KANSAS GEOLOGICAL SURVEY
OPEN-FILE REPORT 87-19

Maps of Saturated Thickness 1986 and Percent Decline in
Saturated Thickness from 1950 to 1986
in GMD #4, Northwestern Kansas

by

Nadeem Shaukat
Thomas McClain
Tariqu Hussain
Yin Tan

KANSAS GEOLOGICAL SURVEY
1930 Constant Avenue
University of Kansas
Lawrence, KS 66047

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(Open File Report #87-19)
October 6, 1987

Kansas Geological Survey
Lawrence, Kansas 66046

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LOCATION

Northwest Kansas Groundwater Management District No.4 (GMD#4) includes all of Sherman, Thomas and Sheridan counties and portions of Cheyenne, Rawlins, Decatur, Graham, Gove, Logan and Wallace counties in Northwestern Kansas. The district covers approximately 3,100,000 acres and is located in the high plains section of the Great Plains Physiographic Province. Elevations range from approximately 3900 feet above sea level at the western District boundary to approximately 2200 feet above sea level at the eastern edge.

The District falls in parts of the drainage basins of the Upper Republican, Solomon, Smoky Hill and Saline Rivers. The District overlies two aquifers. The aquifer shown on the maps is the Ogallala formation which is a Tertiary aged, fluviall deposit consisting of silt, sand and gravel. The Ogallala ranges in thickness from about 300 feet in the west to 50 feet or less in the eastern portion of the District. Small portions of the District overlie alluvial stream valleys which contain Recent deposits of silt, clay, sand and gravel ranging from a few feet to as much as 60 feet.

DATA FOR SATURATED THICKNESS

296 data points were used to calculate the saturated thickness from measured water table data for 1950 and 1986. The saturated thickness and the decline contours were generated with the SURFACE II software package on the Data General MV20000 computer at the Kansas Geological Survey. In some areas of the District, where little data were available, for example, southeastern Sherman and southwestern Thomas counties, data were estimated in order to make the contouring more accurately reflect hydrologic conditions.

This map was machine contoured, so wherever there is data the contours are hydrologically accurate. However outside the District boundary there is little data, therefore the contour extrapolations are only estimates and generally not hydrologically accurate.

MAP COMPONENTS

The following features have been shown on the Map of Saturated Thickness of 1986 in GMD#4.,

1. GMD#4 District Boundary
2. Upper Republican Basin Boundary
3. Ogallala Aquifer Boundary
4. County Boundary Lines
5. Township-Range Lines
6. Hydrology (Streams)
7. Saturated Thickness Contours
8. Saturated Thickness Point Values

The following features have been shown on the Map of Percent Decline in Saturated Thickness from 1950 to 1986 in GMD#4.,

1. GMD#4 District Boundary
2. Upper Republican Basin Boundary
3. Ogallala Aquifer Boundary
4. Counties Boundary Lines
5. Township-Range Lines
6. Hydrology (Streams)
7. Percent Decline in Saturated Thickness Contours
8. Percent Decline in Saturated Thickness Point Values

The first six items on both maps are the components of the base information provided from Kansas Data Base/GIMMAP, while the last two items on each map are based on water level and bed rock data available on the ACCESS system at the Geohydrology Section. The basic input source for the ACCESS is hydrologic data from the Kansas cooperative hydrologic data network.

MAP RANGE

The extremes of both maps in terms of legal location are;

Township - from T01S to T13S
Range - from R21W to R42W

The extremes parameters in degrees on both maps are;

North = 40.125
South = 38.750
West = 102.125
East = 99.500

MAP SCALE

The map scale is 1:250,000 on Modified Polyconic Projection.

DATA STATISTICS

Following are the statistics for Saturated Thickness and Decline in GMD#4.,

Number of Data Points plotted - 296
Maximum Saturated Thickness in 1950 - 216.00 feet
Minimum Saturated Thickness in 1950 - 2.20 feet
Maximum Saturated Thickness in 1986 - 186.10 feet
Minimum Saturated Thickness in 1986 - 2.10 feet
Maximum Decline from 1950 to 1986 - 56.57 %
Minimum Decline from 1950 to 1986 - 0.09 %

May 17, 1996

Recipients of Open-file Report 95-18:

This letter has been drafted to inform you that several maps contained in Open-file Report 95-18 have been modified at the request of the Southwest Kansas Groundwater Management District. The modifications affect the maps C, D, and H, and the affected area includes portions of Townships 32 and 33 south and Ranges 42 and 43 west.

Please note the enclosed document describing map production techniques. This supplemental information has been included in the Open-file Report 95-18 and has been sent to all prior recipients of the Report.

Thank you,

The Kansas Geological Survey
University of Kansas
1930 Constant Avenue, Campus West
Lawrence, KS 66047-3726

PRE-DEVELOPMENT SATURATED THICKNESS

The map depicting pre-development saturated thickness by section center was produced from data used in the M-33 Series maps. This data consisted of values at section centers for bedrock elevation and pre-development water-level elevation, making calculation of saturated thickness at section centers a simple task.

SATURATED THICKNESS 1980-82, 1990-92, AND 1993-95

These three maps were all generated using the same procedures. Well selection (based on geologic units penetrated) and depth-to-water data (based on date of measurement) criteria were the same as those used to select data for the M-33 Series maps. Data were obtained from the USGS GWSI database and water-level elevations were calculated by subtracting the depth to water from the land surface elevation on a well-by-well basis. For those wells with more than one measurement in the three-year period, all values were averaged into one. This data were then triangulated to form a 3-dimensional surface that was sampled at section centers to estimate water-level elevations for each center. Water-level elevation maximum values were constrained by the greater of either land surface elevation or pre-development water-level elevation values determined for each section center, and minimum values were constrained by the lesser of either bedrock elevation or pre-development water-level elevation. Saturated thickness values were then calculated by subtracting the lesser of bedrock elevation or pre-development water-level elevation values from water-level elevation values at each section center. It is important to note that although each of these maps portray average saturated thickness values for 6952 section centers, the actual number of data points used ranges from 496 to 856, indicating the magnitude of interpolation that had to be performed in order to assign a value to every section center.

CHANGE IN SATURATED THICKNESS PRE-DEVELOPMENT TO 1993-95

Once the pre-development and 1993-95 saturated thickness at section center data had been calculated, the change from pre-development to 1993-95 was calculated by subtracting the former from the latter. Although no constraints were placed on maximum or minimum values during the calculations, the map classification scheme groups all change values which were greater than zero into a single category for which section center values are not printed on the map. Note that positive values do not necessarily indicate an increase in saturated thickness over time, but could be the result of any one of numerous assumptions, constraints, averaging or selection techniques, or data inaccuracies.

PROJECTED SATURATED THICKNESS

A ten-year trend in saturated thickness changes was calculated for only those wells that had water-level measurement data in both the 1980-82 and 1990-92 datasets previously established. This trend was extrapolated on a well-by-well basis for the given time intervals and was then added to the water-level elevation value calculated for the base period 1990-92. The maximum projected water-level elevation was constrained at each well by the greater of the pre-development or the averaged 1990-92 water-level elevations, and the minimum projected water-level elevation was constrained by the lesser of the bedrock or the averaged 1990-92 water-level elevations. This data was then triangulated to form a three-dimensional surface representing the projected water-level elevation that was then sampled at section centers. The maximum projected water-level elevation at each section center was constrained by the greater of the pre-development, 1980-82, or 1990-92 water-level elevations, and the minimum projected water-level elevation was constrained by the lesser of the bedrock or pre-development water-level elevations. Then the lesser of the bedrock elevation or pre-development water-level was subtracted from the estimated water-level elevation for each section center to estimate projected saturated thickness.

This document has been included with Open-file Report 95-18 in order to explain some of the processes used to create the maps which make up this Open-file Report. The procedures used were modeled after those described in "A Guide to the M-33 Map Series: Saturated Thickness of the High Plains Aquifer in the Southwest Kansas Groundwater Management District", Kansas Geological Survey Open-file Report 92-45, and were developed by members of the Southwest Kansas Groundwater Management District, the Kansas Geological Survey, and the United States Geological Survey. While the maps themselves contain legends and disclaimers, many of the important details regarding data collection, manipulation, interpretation and representation are noted in the following paragraphs.

TILING BY ONE-MILE SECTIONS

All maps in the Open-file Report present data tiled by one-mile sections. In order to present data in this fashion, each section center point was assigned a value believed to represent a reasonable value for that section. These values were grouped into a classification scheme that assigned a particular color for each class, and this color was then assigned to the entire section. The numbers and colors shown in each section represent a reasonable value for that section and should not be interpreted as exact values at specific points.

LAND SURFACE ELEVATION

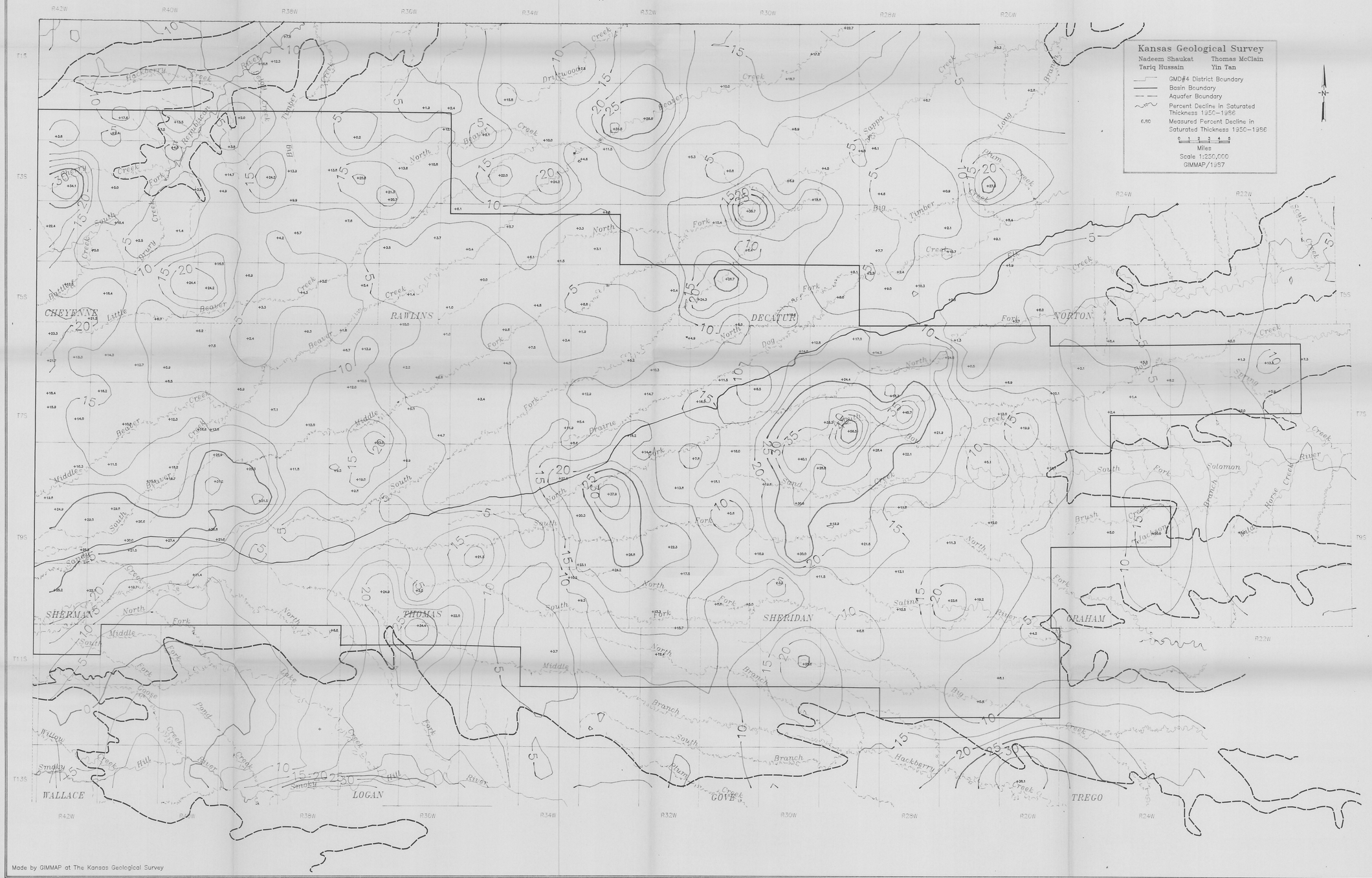
Land surface elevation data were used in the preparation of each of the maps contained in this report, but the sources of these data, their accuracy, and the methods by which they were derived vary depending upon the type of map. For example, the data used to represent pre-development saturated thickness came from the same dataset that was used to produce the Kansas Geological Survey's M-33 Series map titled "Saturated Thickness at Section Centers in the High Plains Aquifer, Southwest Kansas Management District". This dataset contained saturated thickness values that were calculated by subtracting the bedrock elevation at a given well from the pre-development water-level elevation at that well. What is not clearly stated is that these elevation values were calculated by subtracting the depth to water values from land surface elevations obtained from the USGS Groundwater Site Inventory (GWSI) database, and that these calculations took place on a well-by-well basis. In contrast, the surface elevation values used to constrain water-level elevation maximum values by section center were calculated by sampling a three-dimensional land surface lattice created from 1:250,000 scale digital elevation models produced by the USGS.

PRESENCE AND THICKNESS OF SATURATED HIGH PLAINS AQUIFER

One attribute that is common to all maps in this report is the assignment of a regional value to each section which indicates if the subsurface of that section has substantial saturated thickness of the High Plains Aquifer, little or no saturated thickness of the High Plains Aquifer, or has no High Plains Aquifer regardless of the presence or thickness of a saturated zone. The values assigned to each section are taken from the map titled "Saturated Thickness at Section Centers in the High Plains Aquifer in the Southwest Kansas Groundwater Management District", Kansas Geological Survey, 1992. A discussion of the criteria used to determine these values are presented in "A Guide to the M-33 Map Series: Saturated Thickness of the High Plains Aquifer in the Southwest Kansas Groundwater Management District", Kansas Geological Survey Open-file Report 92-45. This classification is significant because data from those sections defined as thinly saturated or non-saturated were not included in any of the maps in this Open-file Report, and while the effect of excluding data in these sections is minimal in comparison to some of the other assumptions and interpolations inherent in the mapped data, it is still present.

NOTE: The maps contained in this Open-file Report are subject to modifications based upon the decisions of the Southwest Kansas Groundwater Management District. While revisions are not anticipated, they are possible, and in the event that revisions are made, the Kansas Geological Survey will contact all recipients of the affected maps so that updates may be purchased if desired.

PERCENT DECLINE IN SATURATED THICKNESS, 1950–1986
GMD#4, Northwestern Kansas



Made by GIMMAP at The Kansas Geological Survey

SATURATED THICKNESS DECLINE CONTOURS.
PLOT NO. 1 DATE 01/22/88 TIME 15:09:38

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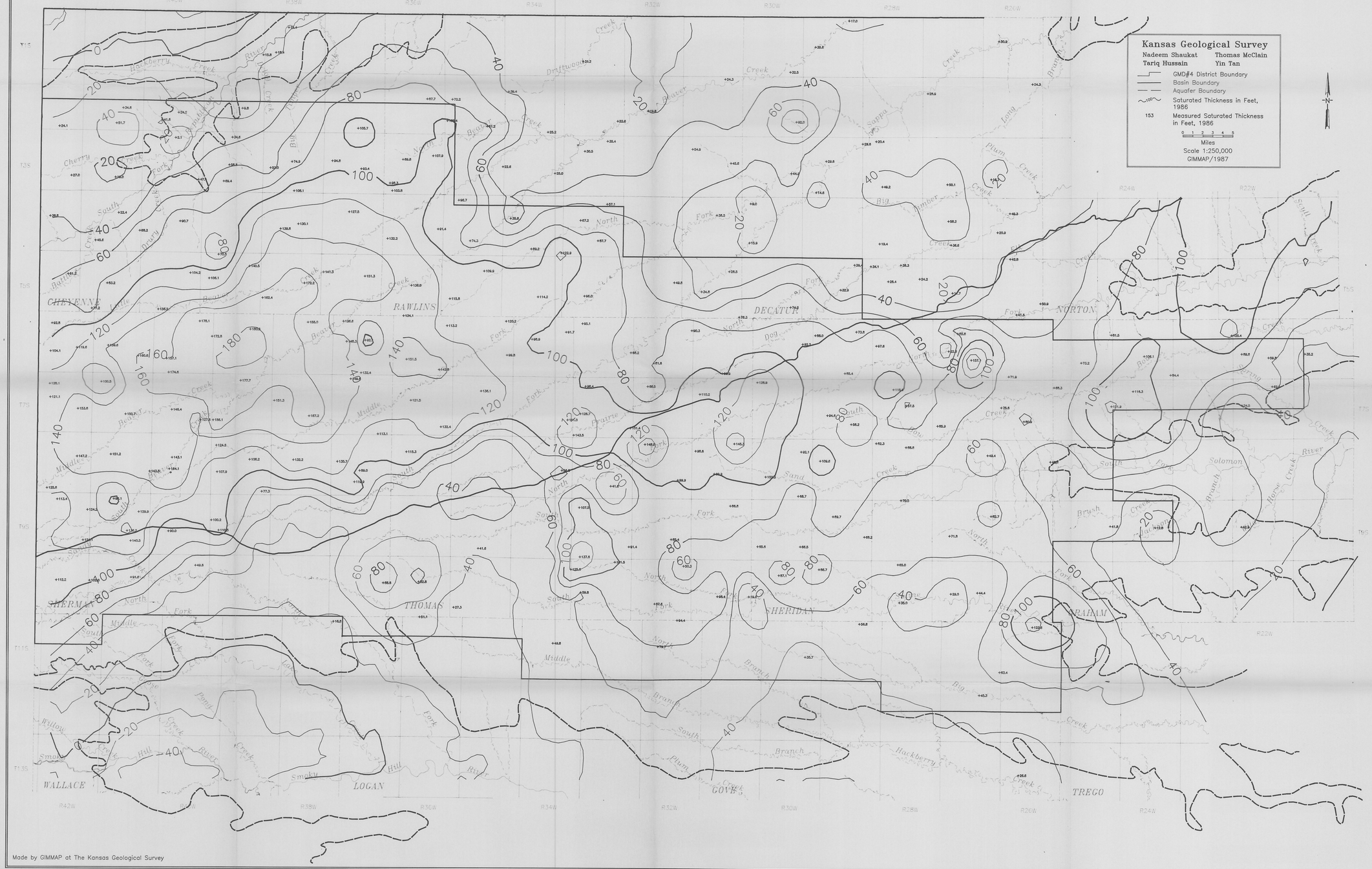
SATURATED THICKNESS IN FEET, 1986
GMD#4, Northwestern Kansas



SATURATED THICKNESS 1986.CONTOURS FOR GMD4.
PLOT NO. 1 DATE 01/04/88 TIME 13:09:58

KGS Open File Report # 87-19