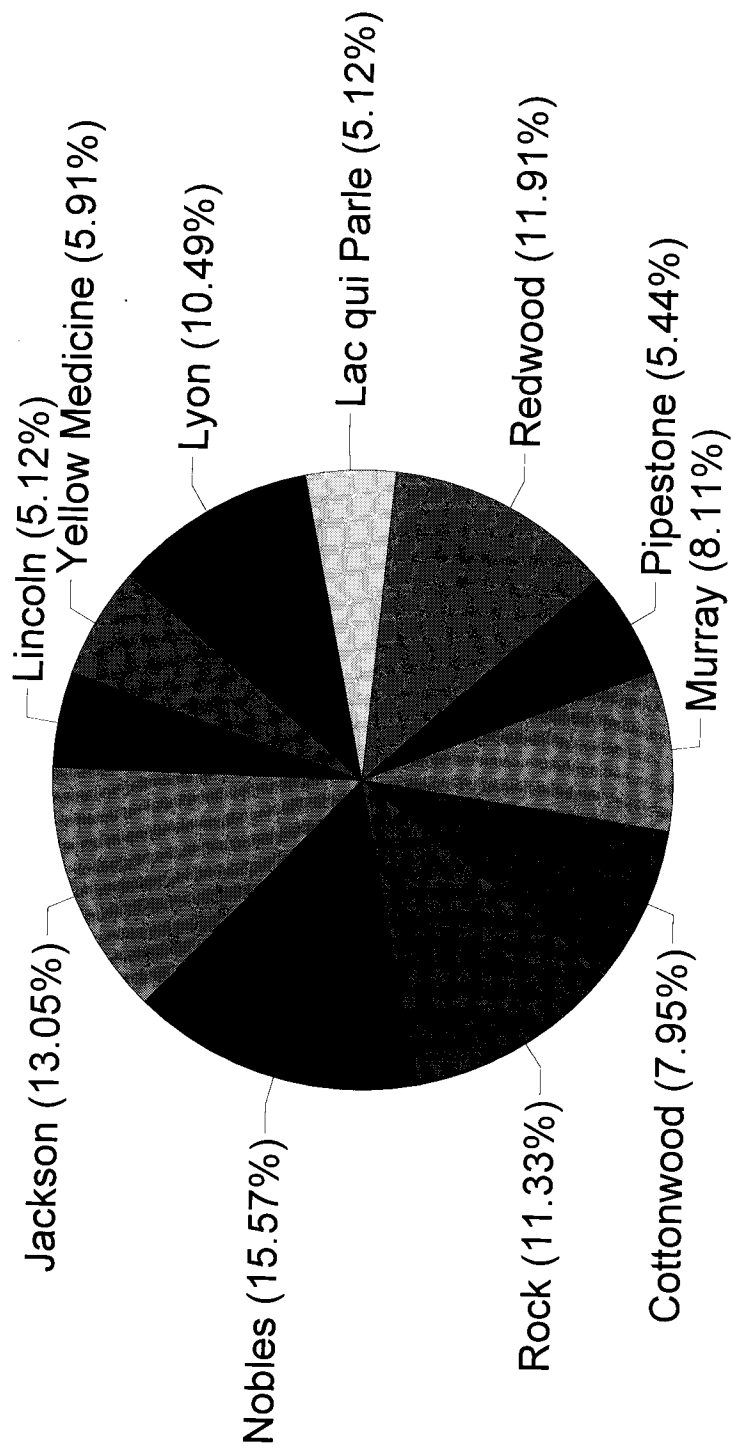


FIGURE 3-16 PERCENTAGE INCREASES IN HOG POPULATIONS IN MINNESOTA COUNTIES DURING STUDY PERIOD

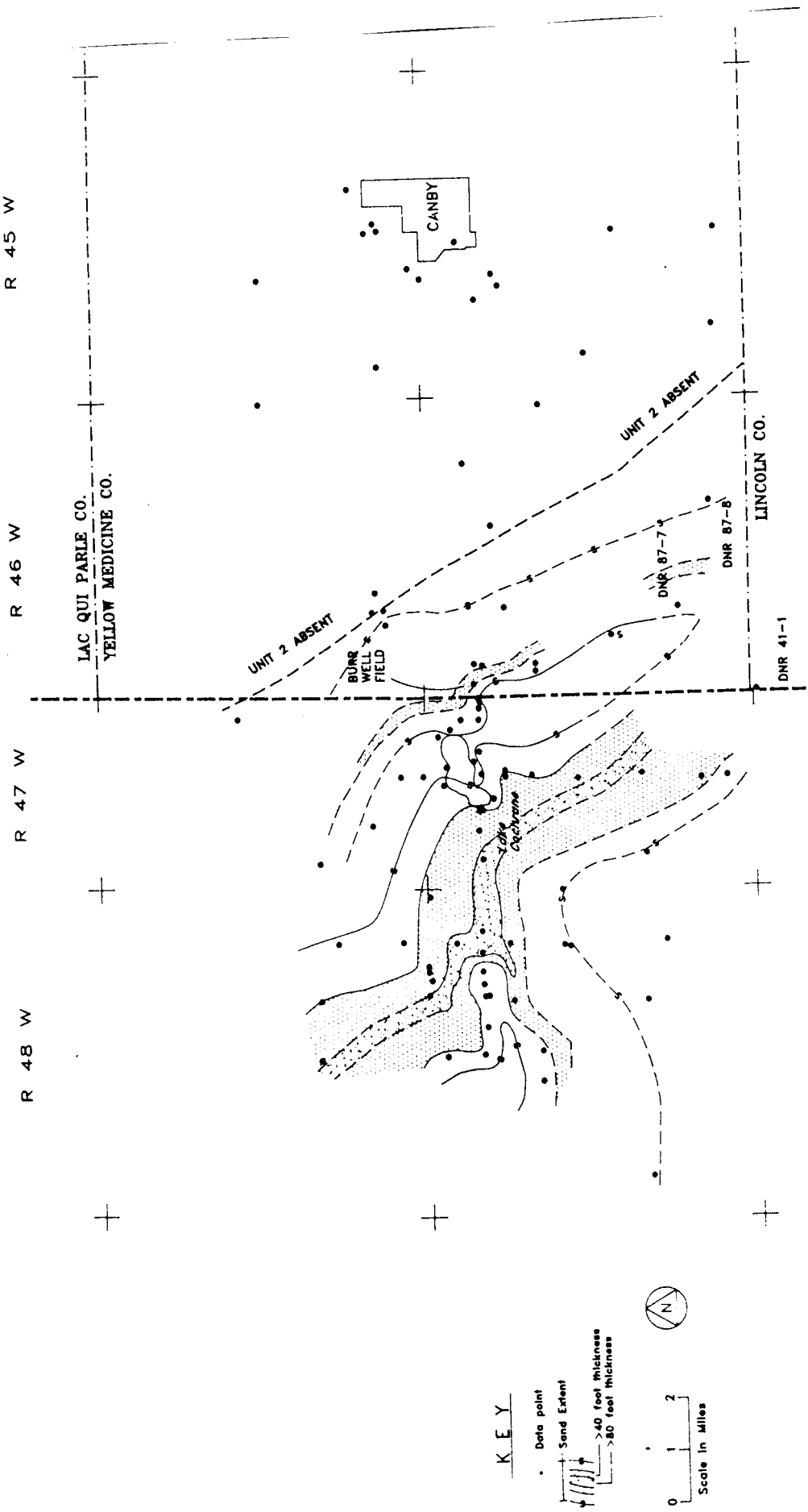


FIGURE 7-1 BURR WELL FIELD/LAKE COCHRANE, UNIT 2 SAND THICKNESS

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-97, Progress Report

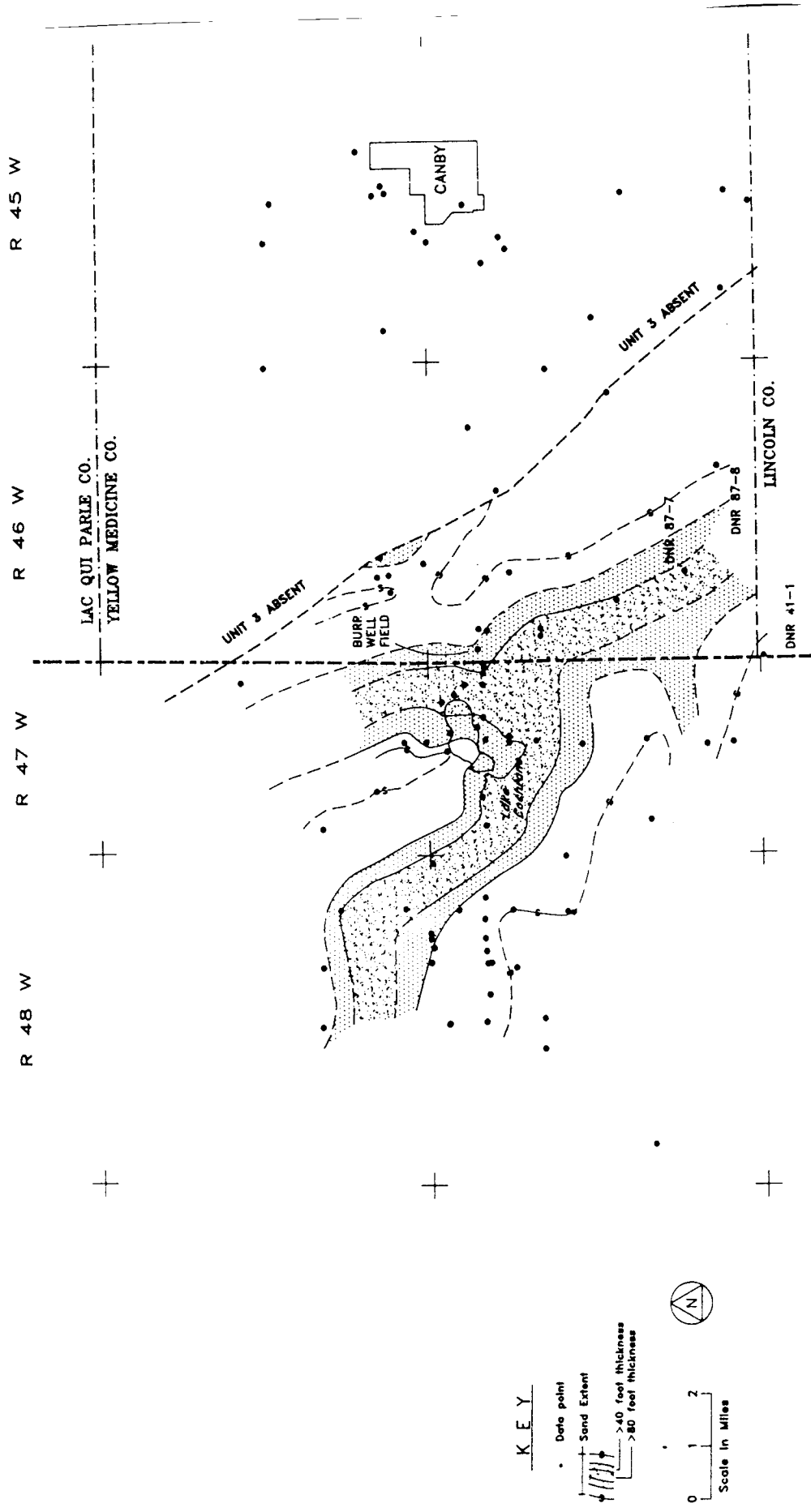


FIGURE 7-2 BURR WELL FIELD/LAKE COCHRANE, UNIT 3 SAND THICKNESS

Source: MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-97, Progress Report

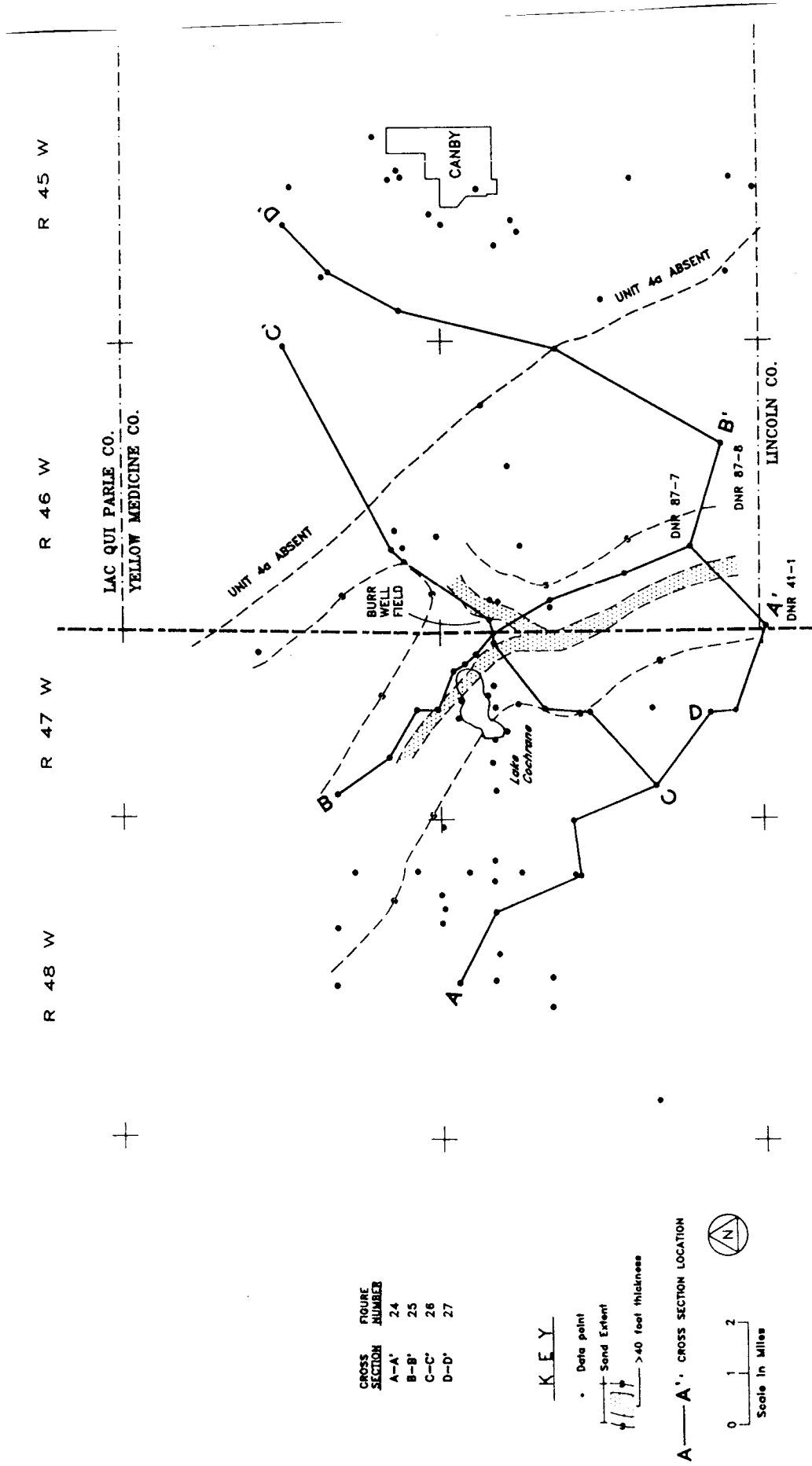


FIGURE 7-3 BURR WELL FIELD/LAKE COCHRANE, UNIT 4A SAND THICKNESS AND CROSS SECTION LOCATIONS

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-97, Progress Report

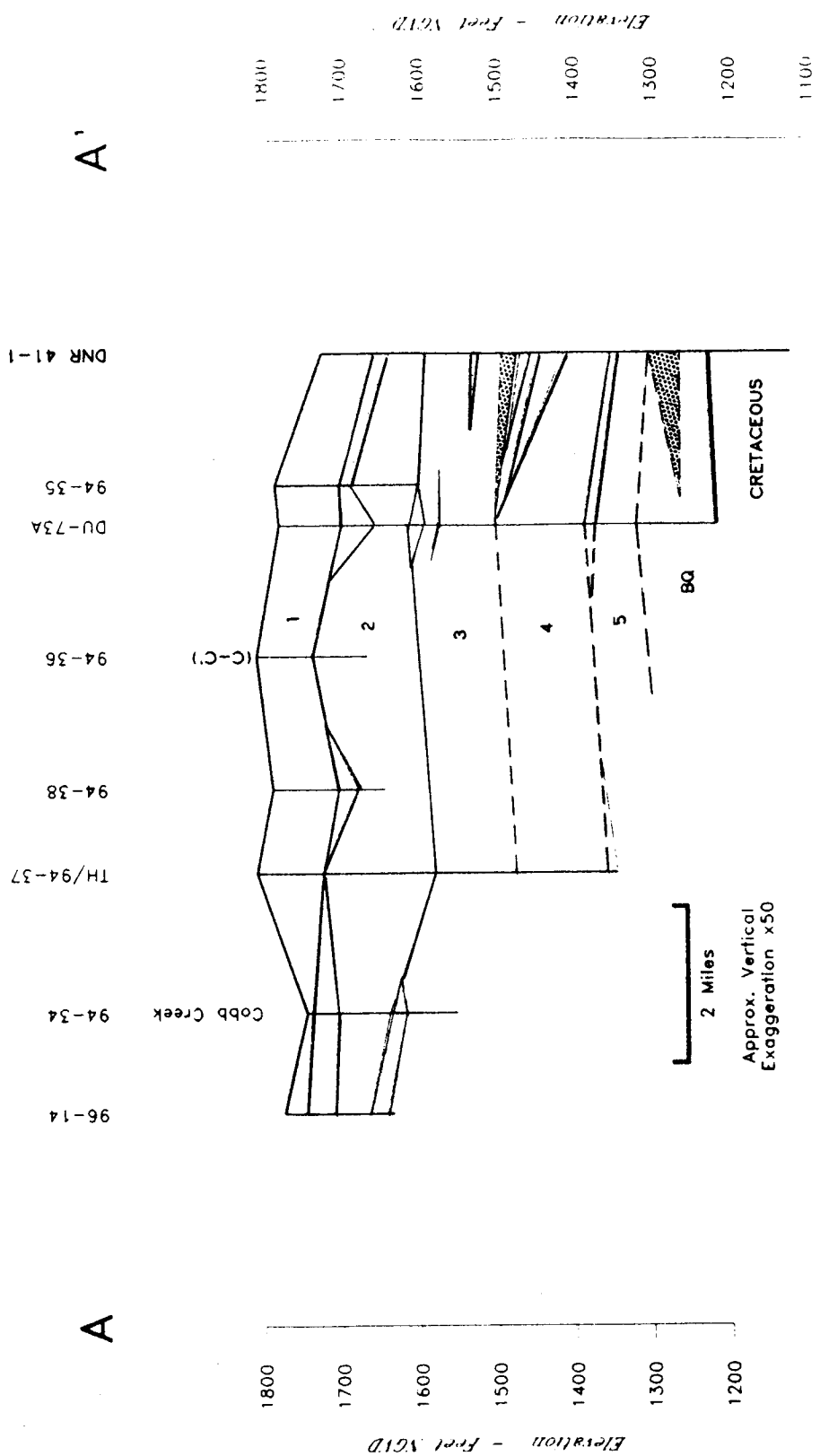
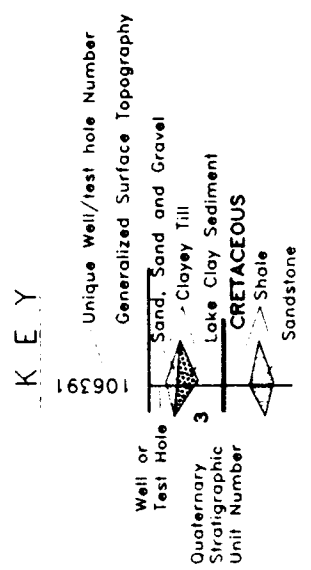


FIGURE 7-4 BURR WELL FIELD/LAKE COCHRANE AREA, CROSS SECTION A-A'

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-97, Progress Report



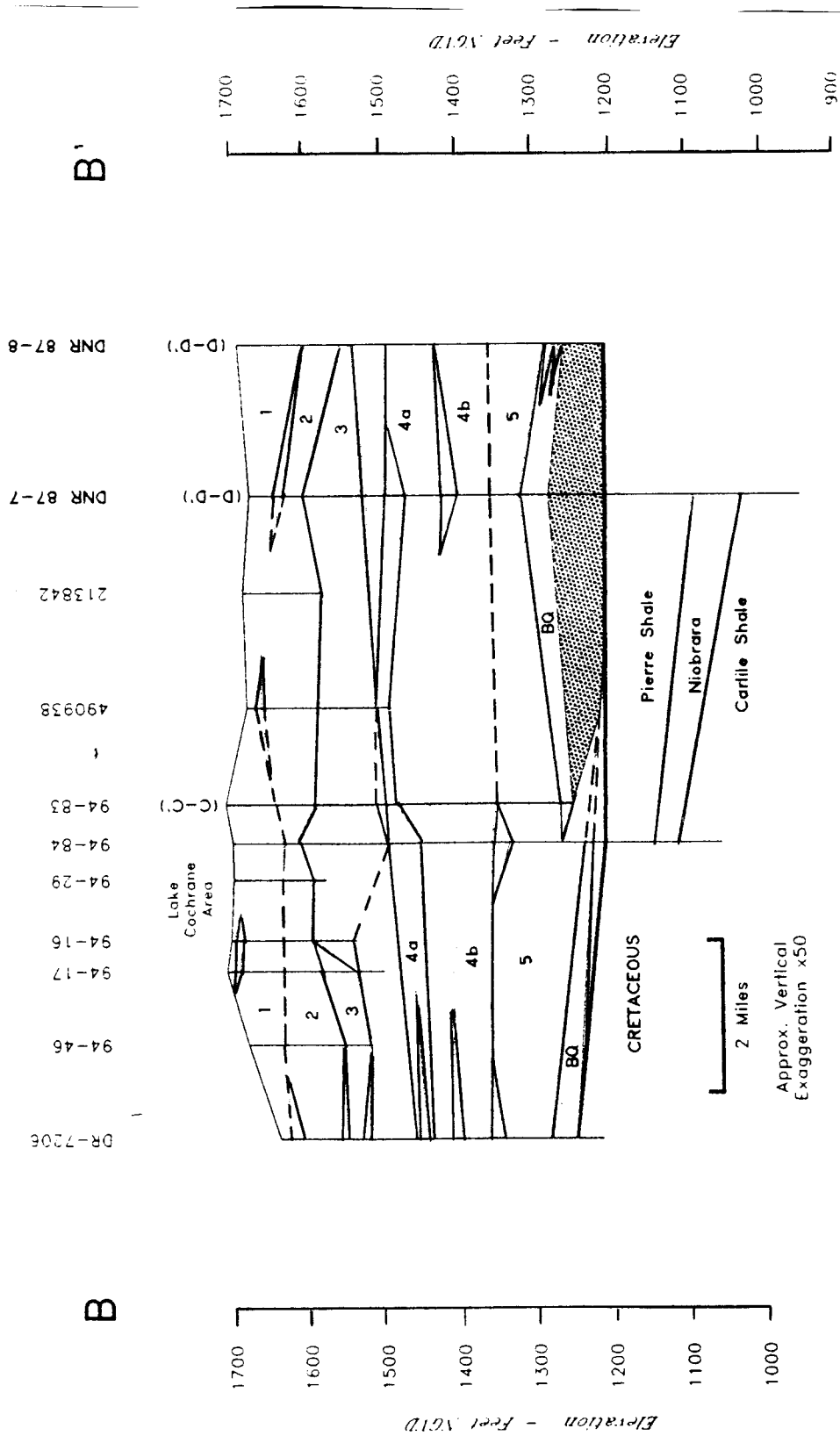
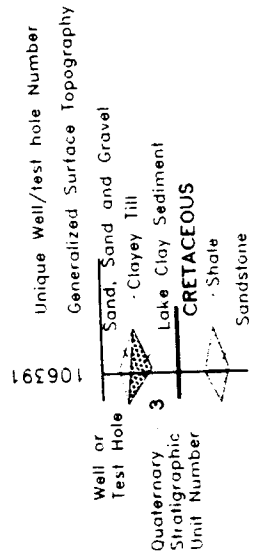


FIGURE 7-5 BURR WELL FIELD/LAKE COCHRANE AREA, CROSS SECTION B-B'

KEY



Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-977, Progress Report

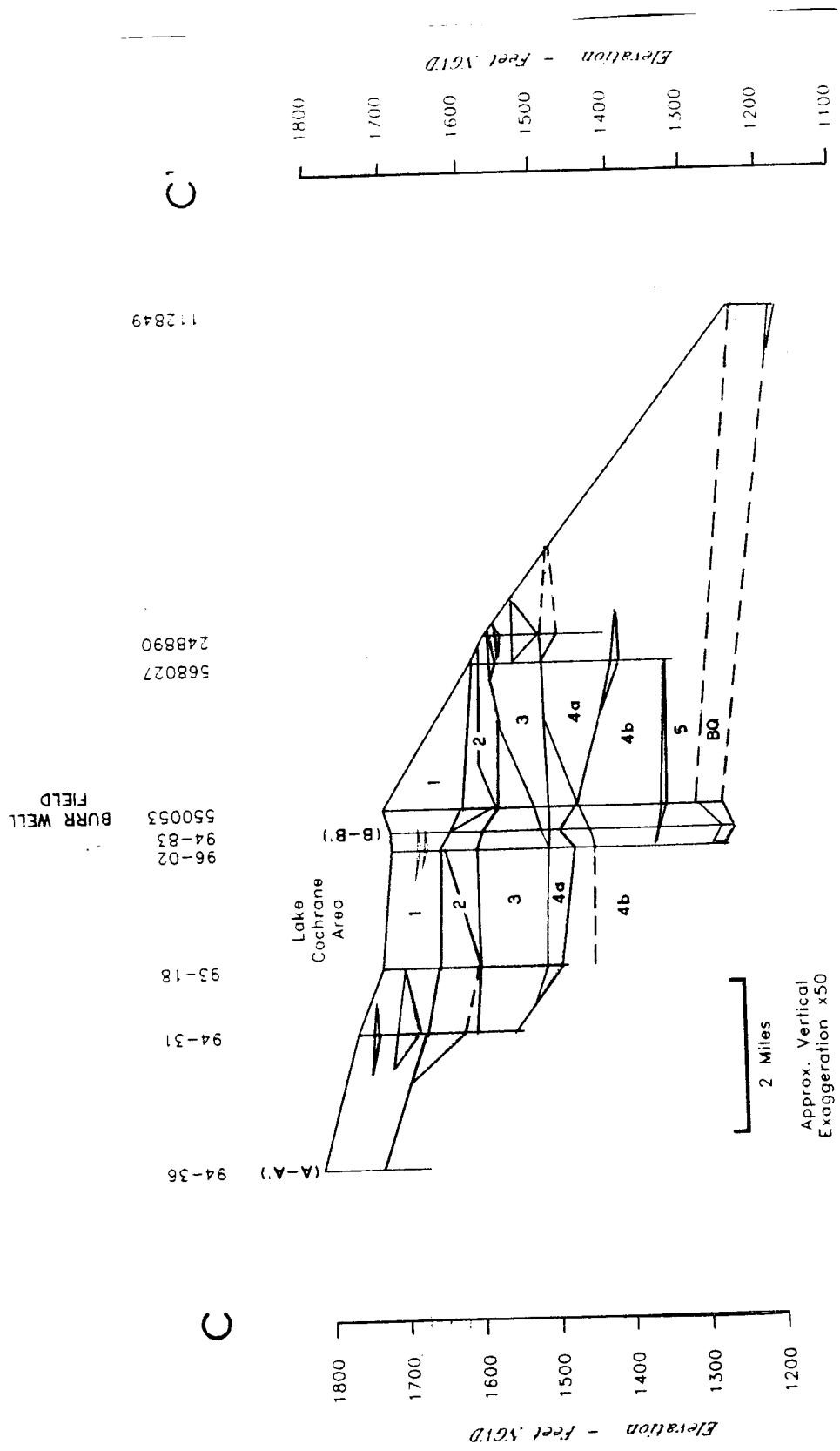
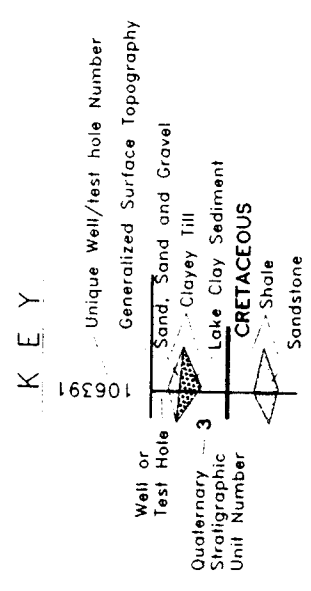


FIGURE 7-6 BURR WELL FIELD/LAKE COCHRANE AREA, CROSS SECTION C-C'

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-97, Progress Report



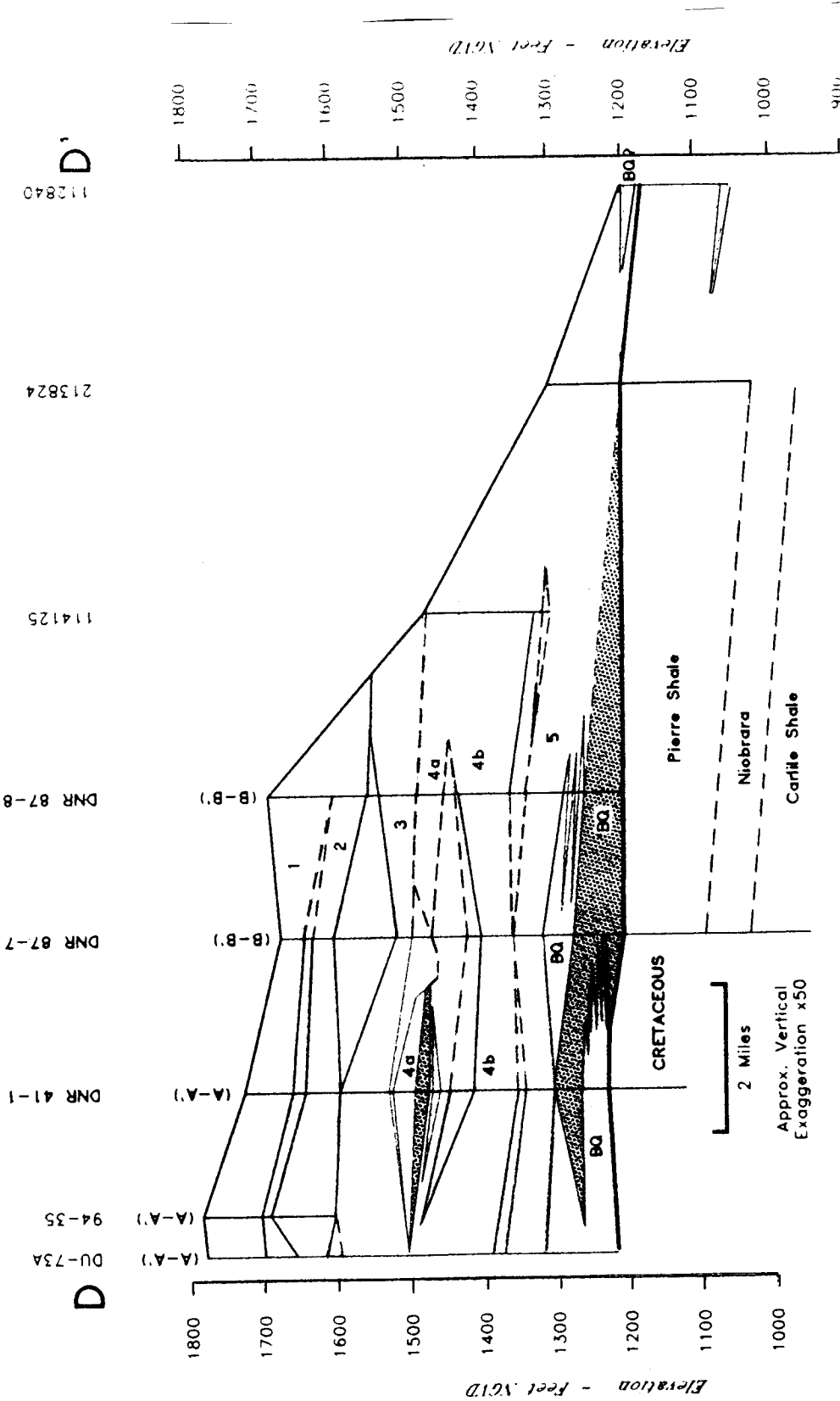


FIGURE 7-7 BURR WELL FIELD/LAKE COCHRANE AREA, CROSS SECTION D-D'

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1996-97, Progress Report

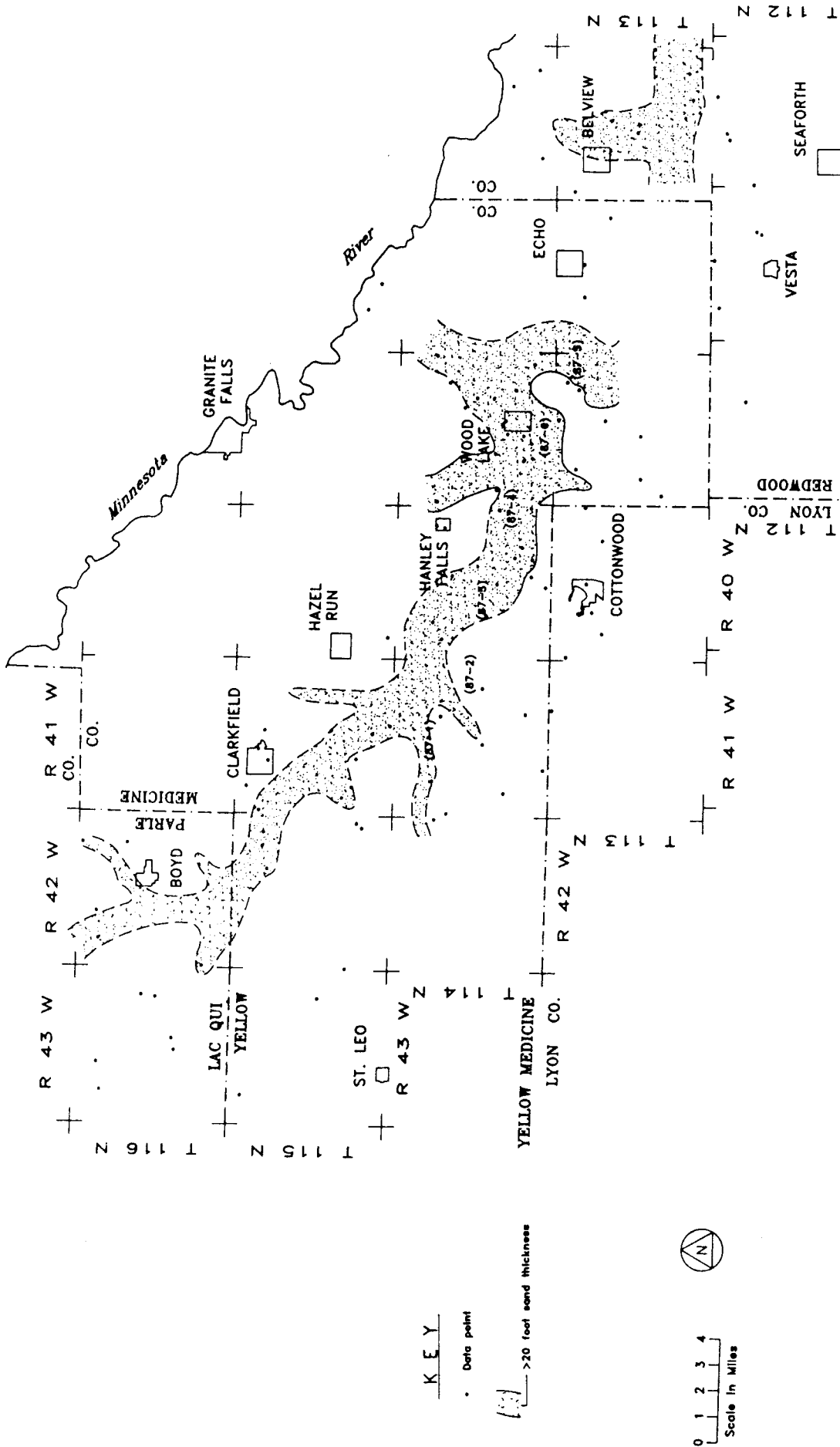


FIGURE 7-8 WOOD LAKE AQUIFER SAND THICKNESS, YELLOW MEDICINE COUNTY

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1997, Final Report

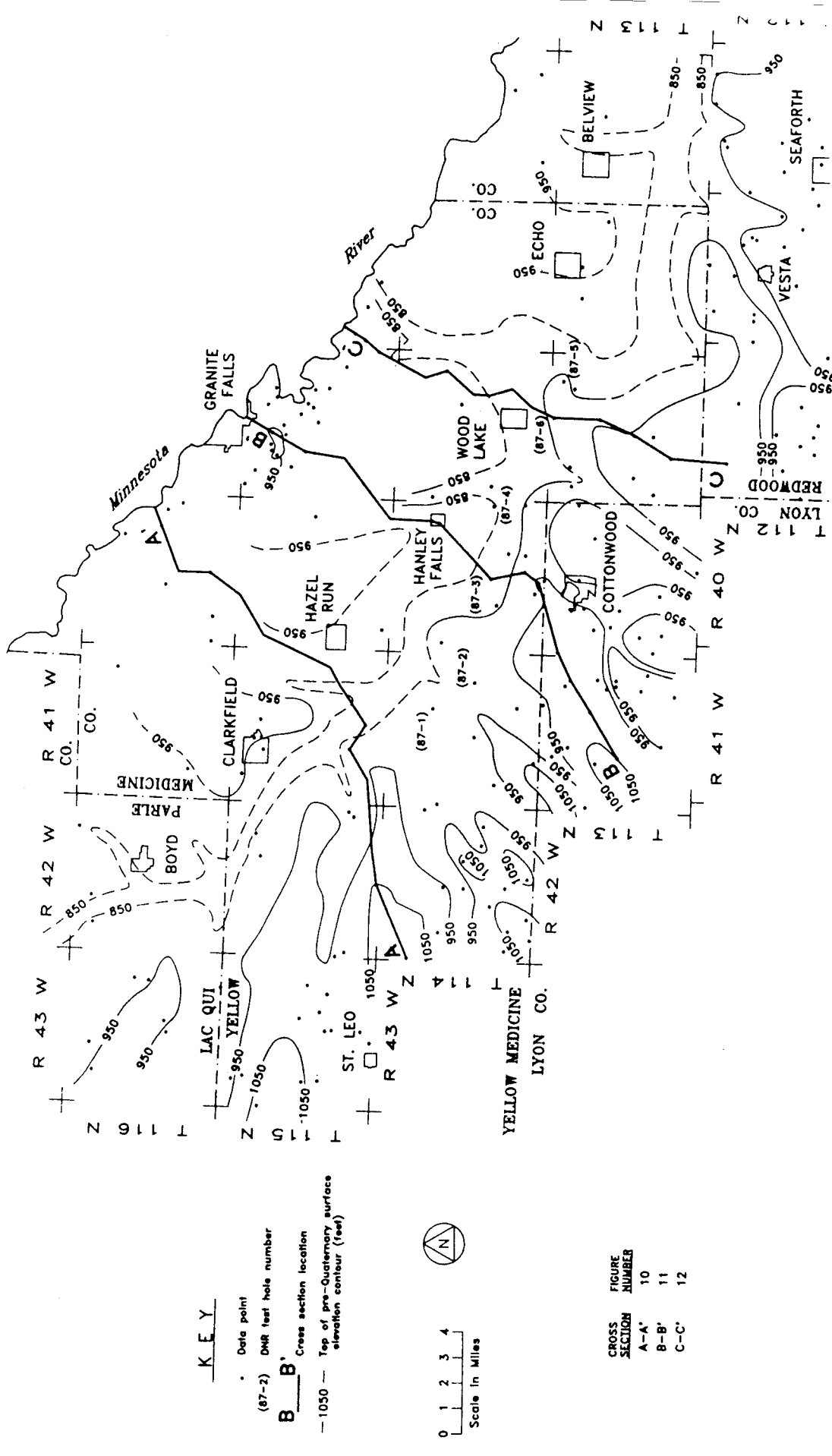


FIGURE 7-9 WOOD LAKE AQUIFER CROSS SECTION LOCATIONS, YELLOW MEDICINE COUNTY

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1997, Final Report 1

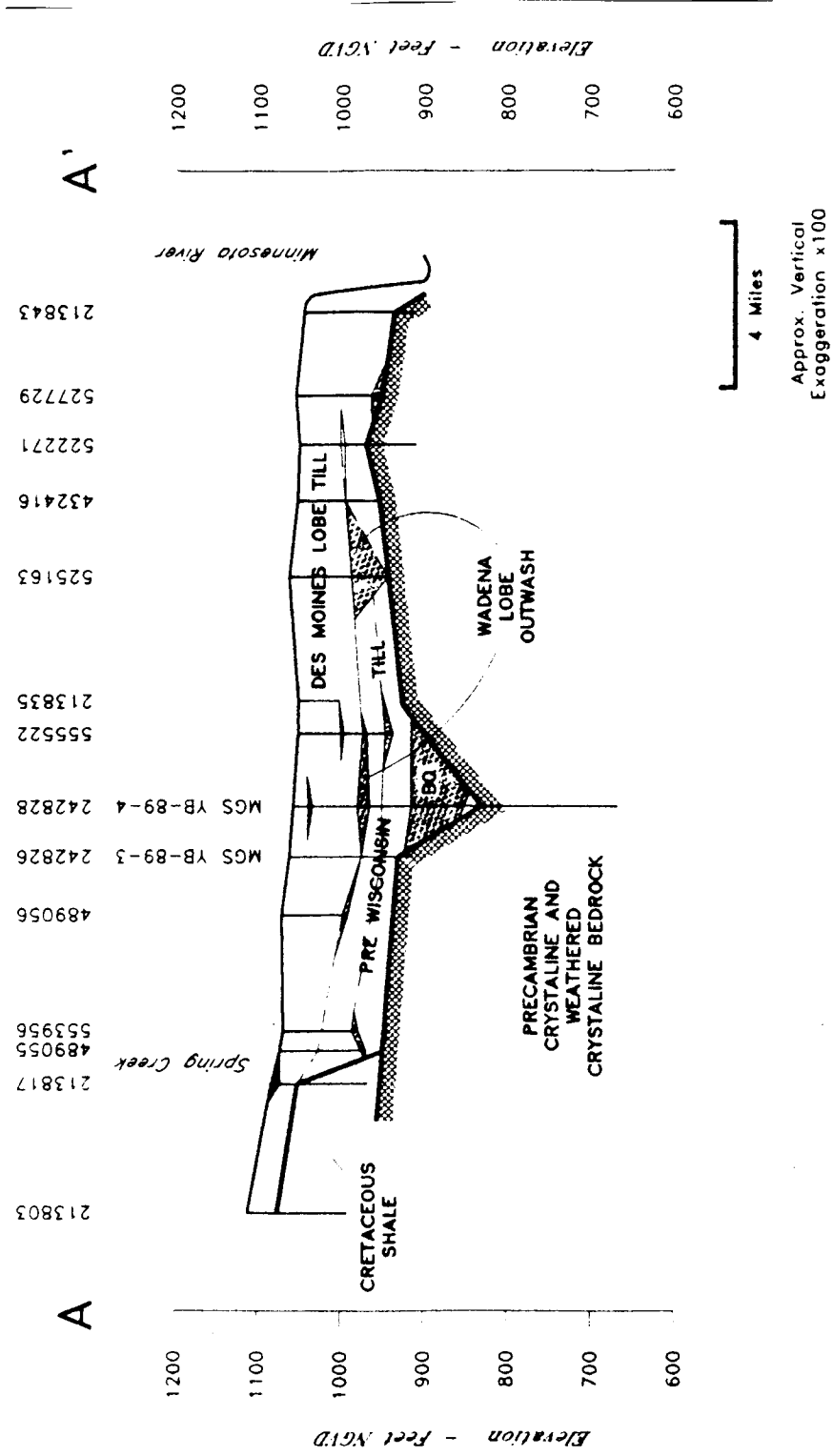
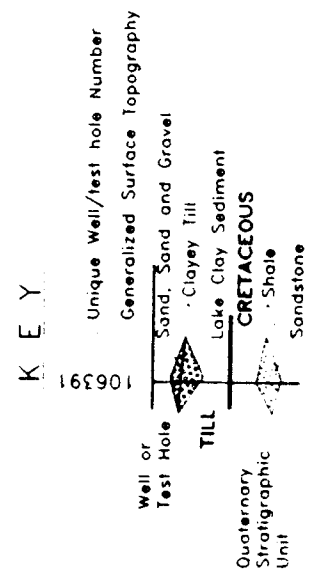


FIGURE 7-10 WOOD LAKE AQUIFER, CROSS SECTION A-A'

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1997, Final Report 1



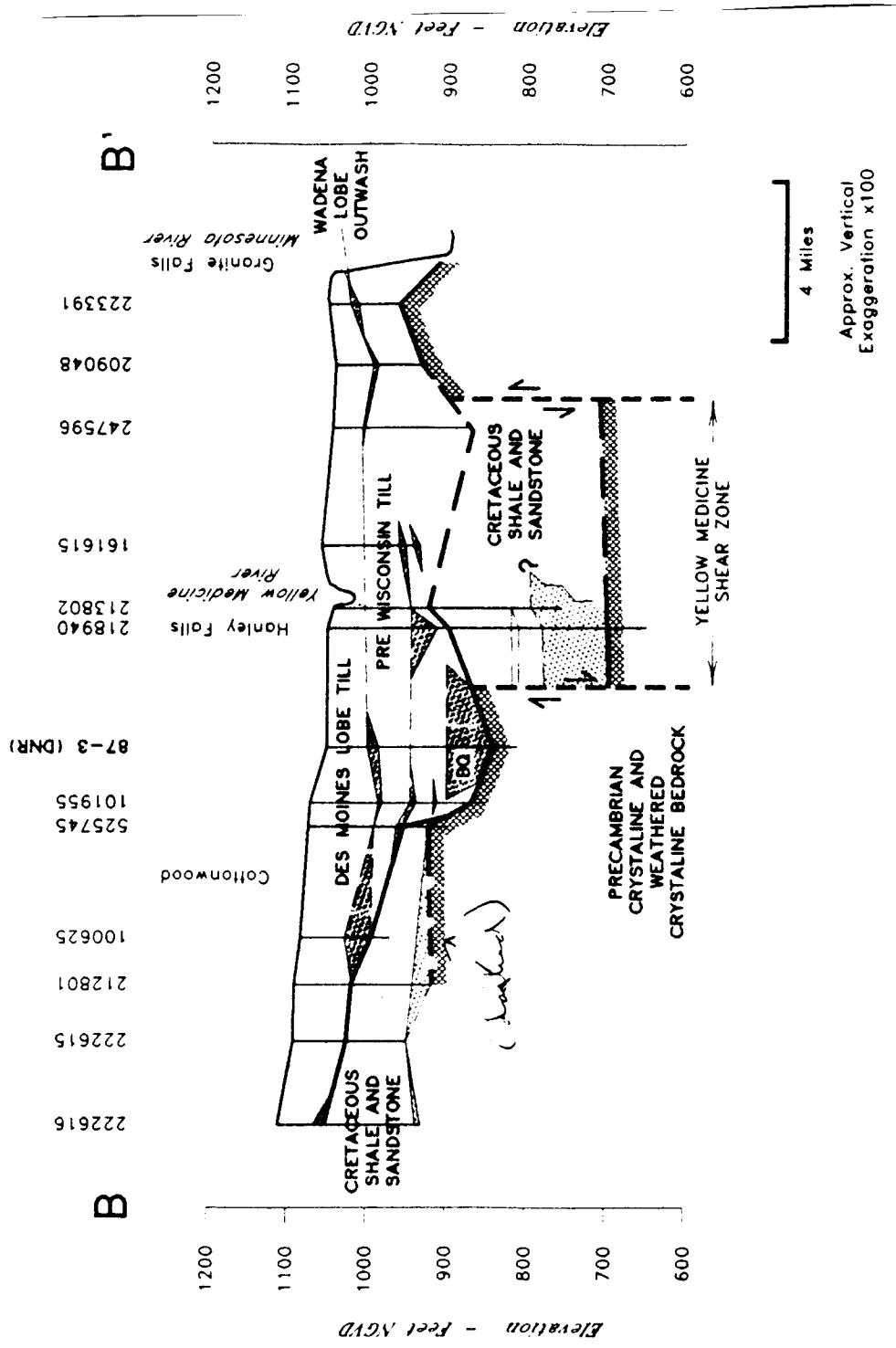
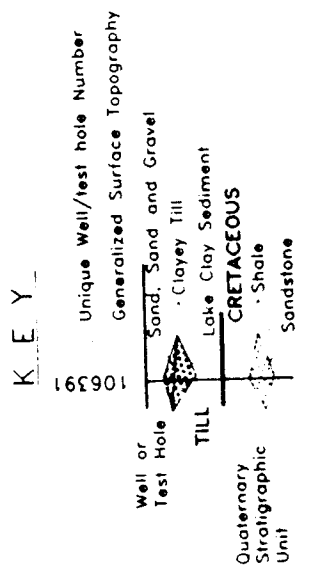
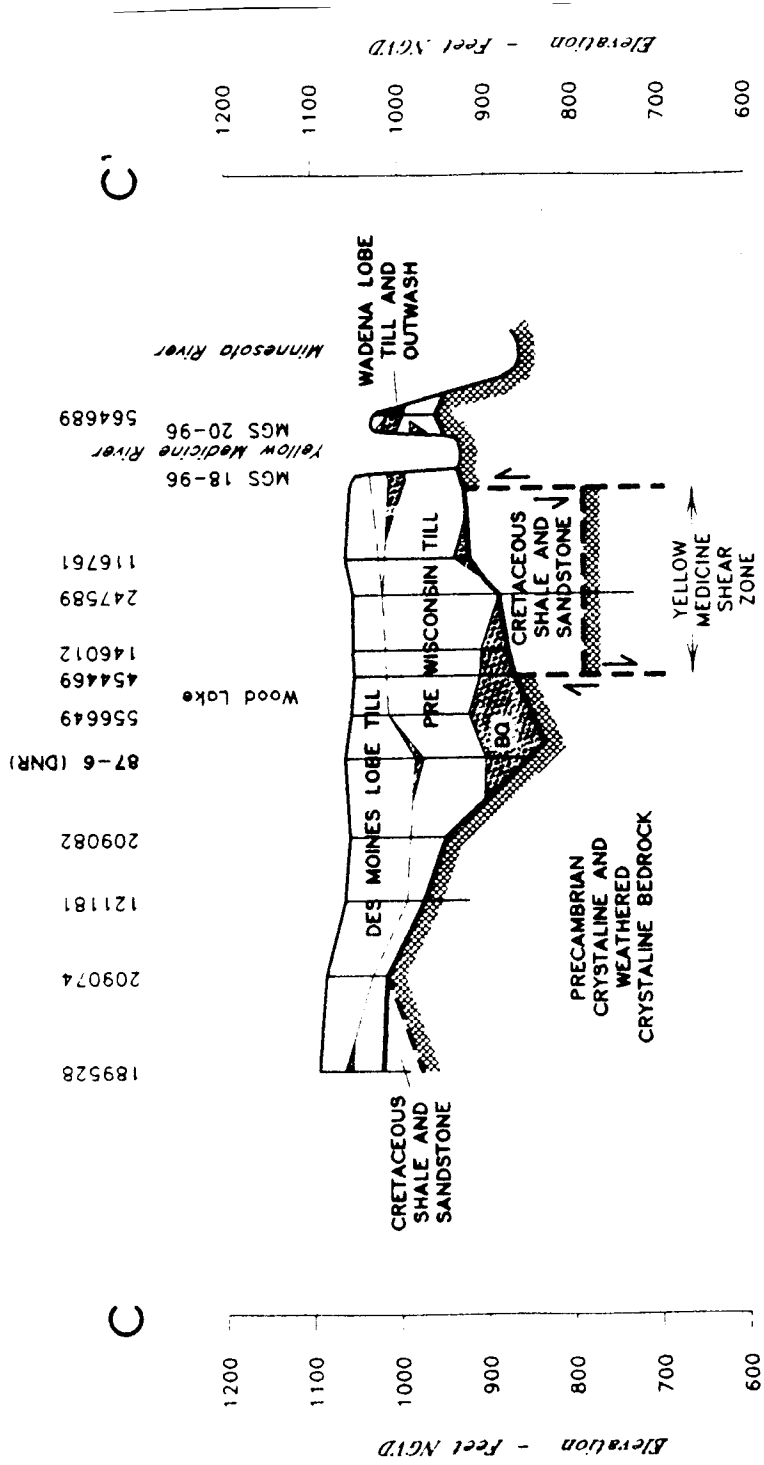


FIGURE 7-11 WOOD LAKE AQUIFER, CROSS SECTION B-B'

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1997, Final Report 1





4 Miles

Approx. Vertical Exaggeration x100

FIGURE 7-12 WOOD LAKE AQUIFER, CROSS SECTION C-C'

Source, MNDNR, Southwestern Minnesota Groundwater Exploration Project, 1997, Final Report 1

