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# Kansas Geological Survey

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## **Set of (water availability) maps for Southwest Kansas Groundwater Management District**

By

Woods, J.J., and Sophocleous, M.A.

2001-45I. Summary of improvements made in the GMD3 map set of KGS Open-file Report 2001-45 as outlined in a letter to Mr. Hank Hansen, GMD3 manager, with additional explanations as outlined in an e-mail letter to then GMD3 Hydrogeologist Diane Coe.

By Marios Sophocleous

Kansas Geological Survey Open File Report 2001-45



The University of Kansas, Lawrence, KS 66047 (785) 864-3965; [www.kgs.ukans.edu](http://www.kgs.ukans.edu)



Woods, J.J., and Sophocleous, M.A., 2002. Set of (water availability) maps for Southwest Kansas Groundwater Management District. Kansas Geological Survey Open-File Report 2001-45.

Contents

- 2001-45A. 1999, 2000, 2001 averaged saturated thickness at section centers in the High Plains aquifer, 1 sheet, scale 1:300,000.
- 2001-45B. Change in saturated thickness at section centers in the High Plains aquifer 1996-1998 to 1999-2001 using data only from wells that have measurements in both periods (1996-1998) and (1999-2001), 1 sheet, scale 1:300,000.
- 2001-45C. Change in saturated thickness at section centers in the High Plains Aquifer predevelopment to 1999-2001, 1 sheet, scale 1:300,000.
- 2001-45D. Depth to water at section centers in the High Plains Aquifer averaged 1999, 2000, and 2001 data, 1 sheet, scale 1:300,000.
- 2001-45E. Saturated thickness at section centers in the High Plains Aquifer projected 2010 data, 1 sheet, scale 1:300,000.
- 2001-45F. Saturated thickness at section centers in the High Plains Aquifer projected 2025 data, 1 sheet, scale 1:300,000.
- 2001-45G. Saturated thickness at section centers in the High Plains Aquifer projected 2100 data, 1 sheet, scale 1:300,000.
- 2001-45H. Bedrock elevation at section centers in the High Plains Aquifer, 1 sheet, scale 1:300,000.
- 2001-45I. Summary of improvements made in the GMD3 map set of KGS Open-file Report 2001-45 as outlined in a letter to Mr. Hank Hansen, GMD3 manager, with additional explanations as outlined in an e-mail letter to then GMD3 Hydrogeologist Diane Coe.

November 15, 2001

Mr. Hank Hansen, Manager  
Southwest Kansas GMD3  
409 Campus Drive  
Garden City, KS 67846

RE: "Maps depicting groundwater availability in the High Plains Aquifer in Southwest Kansas Groundwater Management District No. 3" Contract

Dear Hank:

As per the above-referenced contract, I am enclosing the seven required groundwater availability maps in preliminary draft form (please refer to the above-referenced contract for enumeration of those maps), plus two additional, related maps (one bedrock map—see item 3 below, and one depth-to-water-table map depicting the triangular tin and hull employed with all data points—see item 5 below), also in draft form, for your review and discussion. Please note that the deadline for this project is the near end of December 2001, so we would appreciate your comments at your earliest convenience.

The new 2000 (1999-2001) maps have a number of improved features (compared to the maps produced in previous years), the most important of which are as follows:

1. We employed the Public Land Survey System (PLSS) to provide the latest high-quality digital representation of basic Kansas land divisions, such as section point and polygon coverages, based on USGS 7.5 minute quadrangles.
2. We implemented the latest version of the digital map of the extent of the High Plains aquifer in Kansas to form a new base map, which includes areas where the High Plains aquifer has little or no saturated thickness.
3. We updated the bedrock values at section centers to make them compatible with the PLSS system mentioned above. We also extended the bedrock map surface to include the areas where the aquifer is not saturated (see supplemental map 1).



4. We assembled, compiled, and added all existing 2001 High Plains water level data for the counties in Oklahoma and Colorado bordering Kansas to better represent and interpolate water level data at the Kansas borders.
5. To avoid interpolating beyond the areas where data are available, we implemented a TIN HULL GIS-procedure to outline areas with no data. In addition to data at section centers, we also posted measured points to see the density of data coverage (see supplemental map 2).
6. Finally, we visually surveyed the flowing segments of the Cimarron River during June and September 2001, and took this information into account in plotting our data in the Cimarron River area.

Hope you find these map products satisfactory. Please feel free to contact me for any questions or comments you may have. Thank you.

Best regards,

Marios Sophocleous  
Senior Scientist

Map Enclosures

cc: Don Whittemore, Bill Harrison, Barb McClain, John Woods

**Subject:** 2000 Groundwater Availability Maps for GMD3

**Date:** Mon, 28 Jan 2002 15:33:02 -0600

**From:** Marios Sophocleous <marios@kgs.ukans.edu>

**Organization:** KGS

**To:** Diane Coe <dcoe@gmd3.org>

**CC:** Hank Hansen <hhansen@gmd3.org> ,  
Don Whittemore <donwhitt@kgs.ukans.edu> ,  
Brownie Wilson <bwilson@kwo.state.ks.us> ,  
John Woods <jwoods@kgs.ukans.edu>

Dear Diane,

Following our meeting earlier this month during which we reviewed your comments and our initial responses to them, we thoroughly examined all the data points that indicated a water-level rise from averaged 1997 year (1996-1998) to averaged 2000 year (1999-2001). We wrote a special program which retrieved all water-level rise data points and their measurement dates. That examination indicated that some water-level rise data were highly questionable either because one measurement was obviously highly anomalous compared to either a repeat measurement or yearly measurements before and after, or because that well was abandoned after the 1999 measurement (removed from the network thereafter; observer's comments indicate heavy oily measurement, or other malfunction). In such cases we either took a new average of the measurements excluding the obviously anomalous point, or omitted the already abandoned measurement point altogether. (The latter action involved only two wells that are dropped from the network after the 1999 measurement.)

We also used the updated PLSS section-center coverage for the 1997 data (so that the section centers are identical as the ones used in the improved 2000 surface, as mentioned in my November 15, 2001 correspondence to Hank Hansen), and also took a measurement difference only if a measurement existed at the same well for both the 1997 and 2000 periods. With these changes, some previously water-level rise areas now disappeared; however, a number of areas still do show water-level rises from 1997 to 2000, but now we are more confident that these areas truly exhibited rises.

Another change we did to the 2000 depth to water-level map, was to reduce the blank (no data) aquifer areas by interpolating values there based on the surrounding wells where we felt we could safely (i.e. confidently) do so. Although we could do so for the 2000 depth-to water and probably saturated thickness data, we feel that trying to do a similar thing to other years (past or projected future) might take us a rather long time to complete, and we recommend to leave those blank areas as they are for those time periods so that we can complete this project in a timely manner. We will also be

improving on the coloring of some patterns. Other small changes/corrections have already been implemented.

So we will be finalizing these maps to send to you in the near future. In the meantime, please let me know if you have any further comments or suggestions. Thank you.

Best regards,

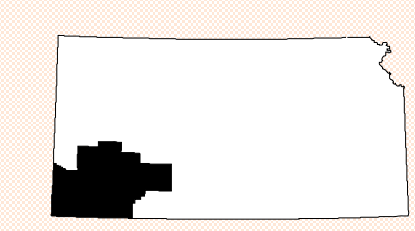
Marios Sophocleous  
Senior Scientist

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<http://www.kgs.ukans.edu/General/Personnel/rs/sophocleous.html>



# 1999, 2000, 2001 AVERAGED SATURATED THICKNESS AT SECTION CENTERS IN THE HIGH PLAINS AQUIFER



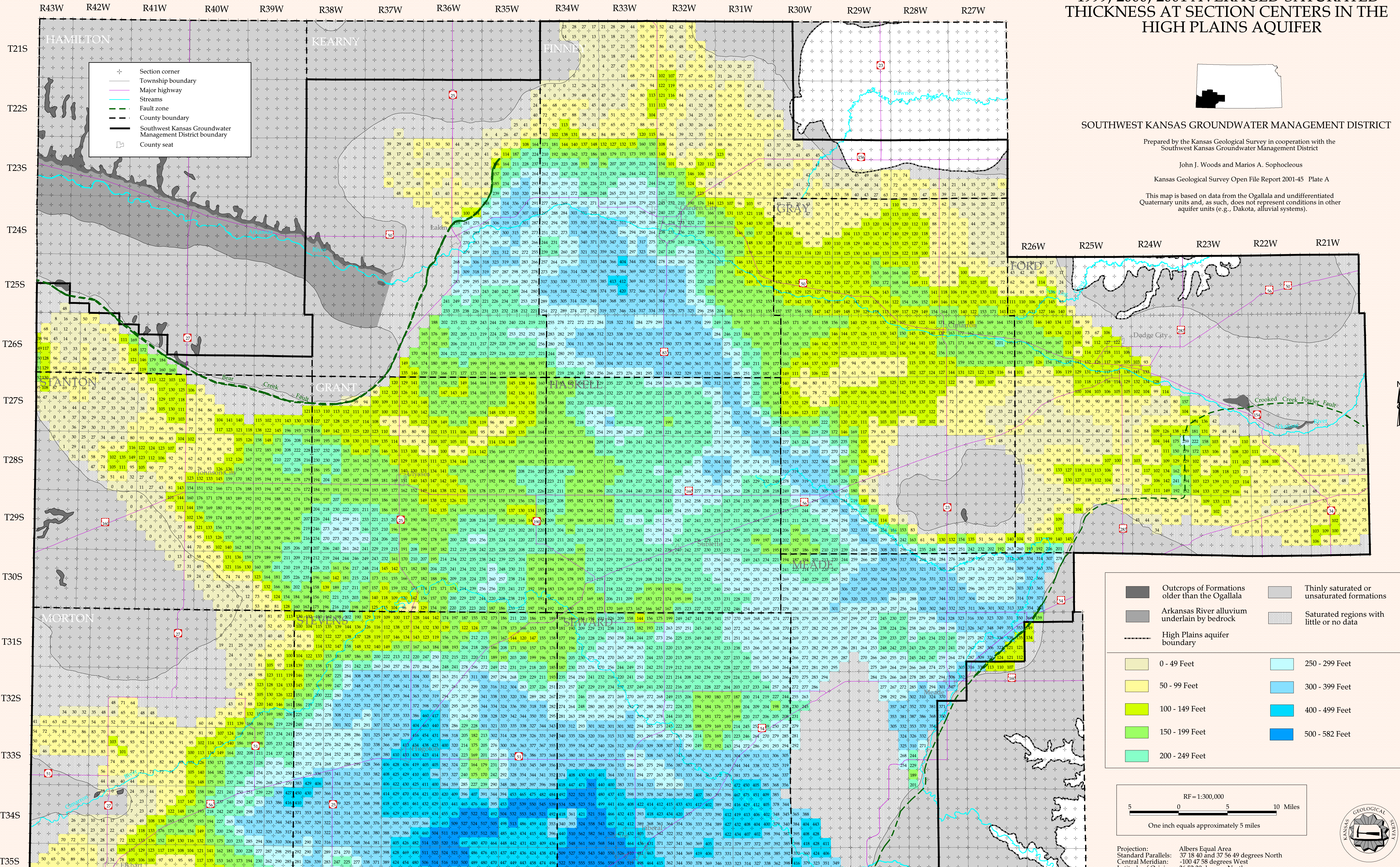
SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT

Prepared by the Kansas Geological Survey in cooperation with the Southwest Kansas Groundwater Management District

John J. Woods and Marios A. Sophocleous

Kansas Geological Survey Open File Report 2001-45 Plate A

This map is based on data from the Ogallala and undifferentiated Quaternary units and, as such, does not represent conditions in other aquifer units (e.g., Dakota, alluvial systems).



Section corner  
 Township boundary  
 Major highway  
 Streams  
 Fault zone  
 County boundary  
 Southwest Kansas Groundwater Management District boundary  
 County seat

<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: gray; border: 1px solid black; margin-right: 5px;"></span> Outcrops of Formations older than the Ogallala</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #cccccc; border: 1px solid black; margin-right: 5px;"></span> Thinly saturated or unsaturated formations</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #808080; border: 1px solid black; margin-right: 5px;"></span> Arkansas River alluvium underlain by bedrock</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #e0e0e0; border: 1px solid black; margin-right: 5px;"></span> Saturated regions with little or no data</li> <li><span style="display: inline-block; width: 15px; border-bottom: 1px dashed black; margin-right: 5px;"></span> High Plains aquifer boundary</li> </ul>	<ul style="list-style-type: none"> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #f0f0f0; border: 1px solid black; margin-right: 5px;"></span> 0 - 49 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #e0e0e0; border: 1px solid black; margin-right: 5px;"></span> 50 - 99 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #d0d0d0; border: 1px solid black; margin-right: 5px;"></span> 100 - 149 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #c0c0c0; border: 1px solid black; margin-right: 5px;"></span> 150 - 199 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #b0b0b0; border: 1px solid black; margin-right: 5px;"></span> 200 - 249 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #a0a0a0; border: 1px solid black; margin-right: 5px;"></span> 250 - 299 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #909090; border: 1px solid black; margin-right: 5px;"></span> 300 - 399 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #808080; border: 1px solid black; margin-right: 5px;"></span> 400 - 499 Feet</li> <li><span style="display: inline-block; width: 15px; height: 15px; background-color: #707070; border: 1px solid black; margin-right: 5px;"></span> 500 - 582 Feet</li> </ul>
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RF = 1:300,000  
 0 5 10 Miles  
 One inch equals approximately 5 miles

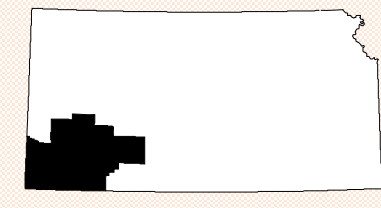
Projection: Albers Equal Area  
 Standard Parallels: 37 18 40 and 37 56 49 degrees North  
 Central Meridian: -100 47 58 degrees West  
 Latitude of Origin: 36 52 30 degrees North



The Kansas Geological Survey and the Southwest Kansas Groundwater Management District do not guarantee this map to be free from errors or inaccuracies and disclaim any responsibility or liability for interpretations from the map or decisions based thereon.



CHANGE IN SATURATED THICKNESS  
 AT SECTION CENTERS  
 IN THE HIGH PLAINS AQUIFER  
 1996-1998 TO 1999-2001  
 using data only from wells that have measurements  
 in both periods (1996-1998) and (1999-2001)



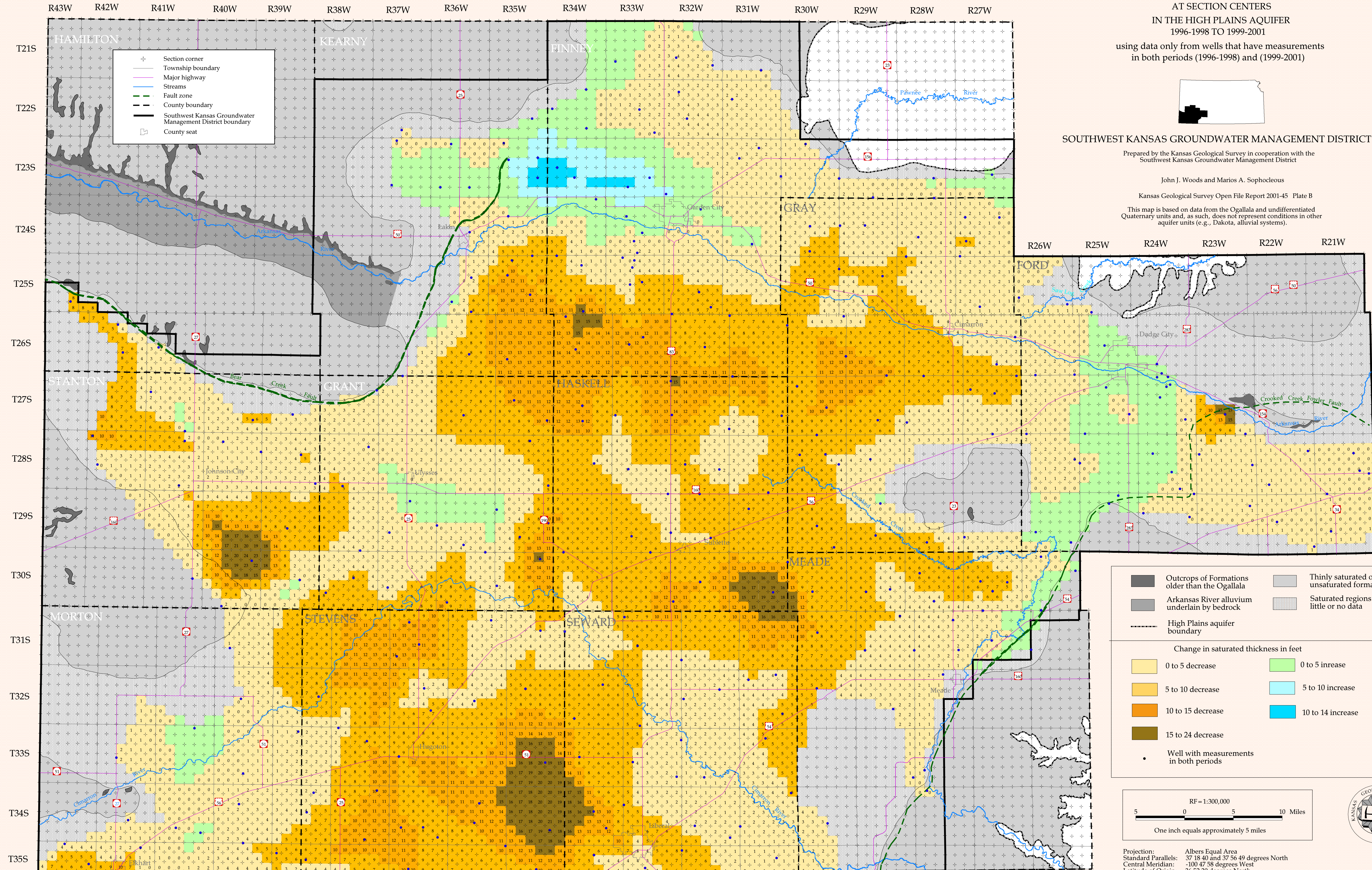
SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT

Prepared by the Kansas Geological Survey in cooperation with the  
 Southwest Kansas Groundwater Management District

John J. Woods and Marios A. Sophocleous

Kansas Geological Survey Open File Report 2001-45 Plate B

This map is based on data from the Ogallala and undifferentiated  
 Quaternary units and, as such, does not represent conditions in other  
 aquifer units (e.g., Dakota, alluvial systems).

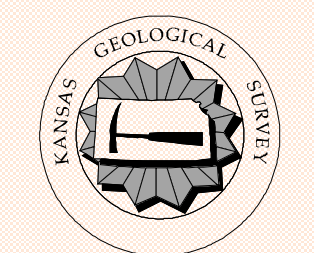
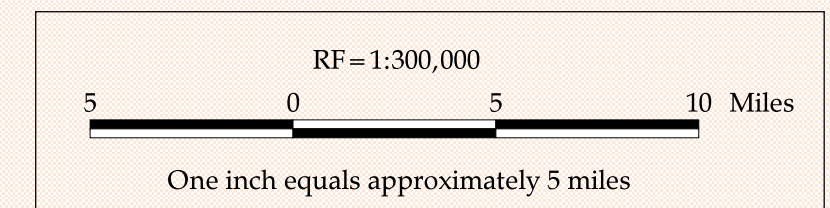


Outcrops of Formations older than the Ogallala	Thinly saturated or unsaturated formations
Arkansas River alluvium underlain by bedrock	Saturated regions with little or no data
High Plains aquifer boundary	

Change in saturated thickness in feet

0 to 5 decrease	0 to 5 increase
5 to 10 decrease	5 to 10 increase
10 to 15 decrease	10 to 14 increase
15 to 24 decrease	

Well with measurements in both periods

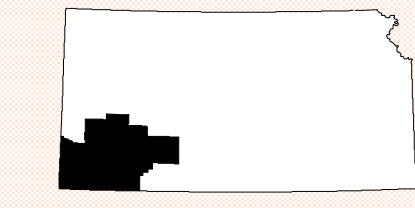


Projection: Albers Equal Area  
 Standard Parallels: 37 18 40 and 37 56 49 degrees North  
 Central Meridian: -100 47 58 degrees West  
 Latitude of Origin: 36 52 30 degrees North

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# CHANGE IN SATURATED THICKNESS AT SECTION CENTERS IN THE HIGH PLAINS AQUIFER PREDEVELOPMENT TO 1999-2001



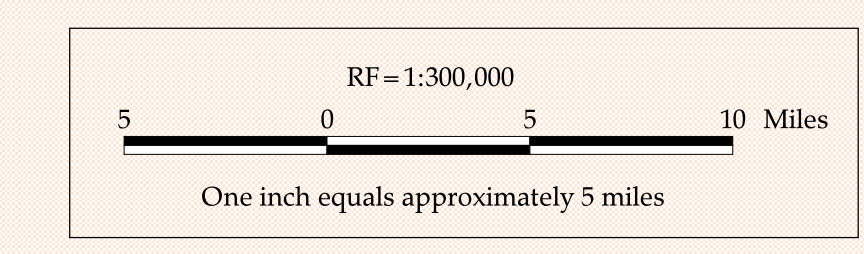
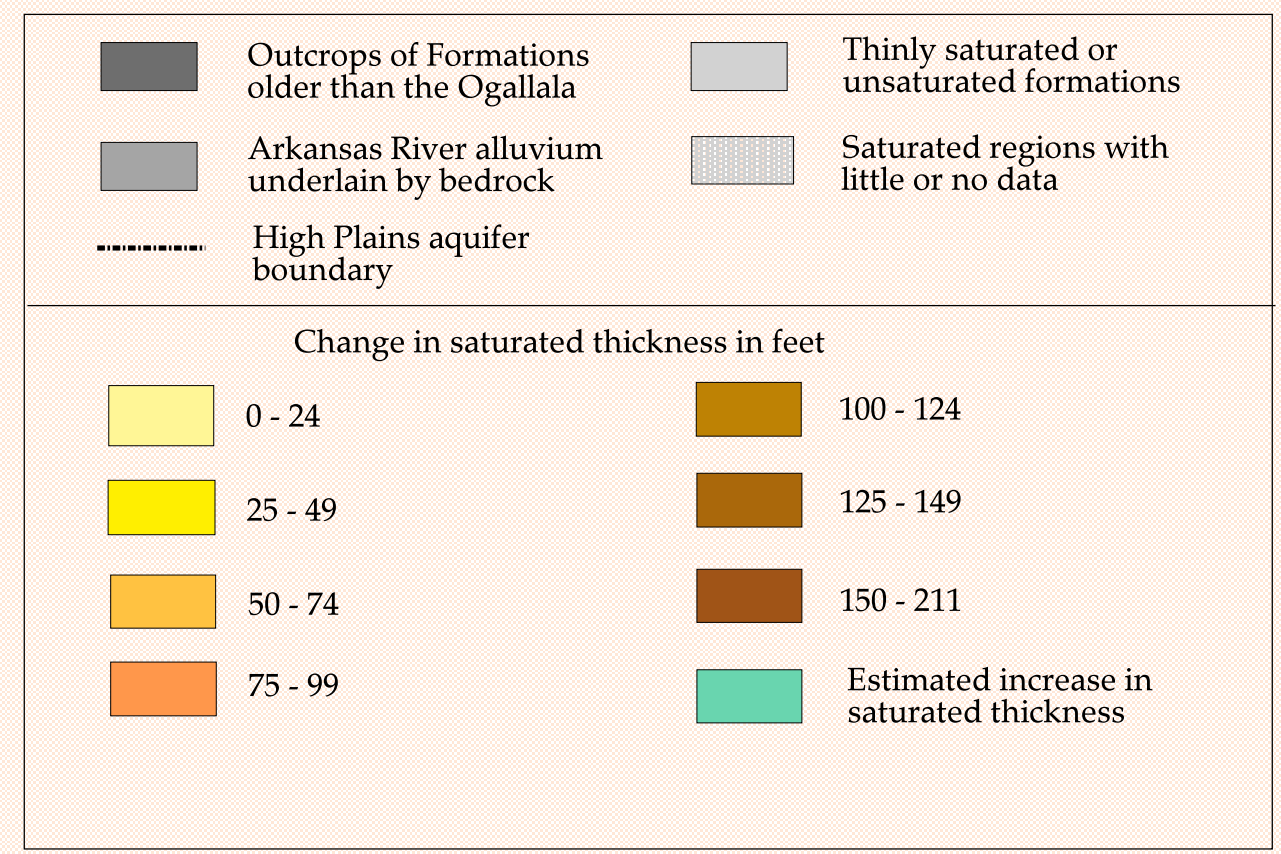
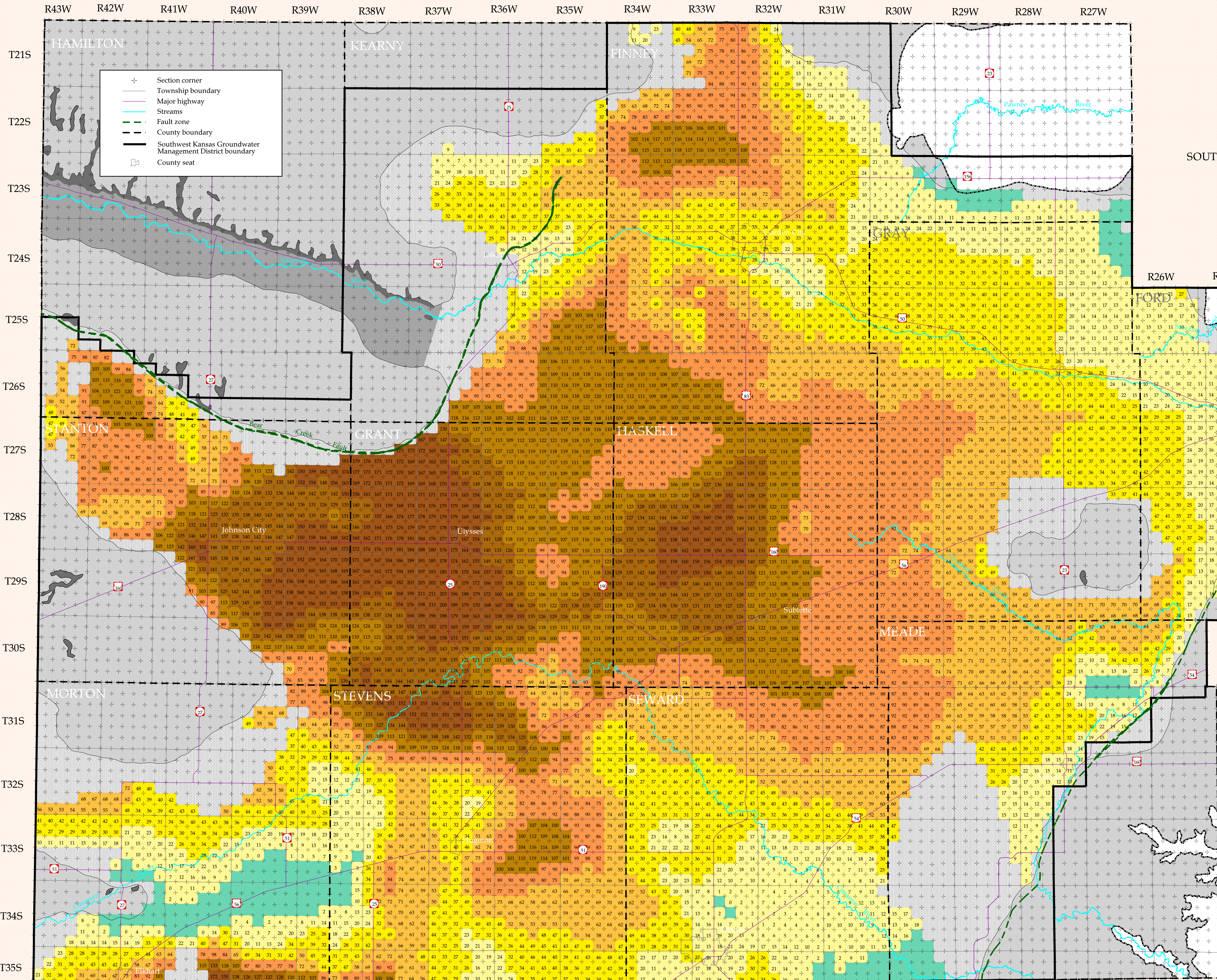
SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT

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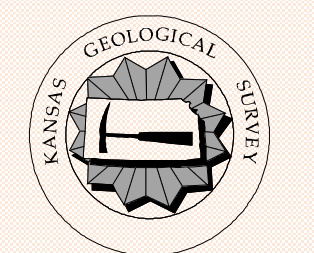
John J. Woods and Marios A. Sophocleous

Kansas Geological Survey Open File Report 2001-45 Plate C

This map is based on data from the Ogallala and undifferentiated Quaternary units and, as such, does not represent conditions in other aquifer units (e.g., Dakota, alluvial systems).



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DEPTH TO WATER  
AT SECTION CENTERS  
IN THE HIGH PLAINS AQUIFER  
AVERAGED 1999, 2000, AND 2001 DATA

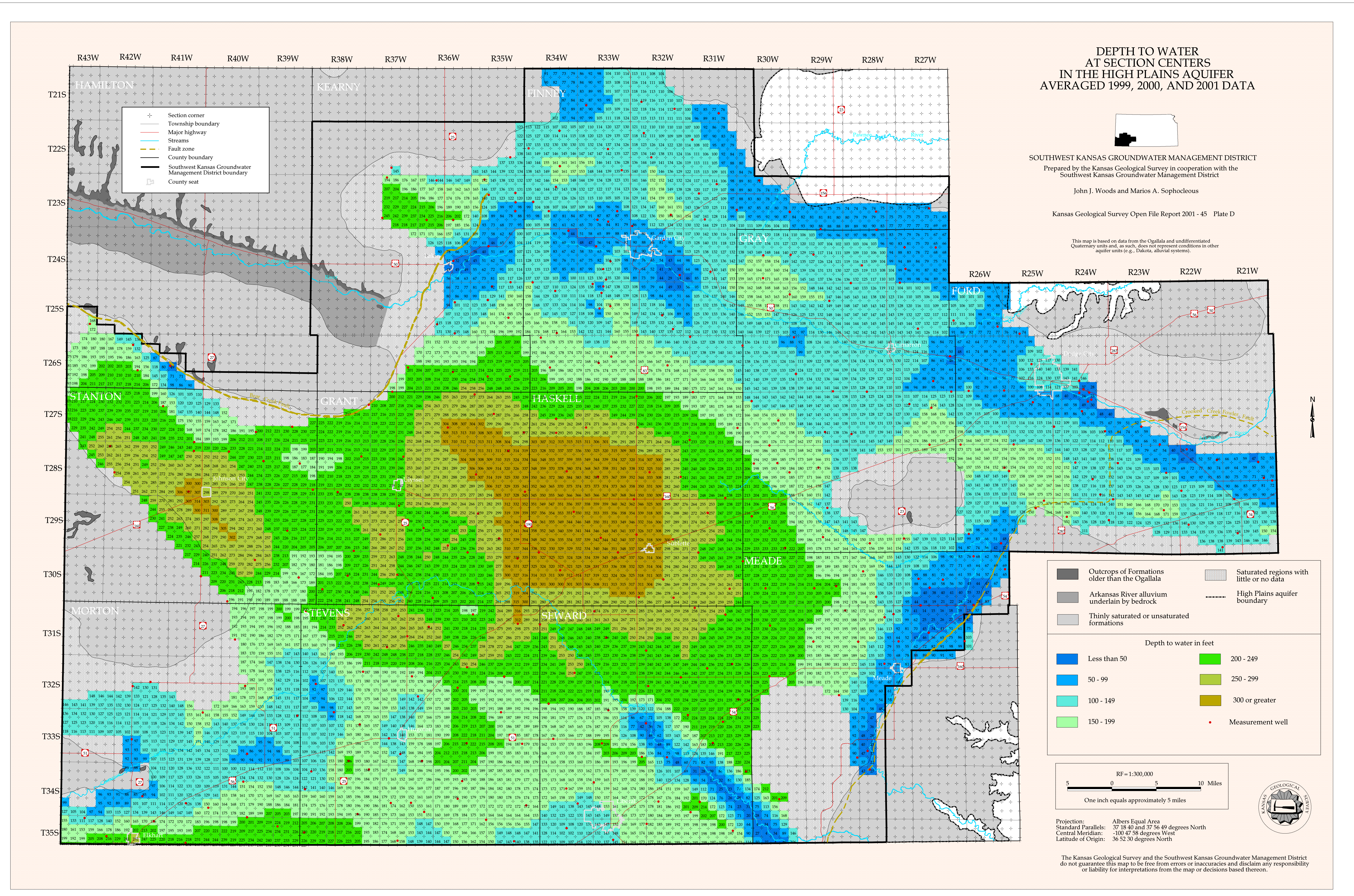


SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT  
Prepared by the Kansas Geological Survey in cooperation with the  
Southwest Kansas Groundwater Management District

John J. Woods and Marisa A. Sophocleous

Kansas Geological Survey Open File Report 2001 - 45 Plate D

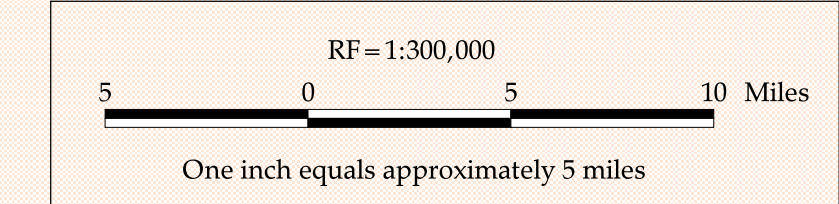
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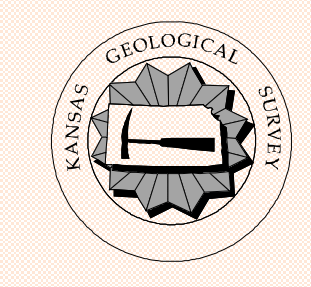
	Outcrops of Formations older than the Ogallala		Saturated regions with little or no data
	Arkansas River alluvium underlain by bedrock		High Plains aquifer boundary
	Thinly saturated or unsaturated formations		

Depth to water in feet	
	Less than 50
	50 - 99
	100 - 149
	150 - 199
	200 - 249
	250 - 299
	300 or greater
	Measurement well



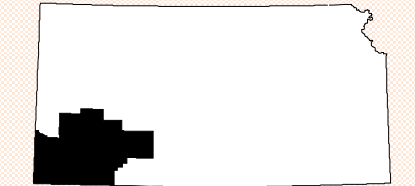
Projection: Albers Equal Area  
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Latitude of Origin: 36 52 30 degrees North



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# SATURATED THICKNESS AT SECTION CENTERS IN THE HIGH PLAINS AQUIFER PROJECTED 2010 DATA



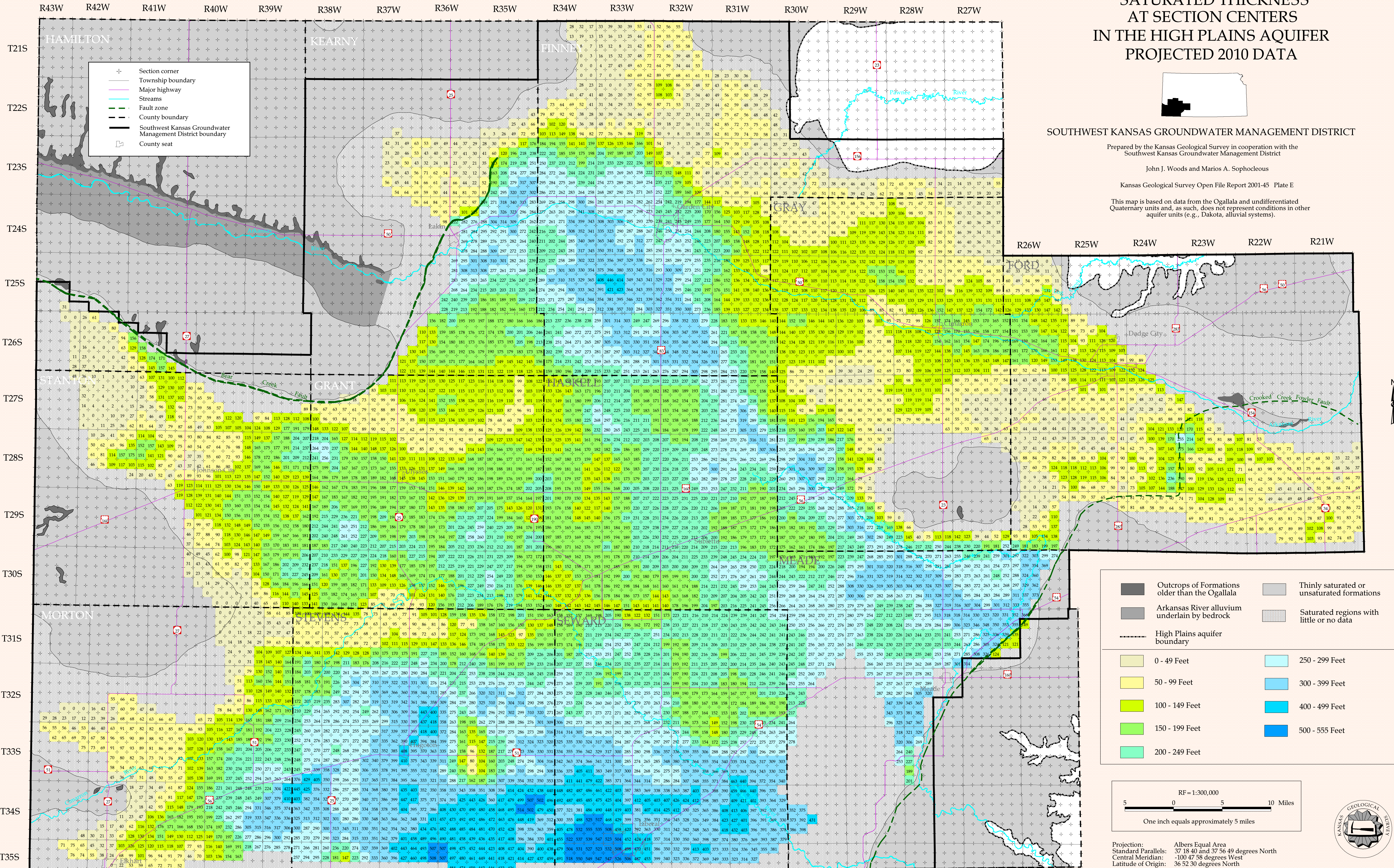
SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT

Prepared by the Kansas Geological Survey in cooperation with the Southwest Kansas Groundwater Management District

John J. Woods and Marios A. Sophocleous

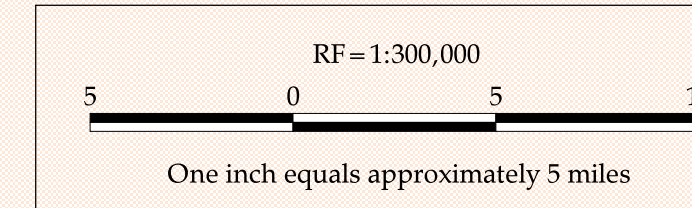
Kansas Geological Survey Open File Report 2001-45 Plate E

This map is based on data from the Ogallala and undifferentiated Quaternary units and, as such, does not represent conditions in other aquifer units (e.g., Dakota, alluvial systems).



+ Section corner  
 --- Township boundary  
 --- Major highway  
 --- Streams  
 --- Fault zone  
 --- County boundary  
 --- Southwest Kansas Groundwater Management District boundary  
 --- County seat

	Outcrops of Formations older than the Ogallala		Thinly saturated or unsaturated formations
	Arkansas River alluvium underlain by bedrock		Saturated regions with little or no data
	High Plains aquifer boundary		
	0 - 49 Feet		250 - 299 Feet
	50 - 99 Feet		300 - 399 Feet
	100 - 149 Feet		400 - 499 Feet
	150 - 199 Feet		500 - 555 Feet
	200 - 249 Feet		



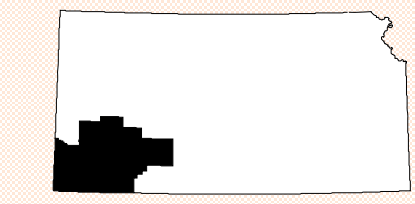
Projection: Albers Equal Area  
 Standard Parallels: 37 18 40 and 37 56 49 degrees North  
 Central Meridian: -100 47 58 degrees West  
 Latitude of Origin: 36 52 30 degrees North



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# SATURATED THICKNESS AT SECTION CENTERS IN THE HIGH PLAINS AQUIFER PROJECTED 2025 DATA



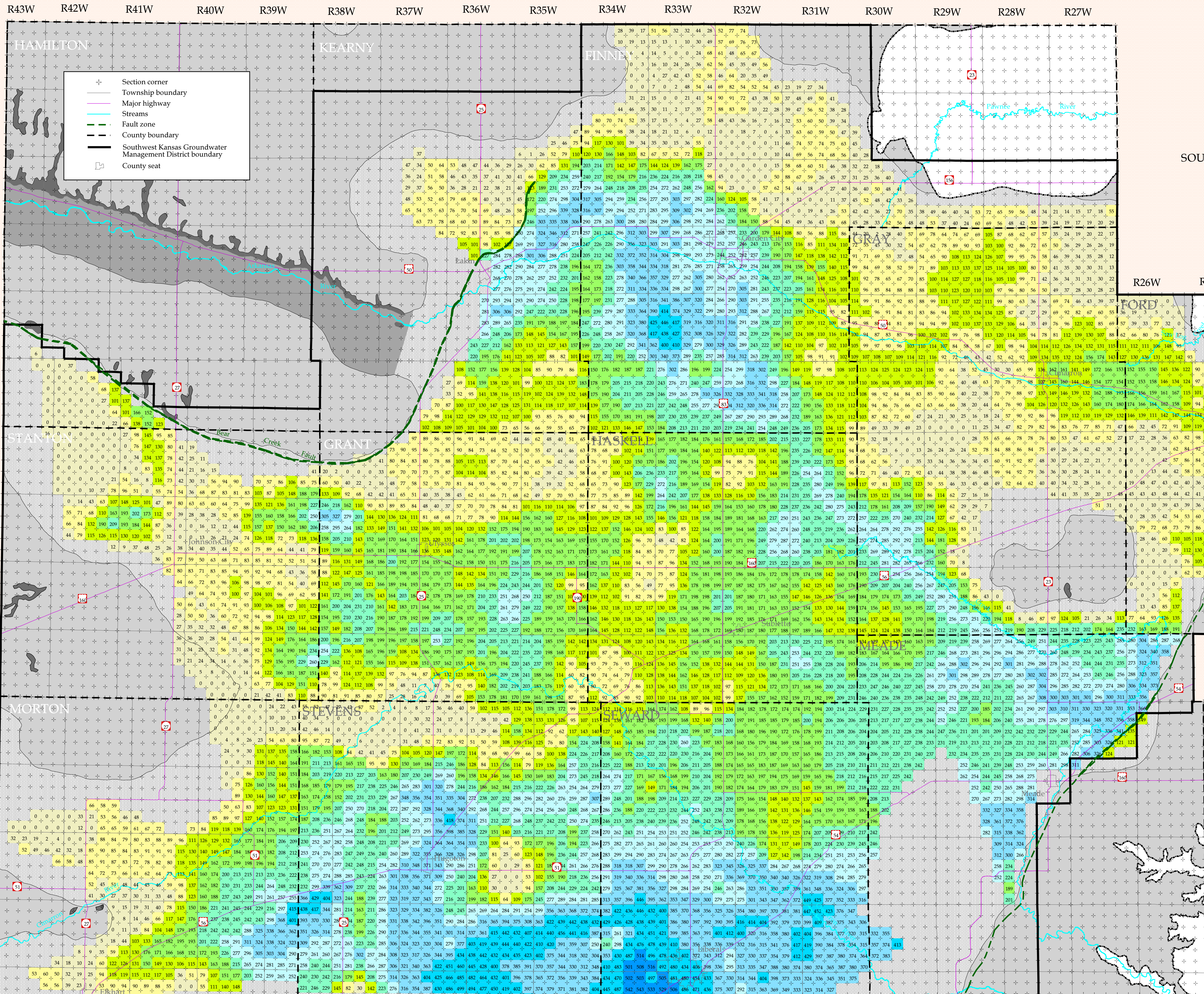
SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT

Prepared by the Kansas Geological Survey in cooperation with the Southwest Kansas Groundwater Management District

John J. Woods and Marios A. Sophocleous

Kansas Geological Survey Open File Report 2001-45 Plate F

This map is based on data from the Ogallala and undifferentiated aquifer units and, as such, does not represent conditions in other aquifer units (e.g., Dakota, alluvial systems).



	Outcrops of Formations older than the Ogallala		Thinly saturated or unsaturated formations
	Arkansas River alluvium underlain by bedrock		Saturated regions with little or no data
	High Plains aquifer boundary		
	0 - 49 Feet		250 - 299 Feet
	50 - 99 Feet		300 - 399 Feet
	100 - 149 Feet		400 - 499 Feet
	150 - 199 Feet		500 - 543 Feet
	200 - 249 Feet		

Scale: 1 inch equals approximately 5 miles

RF = 1:300,000

0 5 10 Miles

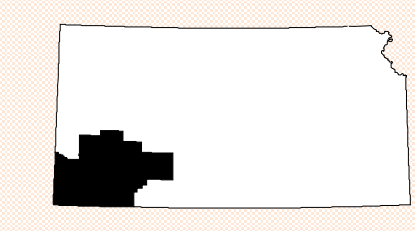
Projection: Albers Equal Area  
 Standard Parallels: 37 18 40 and 37 56 49 degrees North  
 Central Meridian: -100 47 58 degrees West  
 Latitude of Origin: 36 52 30 degrees North



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# SATURATED THICKNESS AT SECTION CENTERS IN THE HIGH PLAINS AQUIFER PROJECTED 2100 DATA



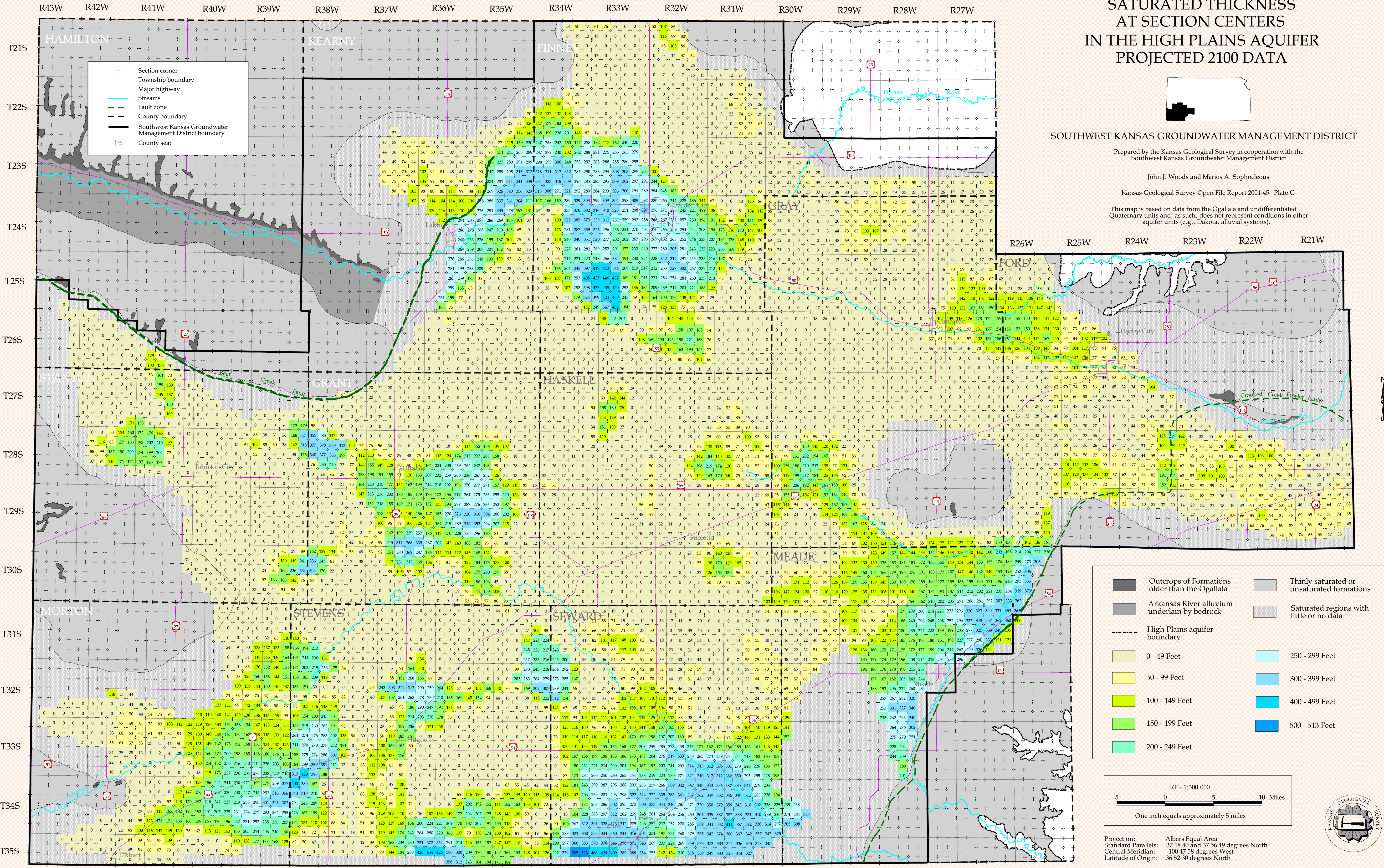
SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT

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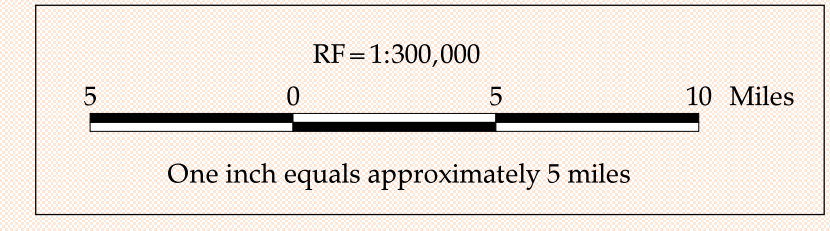
John J. Woods and Marios A. Sophocleous

Kansas Geological Survey Open File Report 2001-45 Plate G

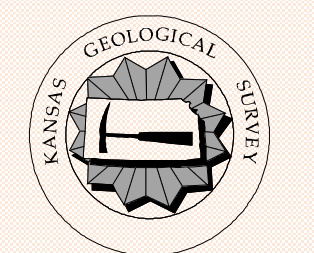
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	High Plains aquifer boundary		
	0 - 49 Feet		250 - 299 Feet
	50 - 99 Feet		300 - 399 Feet
	100 - 149 Feet		400 - 499 Feet
	150 - 199 Feet		500 - 513 Feet
	200 - 249 Feet		



Projection: Albers Equal Area  
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# BEDROCK ELEVATION AT SECTION CENTERS IN THE HIGH PLAINS AQUIFER

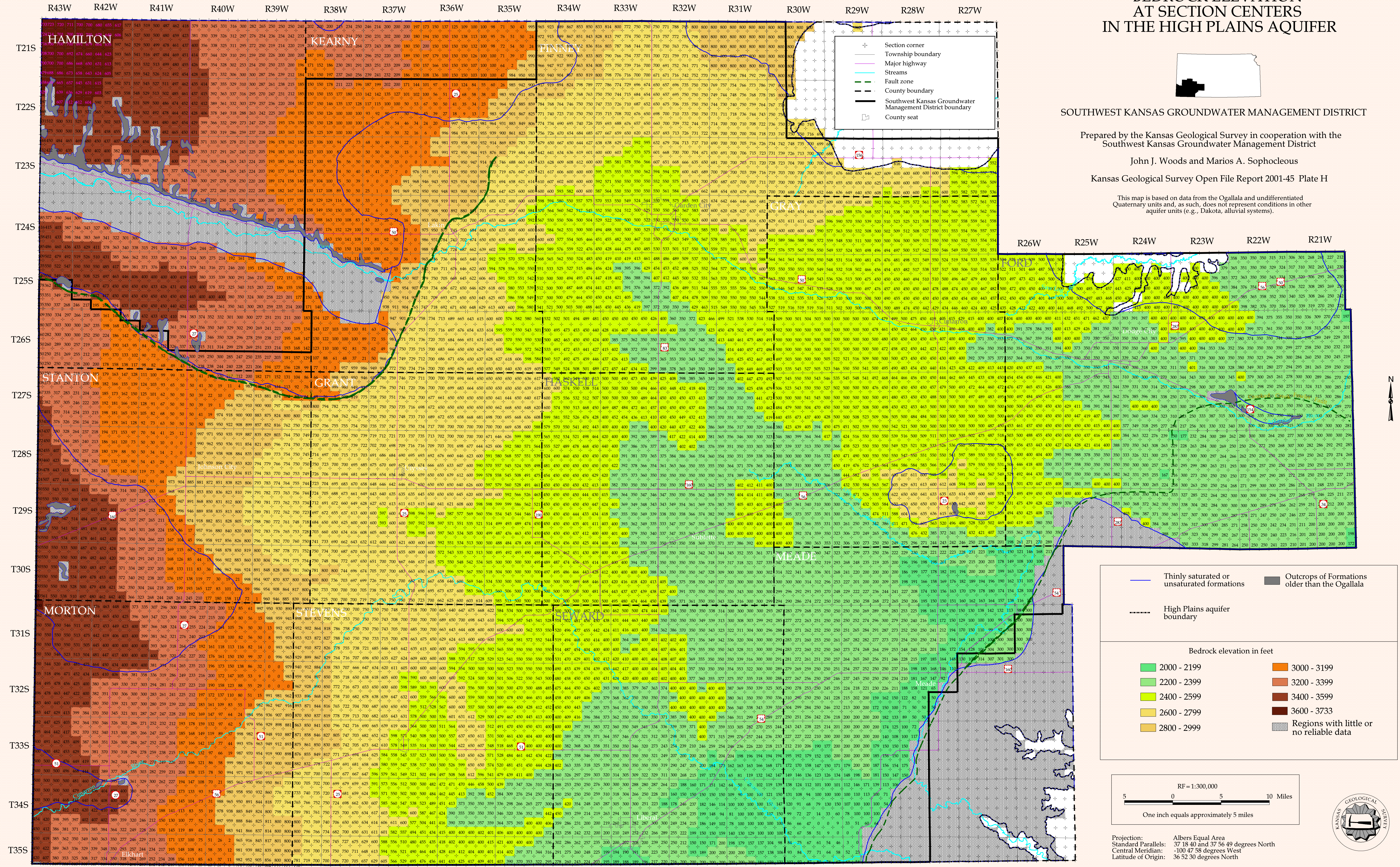
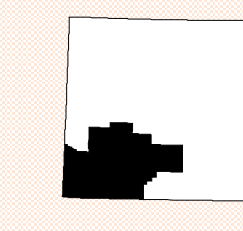
SOUTHWEST KANSAS GROUNDWATER MANAGEMENT DISTRICT

Prepared by the Kansas Geological Survey in cooperation with the Southwest Kansas Groundwater Management District

John J. Woods and Marios A. Sophocleous

Kansas Geological Survey Open File Report 2001-45 Plate H

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- Thinly saturated or unsaturated formations
- High Plains aquifer boundary

- Outcrops of Formations older than the Ogallala

**Bedrock elevation in feet**

- 2000 - 2199
- 3000 - 3199
- 2200 - 2399
- 3200 - 3399
- 2400 - 2599
- 3400 - 3599
- 2600 - 2799
- 3600 - 3733
- 2800 - 2999
- Regions with little or no reliable data

RF = 1:300,000

5 0 5 10 Miles

One inch equals approximately 5 miles

Projection: Albers Equal Area  
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 Central Meridian: -100 47 58 degrees West  
 Latitude of Origin: 36 52 30 degrees North

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