REPORT ON
GROUNDWATER RECHARGE AREAS
MID-STATE REGION

Prepared by

Mid-State Regional Planning Commission
Kenneth F. Glover--Executive Director
David L. Roberts--Regional Planner

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Report On

Groundwater Recharge Areas
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Water is an important natural resource in the Mid-State Region of McPherson, Reno, and Rice Counties. Water is used to quinch the thirst of people and animals, grow crops, and aid manufacturing processes. Groundwater is the most improtant water source for cities, farm homes, and industries, and is playing an increasing role in irrigating crops.

With the increasing demand on groundwater, it is important to decide how this resource is used. The two main possibilities are to use the water until it is gone (mine it), or use it as a renewable resource (which it can be) and take out only as much as is put in by nature or man. The second alternative of using groundwater as a renewable resource is one that will bring the most benefits to the most people over time.

To use groundwater as a renewable resource, it is important to know where and how much water is entering the tables. This recharge can be noted from studies of the groundwater acquifer. The preservation of this groundwater recharge is important if the recharge is to be continued unharmed.

This report is prepared for the two Groundwater Management Districts which are in the Region, city and county commissions, city and county planning commissions, the State Water Resources Board, and others who are concerned with the area's water resources.

The result of the MSRPC study is the map on page 10 which shows the generalized areas for groundwater recharge in the Region. This map summarized more detailed maps prepared for each county. Copies of the more detailed maps will be provided to the Groundwater Management Districts, the Counties, and the State Water Resources Board. The section on page 9 described the recharge areas in the region. Conclusions and Policy Implications are presented on page 11. The bulk of the report is on pages 2 to 9 and explains the methodology and steps to be used in development of the maps.

The study of the groundwater recharge areas was carried out as part of the preparation of a Land Use Plan for the Mid-State Region. The location of these areas was thought to be helpful for the protecting and utilizing the groundwater of the region and for providing important considerations for the use of land, expecially in these areas.

METHODOLOGY

The county geology and groundwater reports (footnotes 1-5) and the Little Arkansas River Basin Plan [6] mention possible recharge areas in the Mid-State Region but do not present maps. It should be recognized that it is difficult to give precise information because we only know a small part about the geology and groundwater below our feet. The methodology that was developed in the MSRPC study is an attempt to meet the needs of delinating groundwater recharge areas. It should be recognized that the study is far from perfect and that others more knowledgeable can, and hopefully will, make much improvement in it. We have tried to evaluate the methodology and feel it is theoretically sound. If it turns out that it is not, we want to challenge others to come up with one that will.

Six major steps were used to develop the groundwater recharge maps and to identify the recharge areas. These steps are:

1. Prepare overlay map of the Aerial Geology of each County.
2. Prepare overlay map of well yield of groundwater of each county.
3. Prepare overlay map of soil permeability of each County
4. Prepare Groundwater Recharge Matrix.
5. Prepare composite overlay of Maps 1 and 2 to become storage and transmission map of groundwater.
6. Prepare Groundwater Recharge map from Maps 3 and 5, using the Groundwater Recharge Matrix.

<u>One-Prepare Overlay Map of the Aerial Geology of Each County</u>

The geology maps from each county's geology report were used to prepare an overlay of the aerial geological formations. Each of these formations were evaluated in terms of the water supply, and/or transmission ability. A value of either 0,2,4, or 6 was assigned to each formation. This value corresponds to the relative ability to store and/or transmit water.

In general, the sand dune formations were considered best for transmitting and/or storing water. Groundwater moves most freely through this formation. Alluvium and Terrace Deposits, and the McPherson Formation were assigned the value of four. Losses, and Sandborn Formations were assigned the value of two. The consolidated deposits were assigned the value of 0, based on their relative resistances or impermeability to storing or transmitting water.

TABLE 1

Storage - Transmission Values of Geology Units

FORMATION	VALUE
McPherson County [1]	
Alluvium	4
Dune Sand	6
McPherson Formation	4
Delmore Formation	2
Kiowa Shale	0
Stone Corral Dolomite	0
Ninnescah Shale	0
Wellington Slate	0
Reno County [2]	
Alluvium	4
Dune Sand	6
Terrace Deposits	6
Sanborn and Meade Formation	2
Blanco Formation	2
Permian	0
Rice County [4]	
Alluvium and terrace deposits	4
Dune Sand	6
Loess	2
Ogallala Formation *	0
Dakota Formation	0
Kiowa Formation	0
Harper Sandstone	0
Stone Corral Formation	0
Ninnescah Shale	0

*Counted as zero because of very smallness of area mapped and because of association with Kiowa formation.

[1]Lohman, Stanley W., & William, Charles C., Geology and Groundwater Resources of a Part of South-Central Kansas, Bulletin 79 State Geological Survey of Kansas, University of Kansas Publication, July 1949; Topeka Ks, Fred Vorland Jr. State Printer 1949

[2]Bayne, C.K. Geology & Groundwater Resources of Reno County, Ks., Bulletin 120, State Geological Survey of Ks., August 1956, Topeka Ks., Fred Vorland Jr., State Printer, 1956.

[3]Bayne, Charles K., and Ward, John R. Geology and Hydrology of Rice County, Central Kansas, Bulletin 206, Part 3, Kansas Geological Survey, University of Kansas Publications, April 1974.

The sandstones of the Kiowa and Dakota formation can store and release suitable water to wells, but in terms of irrigation, they are not sufficient. Table 1 shows the value assigned to each of the aerial geological formations in the region.

Two-Prepare an overlay map of well yield of groundwater in each County.

Well yield information from either the reports "Irrigation in Kansas", or the geology reports was used to determine where the underground water resources are. For McPherson and Reno Counties, the well-yield maps from the report "Irrigation in Kansas" were used to provide the necessary information. For Rice County, Figure 8 of the Geology and Hydrology of Rice County, Bulletin 206 Part 3 was used. It was used in place of the map for Rice County in the report, Irrigation in Kansas because it was the most recent information and presumed to be more accurate.

The well yields were grouped into three categories: 0 to 100 gpm (gallons per minute), 100 to 500 gpm, and greater than 500 gpm. The values assigned to these well yields are shown below.

TABLE 2

Matrix Values for Well Yields

Well Yield	Value
0-100 gpm	0
100-500 gpm	1
500 and more gpm	2

Using these values, the major groundwater supply areas are identified and given emphasis. There are significant areas of the Region which have well yields of 10 to 100 gallons. Some of these, particularly the Dakota and Kiowa sandstone formations have yields above 50 gpm and are the source of water for Cities. But it was felt that areas where well yields are less than 100 gpm would not get enough water for irrigation of significance, and would not supply large cities and industries. Areas with yields of 100 to 500 gpm can provide water for irrigation. Areas of 500 gpm or more, especially those over 1,000 gpm, are major supply areas.

Three-Prepare Overlay Map of Soil Permeability of each County.

The detailed soil reports for Reno [7] and Rice [8] Counties were used to map areas of different rates of soil permeability. Soil permeability is an indicator of how well rain can enter into the groundwater. For McPherson County[10], those portions of the county where the soil types have been mapped were studied for their soil permeability.

Tables were prepared showing the soil units mapped in each county and the soil permeability given for that soil unit. The soil permeability was obtained from appropriate tables in the report and assigned a word description of very slow, slow, moderately slow, moderate, moderately rapid, rapid. Soils were assigned the value of none which overlay shale or rock within five feet of the surface. For soil units made up of a complex of two or more soils, the permeability of the predominate soil was used if it differed from the other. Questions on soil permeability were decided by the McPherson County Soil Scientist, Don Rott. Soil permeabilities for soil units in McPherson County were obtained from Don Rott.

In a few cases, the soil permeability for the same soil units, but in different counties, were assigned different values. Of particular note are the soil units of the Platte complex and Plevna fine sandy loam, and the Elsmere-Tivoli Complex. In Reno County, both the Platte complex and Plevna fine sandy loam have values of moderate permeability, while in Rice County, they are assigned the value of moderately rapid. The Sand Hills area in Reno County have the Elsmere-Tivoli Complex with a value of moderately rapid. These same areas in Rice County and Harvey County are mapped as Dillwyn-Tivoli Complex and have a value of rapid. These differences in the effect of soil permeability mean that Reno County will have slightly lower values for identified recharge areas than Rice and Harvey Counties. The Reno County Soils Report was completed in March of 1966, while Rice County was completed in December 1974, and Harvey County in November, 1974.

Table 3 shows the soil permeability of the word description in terms of inches per hour, as used by the Soil Conservation Service now.

TABLE 3

SOIL PERMEABILITY

	INCHES PER HOUR	Values in Matrix
very slow	.06	-4
slow	0.06 to -0.2	-2
Moderately slow	0.02 to 0.6	0
moderate	0.6 to 2.0	2
moderately rapid	2.0 to 6.0	4
rapid	6.0 to 20	6
very rapid	20	

Source: Soil Conservation Service. Supplement to Guide to Authors of Published Soil Surveys, TSC Trasm. Sheet LT-1, 10-4-74.

Table 4 in the back of the report shows the soil units and the permeability assigned for each of the Counties.

Those soils with a permeability of none are noted that way because of the presence of rock, particularly shale, but sometimes sandstone within five feet of the surface. In reality there is some recharge of water to the rocks, particularly the sandstone, but in comparison to the other soils, there is very little so it was noted as none.

The soil survey for McPherson County is still in progress and there may be changes in soil units as more of the area is surveyed and the soil profile examined and tested. As a result of this continued work, some of the soil units may change names and additional soil units may be added. The soils over the Equus Beds are almost mapped. The Equus Beds are the biggest water resource in the County. The soils in the alluvium valley along the Smokey Hill River are not yet mapped. This valley is also an important water resource in the County.

In Reno County, the areas of moderate recharge occur primarily along the Ninnescah River, along the Arkansas River, a zone between the Arkansas River and the Sand Hills north of Hutchinson and a large area south of the Arkansas River from just west of Yoder to the southeast. The moderately rapid and rapid permeability areas occur in sandy areas in western Reno County, northeastern Reno County, along the Ninnescah River and along the Arkansas River.

Soils of moderately slow permeability cover the most area in Reno County, especially in the central portions. Slow areas cover a large zone between the Arkansas River and the Sand Hills north of Hutchinson. Very slow areas cover significant areas along or near Pearce and Salt Creeks. Other areas of slow and very slow soils are scattered over the County. Soils over shale, essentially no recharge, cover a large area north of the Ninnescah River in southeast Reno County.

In Rice County, rapid and moderately rapid soils cover large areas in southeastern, southwestern, and central western parts of the County. There are also some scattered areas of these soils in the area between Cow Creek and the Arkansas River north of Sterling. Moderately permeable soils cover significant portions of the center of the County around Lyons and southeast and around Chase, especially to the west and south and along the major streams like Cow Creek, Little Cow Creek, Lost Creek, Plum Creek and the Little Arkansas River Valley. Recharge of the northern and central parts of Rice County may be greatly aided by flooding along these streams which puts significant amounts of water on the moderately permeable soils along them.

Moderately slow permeable soils occur primarily in the area between the Arkansas River and Cow Creek and south Cow Creek in west central portions of the County. Slow permeability soils cover the largest amount of area in the County, especially over Loess deposits in northern and east central Rice County. Other areas of slow and very slow permeability soils are scattered in west central, and south central parts of the county. An area with soils of no recharge occurs in the northeastern corner of the County.

In McPherson County, the areas that are mapped are the fifteen southern townships. An area four sections wide from Moundridge east and extending north 11 miles is not completed yet. Of the areas, mapped, the only area of moderately rapid or rapid soils are in the southwestern corner along or south of the Little Arkansas River. Along the streams are soils of moderate permeability. As in Rice County, the flooding along these streams probably contributes significantly to recharging the Equus Beds by putting more water over the soils.

Slowly permeability soils cover most of the area mapped There are some significant areas of very slow soils along Blaze Fork Creek. Most of the very slow soils occur northeast of McPherson and north of Galva and in the eastern and southeastern parts of the County.

Four-Preparation of the Groundwater Recharge Matrix

The Groundwater Recharge Matrix was developed and used to relate the three overlay maps together to determine the potential for recharge. Depending on the values, areas were identified for very high, high, and moderate recharge. These areas being considered the more important in terms of recharging the groundwater resources in the Mid-State Region. Groundwater recharge occurs in most all areas of the region and each of recharge is important. This study helps to identify the most important areas; areas which,relatively speaking, recharge a greater proportion of the water.

Table 5 shows the Groundwater Recharge Matrix.

TABLE 5

Recharge Potential

Well Yield	Geology	High	High	Moderate				
2	6	14	12	10	8	6	4	-
1	6	13	11	9	7	5	3	-
0	6	12	10	8	6	4	2	-
2	4	12	10	8	6	4	2	-
1	4	11	9	7	5	3	1	-
0	4	10	8	6	4	2	0	-
2	2	10	8	6	4	2	0	-
1	2	9	7	5	3	1	-1	-
0	2	8	6	4	1	0	-2	-
2	0	8	6	4	2	0	-2	-
1	0	7	5	3	0	-1	-3	-
0	0	6	4	2	0	-2	-4	-*

Soil Permeability Value

*Shallow soil over consolidate rock, especially shale, but also sandstone. Rock within 5 feet of surface.

Very high recharge areas are areas with soil of rapid permeability over geology of dune sand or terrace deposits with well yields of greater than five hundred gallons per minute;; very high recharges areas take a score in the matrix of 14. High recharge areas have soils of rapid or moderately rapid permeability and geology of dune sand, terrace deposits, alluvium or McPherson Formation These recharge areas have at least a score of 11. Moderate recharge areas have a soil permeability of at least moderately slow with high yield yields and dune sand to rapid soils overlaying on moderately favorable geology and well yields. Moderate recharge areas take a score of at least 8.

<u>Five-Prepare Composite Overlay of Maps 1 and 2 to become Map of Storage and Transmission Map of Groundwater</u>.

To help aid identifying areas for recharge, the well yield and geology map were combined and each area noted by a two number value that corresponds to the left side of the groundwater recharge matrix. This composite map summarizes where the groundwater is stored or where it is transmitted from the soils to the storage areas (high well yield areas).

Six-Prepare Groundwater Recharge Map from Overlays Described in Section Three and Five, using the Groundwater Recharge Matrix.

The soil permeability map was overlaid over the composite map on well yields and geology and a groundwater recharge overlay was made. Any area with a score of 14 was identified as a very-high recharge area. Areas with a score of 11 to 13 were identified as high recharge areas. Areas with a score of eight to 10 were identified as moderate recharge areas. The information on the groundwater recharge map was then added to a base map to identify the areas and their potential for charge.

GROUNDWATER RECHARGE AREAS

The groundwater recharge areas in McPherson County are in the southwest corner of the County, south of the Little Arkansas River and along the streams running the major streams like Dry Turkey Creek, Running Turkey Creek, Turkey Creek, Black Kettle Creek. The areas have been identified only in the south half of McPherson County. Areas in the north part will be identified after the soil survey maps have been completed.

In Reno County, very high and high recharge areas cover the sandy area in the Sand Hills north of Hutchinson, in terraces along the Arkansas River and the sandy areas in Western Reno County. Moderate recharge areas include more of the Sand Hills north of Hutchinson, the river valley along much of the Arkansas River, broad areas of sandy areas in northwestern Reno County and along the Ninnescah River.

In Rice County, the sandy areas in the southeastern part of the County, and along and south of the Arkansas River are Very-High and High recharge areas. Moderate recharge areas cover more areas along the Arkansas River, a sandy area in middle of the western area of the County and south of Cow Creek below Lyons.

Significant portions of Reno and Rice Counties are areas of significant groundwater recharge. Map 3-11 is a generalized map of these groundwater recharge areas. Detailed countywide maps were prepared for the Groundwater Management Districts and the Counties.

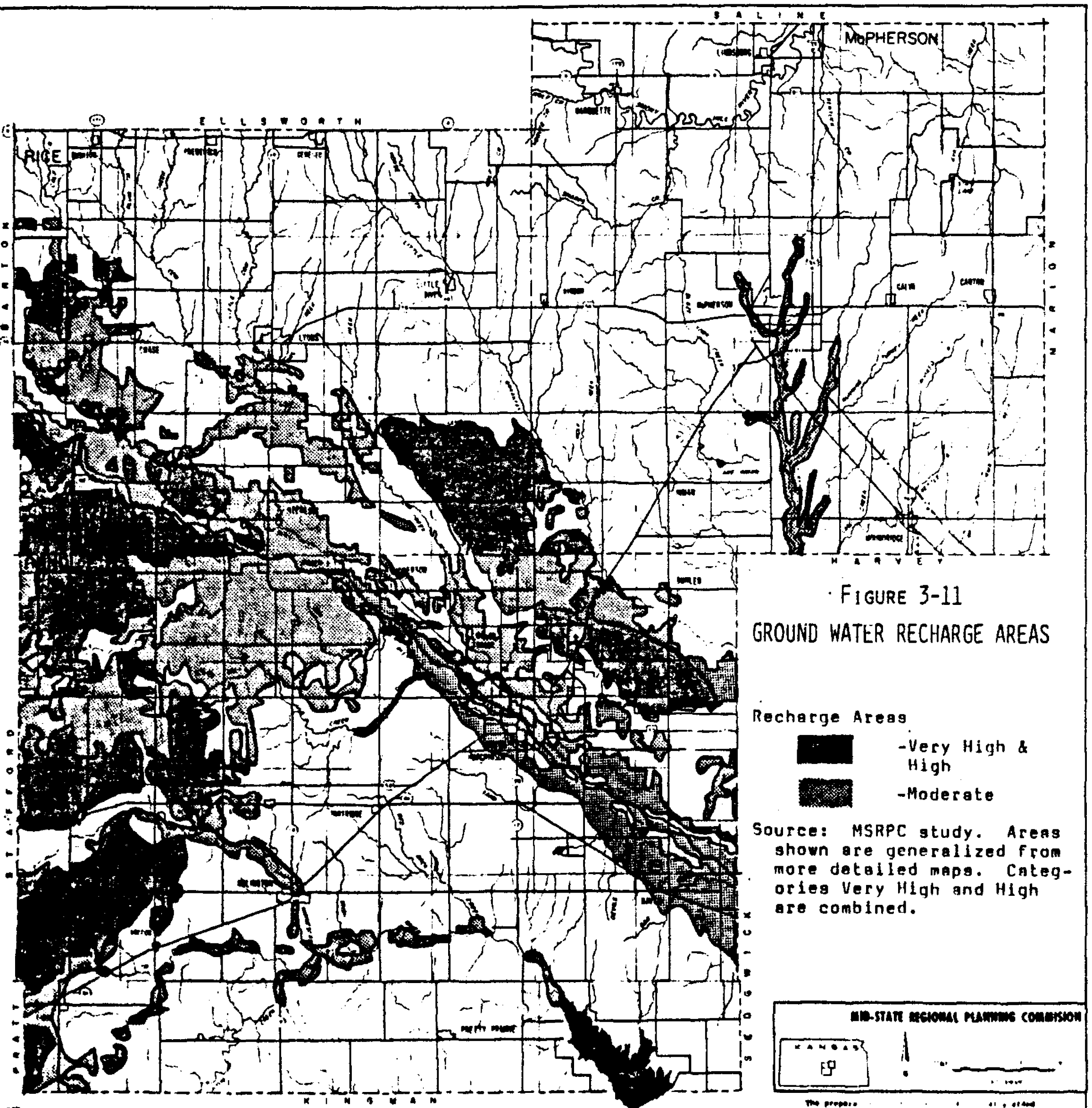

FIGURE 3-11
GROUND WATER RECHARGE AREAS

Recharge Areas

-Very High & High

-Moderate

Source: MSRPC study. Areas shown are generalized from more detailed maps. Categories Very High and High are combined.

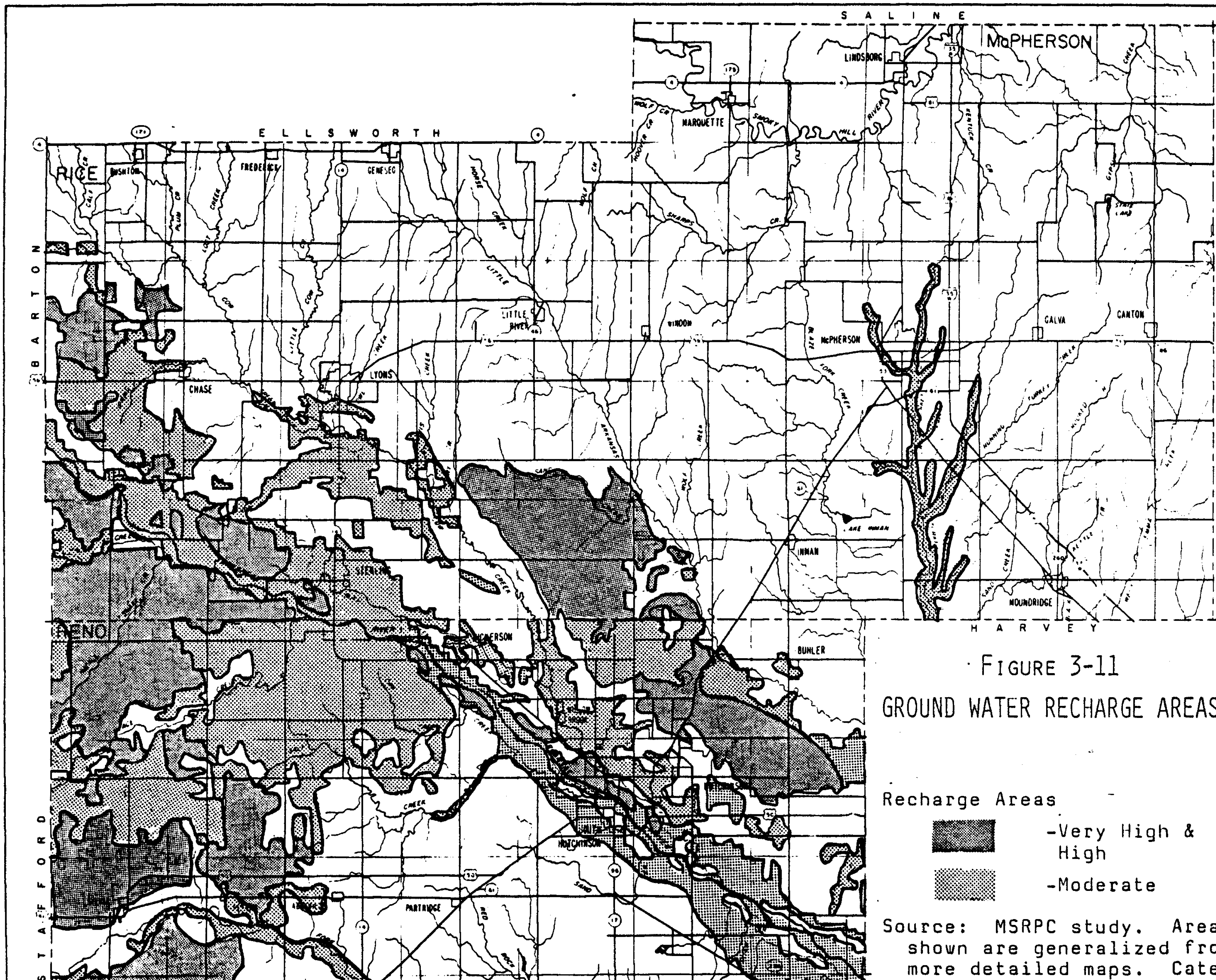

FIGURE 3-11

GROUND WATER RECHARGE AREAS

Recharge Areas

-Very High & High

-Moderate

Source: MSRPC study. Areas shown are generalized from more detailed maps. Categ

CONCLUSIONS AND POLICY IMPLICATIONS

Groundwater recharge areas carry out an important job in supplying water to the underground acquifier. Their identification can help us know and use this important environmental and economic asset more wisely.

Because groundwater recharge areas are important in maintaining the groundwater resources of the area, they should be well cared for. Development over, on, and through these areas should be done with care, or we risk harming the resource. The potential for harming the groundwater is high in these areas because greater amounts of water make their way through the soils and geologic materials at a rate faster than other areas. Oil drilling activity, especially associated brine water, may cause damage to the groundwater if wells are plugged or cased improperly. The brine should be handled so as not to go into the soils or the groundwater. Fertilizing in these groundwater recharge areas, especially with nitrogen, may pose a higher risk of nitrates getting into the groundwater. Feed lots, the larger ones especially, should not be located in these areas to help avoid nitrate and other pollutant problems. Detailed investigation of soil on the site should be done if a feedlot is proposed in a recharge area.

Sanitary Land fills should not be located in these recharge areas, or should have a soil survey investigation to help determine the extent of any problem.

Land uses in the recharge areas should be carried out so as to not add pollutants to the groundwater and,as much as possible, preserve the area so that it can function as a groundwater recharge area.

Urban development should be discouraged in such areas, especially urban sprawl. If possible, such areas should be preserved for their use as a groundwater recharge area and cities should build away from them. If there are no other choices, then the city growth should be made as compact as possible over these areas. More detailed maps should be prepared for those cities which overly recharge areas.

Scattered subdivision and urban development should be avoided, or minimized, or at least carefully done so as to lessen the loss of the recharge. Developments with individual wells and septic tanks should be designed to avoid contamination of their own well, their neighbor's well, and the groundwater.

The groundwater recharge areas are an important environmental and economic resource in the Mid-State Region and should be used wisely.

TABLE 4 Part 1

Soil Survey Legend
McPherson County, Kansas

10-2-77

Map Symbol	Soil Permeability	Field Name
L5B	mr	Attica loamy fine sand, 1 to 4% slopes
1M41 (12)	m	Bridgeport silt loam
S2A	s	Carwile fine sandy loam
F3B	s	Clime silty clay, 1 to 3 % slopes
F3C	s	Clime silty clay, 3 to 6% slopes
M33A	s	Crete silt loam o to 1 % slopes
M33B	s	Crete silt loam 1 to 3% slopes
3B3	s	Crete silty clay loam, 1 to 3 % slopes eroded 1
1M2	s	Detroit silty clay loam
M28A	vs	Drummond soils 1
F5D	vs	Edalgo clay loam, 3 to 12% slopes
M3B	ms	Farnum loam, 1 to 3% slopes
M31B	ms	Geary silt loam, 1 to 3% slopes 1
H2A	vs	Goessel silty clay
1M4	m	Hobbs silt loam
1M5	m	Hord silt loam
F25B	vs	Irwin silty clay loam, 1 to 3% slopes
F2A	vs	Ladysmith silty clay loam
F28A	vs	Ladysmith-Drummond complex 2
M41C	m	Landcaster-loam 3 to 6% slopes
M41D	m	Landcaster-Hedville complex 6 to 12% slopes 2
2SS	m	McCook fine sandy loam
S5A	mr	Plevna fine sandy loam
L6X	r	Pratt loamy fine sand rolling
1F3	m	Roxbury silty clay loam
M4B	ms	Shellabarger loam, 1 to 3% slopes 2
M4C	ms	Shellabarger loam, 3 to 6% slopes 2
F27B	s	Smolan silty clay loam, 1 to 3 % slopes
F27C	s	Smolan silty clay loam, 3 to 6% slopes
27C3	s	Smolan silty clay loam, 2 to 6% slopes, eroded
4KC	vs	Vernon clay, 3 to 7% slopes (b)

vs- very slow
s slow
ms moderately slow
m moderate
mr moderately rapid
r rapid

TABLE 4
Part 2

SOILS IN RENO COUNTY

Map Symbol	Soil Permeability	Soil Legend
Ab	m	Albion-Shellabarger sandy loams, 0 to 1% slopes
As	m	Albion-Shellabarger sandy loams, 1 to 4% slopes
Ba	ms	Bethany silt loam, 0 to 1 % slopes
Be	ms	Bethany silt loam, 1 to 3% slopes
Bk		Breaks-Alluvial land complex
Ca	mr	Canadian fine sandy loam
Cd	s	Carwile fine sandy loam
Cf	s	Carwile-Farnum fine sandy laom
Ck	ms	Clark fine sandy loam
Cm	ms	Clark-Ost complex, 0 to 1 % slopes
Co	ms	Clark-Ost complex, 1 to 3% slopes
Cp	ms	Clark-Ost complex, 3 to 6 percent slopes
Da	ms	Dale clay loam
Ep	mr	Elsmere-Plevna complex
Et	mr	Elsmere-Tivoli complex
Fa	ms	Farnum fine sandy loan, 0 to 1 % slopes
Fm	ms	Farnum loam, 1 to 3 % slopes
Fn	ms	Farnum loam, 1 to 3% slopes
Fs	s	Farnum-Slickspot complex
Ft	s	Farnum-Tabler complex
Lc	ms	Lesho clay loam
Na	ms	Naron fine sandy loam, 0 to 1 % slopes
Ne	ms	Naron fine sandy loam, 1 to 3% slopes
Nf	ms	Naron-Farnum complex
Np	ms	Naron-Pratt complex
Ns	n	Nash-Lucien complex, 1 to 3 % slopes
Nt	n	Nash-Lucien complex, 3 to 6 % slopes
Nu	n	Nash-Lucien complex, 6 to 15 % slopes
Pa	m	Platte soils
Pe	m	Plevna fine sandy loam
Pl	ms	Port clay loam
Pm	r	Pratt loamy fine sand, undulating
Pr	r	Pratt loamy fine sand, hummocky
Pt	mr	Pratt-Carwile complex
Rc	n	Renfrow clay loam, 0 to 1 % slopes
Re	n	Renfrow clay loam, 1 to 3% slopes
Rv	n	Renfrow-Vernon clay loams.
Sa	ms	Shellabarger fine sandy loam, 0 to 1 % slopes
Sb	ms	Shellabarger fine sandy loam, 1 to 3% slopes
Sc	n	Shellabarger fine sandy loam, shale substratum 0 to 3 % slopes

Table 4, Part 2 (cont.)

Part 2 (cont.)
SOILS IN RENO COUNTY

Map Symbol	Soil Permeability	Soil Legend
Se	ms	Shellabarger loamy fine sand, undulating
Sg	ms	Shellabarger & Albion soils, 7 to 15 % slopes
Sh	ms	Shellabarger-Clark-Albion complex, 2 to 6 % slopes
Sm	ms	Shellabarger-Farnum complex, 1 to 3 % soils
Sn	ms	Shellabarger and Farnum soils, 3 to 7% slopes eroded
So	v.s	Slickspots
Sp	s	Smolan silty clay loam, 1 to 3% slopes
St	s	Smolan silty clay loam, 3 to 6 % slopes, eroded
Ta	vs	Tables clay loam
Tb	vs	Tabler-Slickspot complex
Tf	r	Tivoli fine sand,hilly
Th	r	Tivoli soils, hummocky
Va	m	Vanoss silt loam, 0 to 1 % slopes
Vb	m	Vanoss silt loam, 1 to 3 % slopes
Vc	m	Vanoss silt loam, 3 to 7 % slopes, eroded
Ve	n	Vernon soils
Wa	mr	Wann fine sandy loam
We		Wet alluvial land

n	none
vs	Very Slow
s	Slow
ms	Moderately slow
m	Moderate
mr	Moderately rapid
r	Rapid

TABLE 4, Part 3

SOILS IN RICE COUNTY

Map Symbol	Soil Permeability	Soil Legend
At	mr	Attica fine sandy loam, 1 to 4% slopes
Ca	mr	Canadian fine sandy loam
Cd	s	Carwile fine sandy loam
Ce	m	Clark complex, 1 to 4% slopes
Ck	n	Clark loam, red variant, 1 to 4 % slopes
Cr	s	Crete silt loam, 0 to 1 % slopes
Cs	s	Crete silt loam, 1 to 2 % slopes
Ct	s	Crete soils, 1 to 3 % slopes, eroded
De	s	Detroit silt loam
Dp	r	Dillwyn-Plevna loamy fine sands
Dt	r	Dillwyn-Tivoli complex
Du	vs	Drummond complex
Fa	ms	Farnum fine sandy loam, 0 to 2 % slopes
Fn	ms	Farnum loan, 0 to 3 % slopes
Fs	ms	Farnum-Slickspots complex
Ga	m	Geary silt loam, 1 to 3 % slopes
Gc	m	Geary-Clark complex, 3 to 7% slopes, eroded
He	n	Hedville-Lancaster complex, 5 to 20 % slopes
Ho	m	Hobbs silt loam
Hs	m	Hobbs silt loam, seldom flooded
Ka	m-mr	Kaski loam
Kc	n	Kipson complex, 3 to 15 % slopes
La	n	Lancaster loam, 1 to 3% slopes
Lc	n	Lancaster loam, 3 to 7 % slopes
Le	ms	Lesho clay loam
Na	m-mr	Naron fine sandy loam, 0 to 1 % slopes
Nf	m-mr	Naron fine sandy loam, 1 to 3% slopes
Pc	mr	Platte complex
Pe	mr	Plevna fine sandy loam
Pf	r	Pratt loamy fine sand, 1 to 5 percent slopes
Pg	r	Pratt loamy fine sany, 5 to 10 percent slopes
Pr	r	Pratt-Carwile complex
Pt	r	Pratt-Tivoli loamy fine sands
Sm	s	Smolan silty clay loam, 1 to 3 % slopes
So	s	Smolan soils 2, to 7 % slopes, eroded
Ta	vs	Tabler clay loam
Ts	vs	Tabler-Slickspots complex
Tv	r	Tivoli fine sand
Wa	mr	Waldeck fine sandy loam

n- none   s-slow   m -moderate   r-rapid
vs-very slow   ms-moderately slow   mr-moderately rapid

TABLE 4, Part 4

HARVEY COUNTY SOIL LEGEND

Map Symbol	Soil Permeability	Soil Legend
Ad		Alluvial land, broken
Ba		Breaks-Alluvial land complex
Ca	s	Carwile fine sandy loam
Cc	m	Clark clay loam, 1 to 3 % slopes
Cd	n	Clime silty clay, 1 to 3 % slopes
Ce	n	Clime silty clay, 3 to 6% slopes
Cf	n	Clime silty clay, 2 to 6 % slopes, eroded
Cm	n	Clime complex, 6 to 12 % slopes
Cr	s	Crete silt loam, 0 to 1% slopes
Ct	s	Crete silt loam, 1 to 3 % slopes
De	s	Detroit silty clay loam
Dp	r	Dillwyn-Plevna complex
Dt	r	Dillwyn-Tivoli complex
Du	vs	Drummond Complex
Fa	ms	Farnum fine sandy loam, 0 to 1 % slopes
Fc	ms	Farnum loam 0 to 1% slopes
Fd	ms	Farnum loam, 1 to 3% slopes
Fe	ms	Farnum loam, 3 to 6 % slopes
Fs	ms	Farnum-Slickspots complex
Gc	m	Geary silt loam, 0 to 1% slopes
Gd	m	Geary silt loam, 1 to 3 % slopes
Ge	m	Geary silt loam, 3 to 6% slopes
Go	vs	Goessel silty clay, 0 to 1 % slopes
Gs	vs	Goessel silty clay, 1 to 2 % slopes
Ho	m	Hobbs silt loam
Ir	vs	Irwin silty clay loam, 1 to 3% slopes
Is	vs	Irwin silty clay loam, 3 to 6% slopes
It	vs	Irwin silty clay loam, 2 to 6 % slopes, eroded
Ka	m	Kaski loam
La	vs	Ladysmith silty clay loam, 0 to 1 % slopes
Lb	vs	Ladysmith silty clay loam, 1 to 2% slopes
Ld	vs	Ladysmith-Slickspots complex
Le	ms	Lesho loam
Na	m	Naron fine sandy loam, 0 to 1 % slopes
Nb	m	Naron fine sandy loam, 1 to 4 % slopes
Pa	mr	Pratt loamy fine sand, 1 to 5% slopes
Pc	r	Pratt-Carwile complex
Pt	r	Pratt-Tivoli loamy fine sandy
Ro	n	Rosehill silty clay, 1 to 3 % slopes
Rs	n	Rosehill silty clay, 3 to 6% slopes
Sm	s	Smolan silty clay loam, 1 to 3% slopes
Tv	r	Tivoli fine sand

n-none s-slow m-moderate r-rapid
vs-very slow ms-moderately slow mr-moderately rapid

FOOTNOTES

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[3]Fent,O.S., Geology and Ground-Water Resources of Rice County, Ks., Bulletin 85, State Geological Survey of Kansas, University of Kansas Publication, July 1950, Topeka, Kansas, Fred Vorland Jr., State Printer, 1950.

[4]Bayne, Charles K. and Ward, John R., Geology and Hydrology of Rice County, Central Kansas, Bulletin 206, Part 3, Kansas Geological Survey, University of Kansas Publications, April 1974.

[5]Water Resources Board, Irrigation in Kansas, September 1967, Planning for Development, 701 Report No. Kans. P-43, Topeka, Kansas Kansas Economic Development Planning Program, 1967.

[6]Pinney, John J., Jr., Henderson John A., Kostecki, Donald F., Little Arkansas River Basin,State Water Plan Studies, Part C, Kansas Water Resources Board, Topeka Ks, State of Kansas 1975.

[7]U.S. Department of Agriculture, Soil Survey, Reno County, Kansas, Washington D.C. U.S. Government Printing Office, March 1966.

[8]U.S. Department of Agriculture, Soil Survey of Rice County, Kansas Washington D.C., U.S. Government Printing Office, December 1974.

[9]U.S. Department of Agriculture, Soil Survey of Harvey County, Ks., Washington D.C. U.S. Government Printing Office, November 1974.

[10]Don Rott, Soil Scientist McPherson County, Field Maps of Soil Units Mapped in McPherson County.

[11]Department of Planning and Development, City of Hutchinson, Ks., Reno County Soils Limitation for Urban Development, City of Hutchinson, May 1973.