

Proposed Desired Future Conditions for the Ogallala Aquifer

North Plains Groundwater Conservation District

December 15, 2008



Executive Summary

North Plains Groundwater Conservation District proposes to establish an Ogallala aquifer (Aquifer) Desired Future Condition (DFC) for Dallam, Hartley, Moore, and Sherman Counties; and Hansford, Hutchinson, Ochiltree, and Lipscomb Counties in Groundwater Management Area 1 (GMA-1). The District proposes a DFC of at least 40% of the Aquifer to be remaining in 50 years for the area of Dallam, Hartley, Moore, and Sherman Counties and the District proposes a DFC of at least 50% of the Aquifer to be remaining in 50 years for the area of Hansford, Hutchinson, Ochiltree, and Lipscomb Counties within the District. The District proposes two DFCs because the uses or conditions for the aquifer within the District differ substantially from one geographic area to another.

The District proposes the Aquifer DFCs based on the District's evaluation of Aquifer characteristics, Aquifer storage, current demand and estimated future demand; development of DFC statements; evaluation of managed available groundwater based on those statements; evaluation of DFC effects on other Districts, and District stakeholder desires.

Introduction

In establishing the desired future conditions of the aquifers the GMA-1 shall consider uses or conditions of an aquifer within the management area that differ substantially from one geographic area to another. GMA-1 may establish different desired future conditions for:

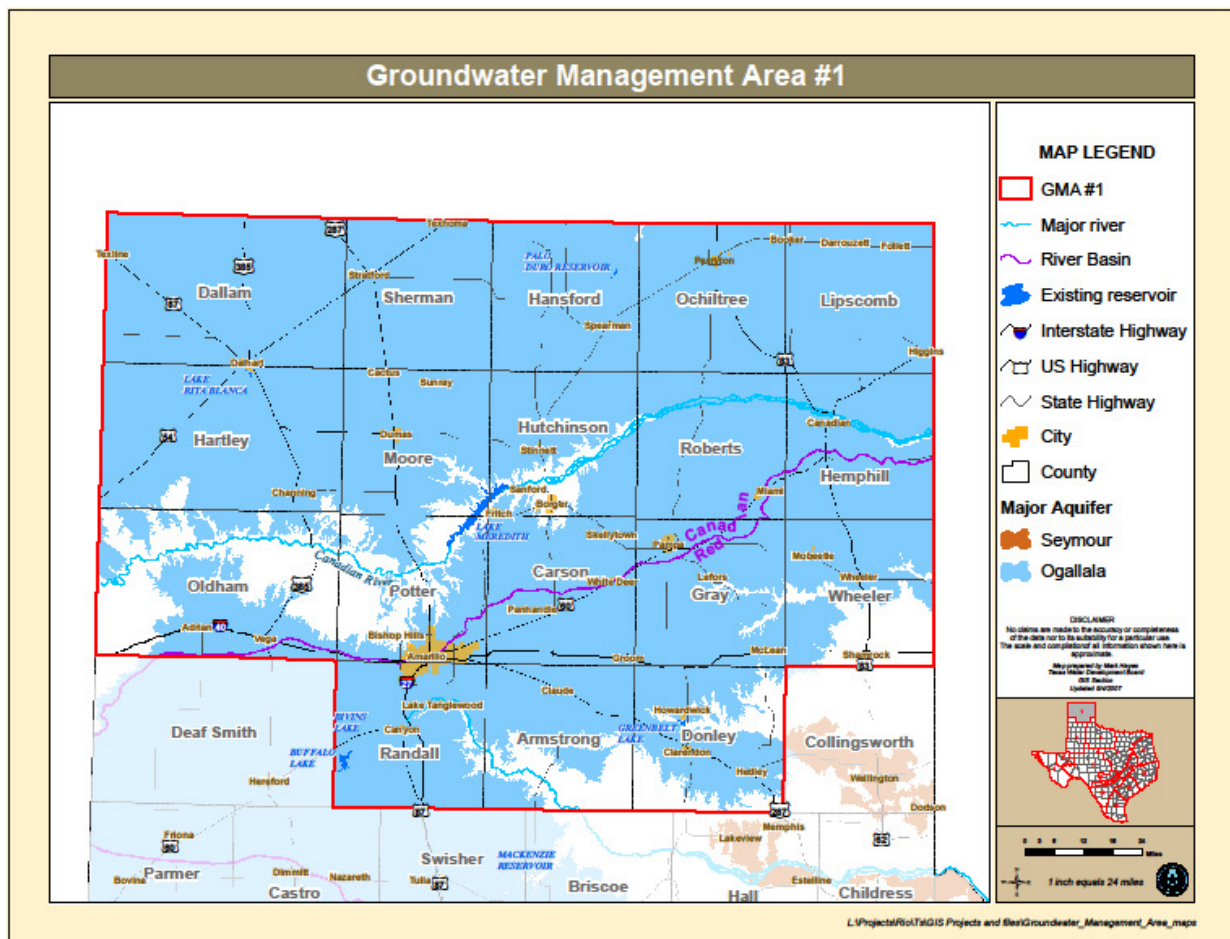
- Each aquifer, subdivision of an aquifer, or geologic strata located in whole or in part within the boundaries of the management area; or
- Each geographic area overlying an aquifer in whole or in part or subdivision of an aquifer within the boundaries of the management area.

To propose DFC(s) for the Aquifer within the District, the District evaluated Aquifer characteristics; Aquifer storage; current demand; estimated future demand; possible DFC statements; manage available groundwater based on those statements; DFC effects on other Districts; and local stakeholder desires.

Aquifer Characteristics

The Ogallala aquifer is the primary aquifer within the North Plains Groundwater Conservation District. The Ogallala Formation unconformably overlies Permian, Triassic, Jurassic, and Cretaceous strata and consists primarily of heterogeneous sequences of coarse-grained sand and gravel in the lower part grading upward into fine clay, silt, and sand. Water-bearing areas of the Ogallala Formation are hydraulically separated from the South Plains except in Roberts County (part of Panhandle Groundwater Conservation District) and Hemphill County (Hemphill County Underground Water Conservation District). Figure 1 shows the Ogallala Aquifer in GMA-1

Figure 1 – Map of Groundwater Management Area 1 showing extent of Ogallala Aquifer (Source: TWDB).



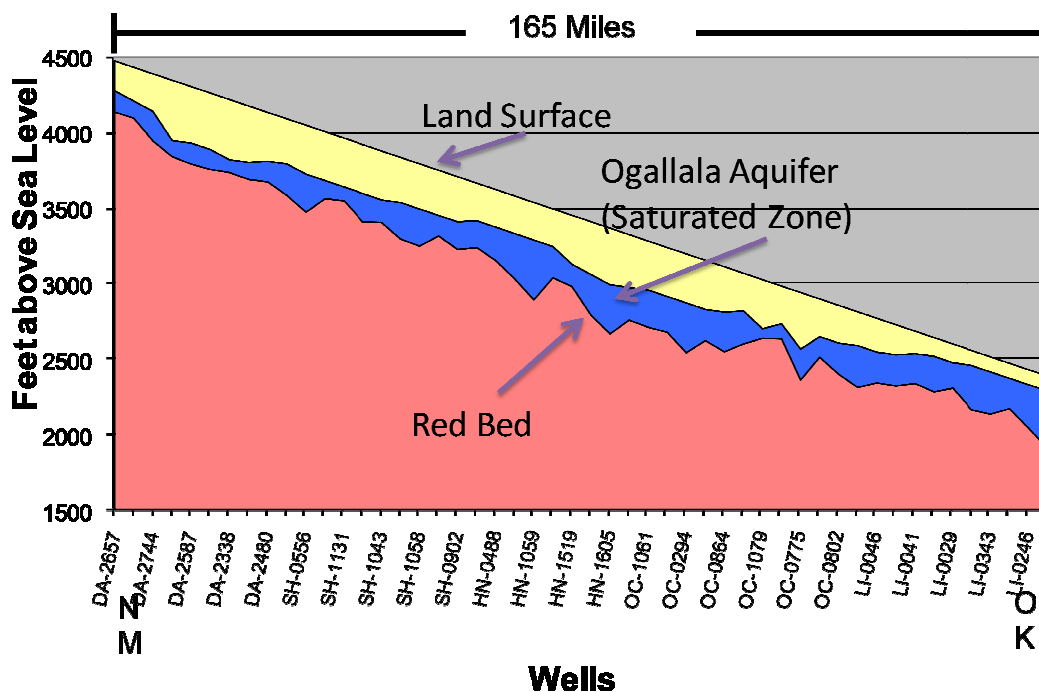
The Ogallala aquifer is hydraulically connected to a portion of the Dockum aquifer and the District historically has not differentiated between the Ogallala and Dockum aquifers. Many wells drilled into the Dockum may also gather groundwater from the Ogallala. Within the District, the Dockum aquifer is present only in Dallam, Hartley, Sherman and Moore counties. Since the Dockum is listed as a minor aquifer in the state, the TWDB is modeling the Dockum separately from the Ogallala. The District anticipates that the Dockum aquifer will be the subject of a separate DFC

statement and managed available groundwater amount and is not included in this DFC proposal.

Aquifer Gradient

Ogallala aquifer groundwater level conditions and Red Bed elevation conditions vary substantially from the New Mexico state line adjacent to Dallam and Hartley counties and the Oklahoma state line adjacent to the eastern boundary of Lipscomb County. The groundwater level elevation ranges from approximately 4275 feet above sea level (asl) and the Red Bed elevation ranges from 4141 feet asl in western Dallam and Hartley counties to approximately 2425 feet asl in northern Lipscomb county and approximately 2000 feet asl in eastern Lipscomb County. The base of the Ogallala (Red Bed) is 400 feet higher in western Dallam and Hartley counties than the land surface elevation at Sherman County/Hansford County line. This condition shows that the gradient of the aquifer slopes approximately 11 feet to 12 feet per mile from western Dallam and Hartley counties to eastern Lipscomb County. Most of the Aquifer pumping occurs in Dallam, Hartley, Sherman, and Moore counties. This pumping condition is up gradient from Hansford, Hutchinson, Ochiltree, and Lipscomb counties. This condition allows development of pumping in the eastern portion of the District that should not adversely affect groundwater supplies in the western portion of the District for the foreseeable future. Figure 2 is a cross section of the Ogallala aquifer from New Mexico (west) to Oklahoma (east) in the District.

Figure 2 – Cross section of the Ogallala aquifer from New Mexico (west) to Oklahoma (east).



Saturated Thickness

The saturated thickness conditions of the Ogallala Aquifer vary substantially within the District. Saturated thickness may vary over 400 feet from one area to another. Average saturated thickness conditions range from approximately 146 feet within Dallam and Hartley counties to approximately 214 feet in Ochiltree and Lipscomb counties. The average saturated thickness is 160 feet in Dallam, Hartley, Sherman and Moore Counties compared to 201 feet in Hansford, Hutchinson, Ochiltree, and Lipscomb counties.

Transmissivity

The transmissivity of an aquifer is a measure of how much water can be transmitted horizontally. Transmissivity is directly proportional to the aquifer thickness. Generally, as the saturated thickness in an aquifer such as the Ogallala declines, its transmissivity or the ability for groundwater to flow from one area to another also declines. As areas within the District develop thinner saturated thicknesses resulting from pumping, as in Dallam, Hartley, Sherman and Moore counties, groundwater transmissivity should decline faster than in Hansford, Hutchison, Ochiltree, and Lipscomb counties.

Number of Wells.

The number of wells that withdraw groundwater from the aquifer within the District in Dallam, Hartley, Sherman, and Moore counties differ substantially from the number of wells that withdraw groundwater from the aquifer in Hansford, Hutchinson, Ochiltree, and Lipscomb counties. Dallam, Hartley, Sherman and Moore counties (5403 active wells) have 3.5 times the number of wells found in Hansford, Hutchinson, Ochiltree, and Lipscomb counties (1504 active wells). Since January 2004, at least 475 new wells have been drilled in Dallam, Hartley, Sherman, and Moore counties compared to 64 new wells that have been drilled in Hansford, Hutchinson, Ochiltree and Lipscomb counties. The number of new well completions in the western counties differs substantially from the eastern counties and is far outpacing the new well completions in the eastern counties of the District by more than 7 to 1 over the past five years. These additional wells indicate the likelihood of increased pumping and increased decline rates west of Hansford and Hutchinson Counties. The number of wells is a direct indicator of groundwater demand within the District. Table 1 shows the active wells by county within the District. Table 2 shows the new wells drilled by county since January 2004. The District notes that some wells drilled in the past 120 days may not have yet been reported completed by the driller.

Table 1 – Active wells within the district

| County | Active Wells |
|------------|--------------|
| Dallam | 1541 |
| Hartley | 1517 |
| Moore | 1064 |
| Sherman | 1281 |
| Hansford | 700 |
| Hutchinson | 222 |
| Ochiltree | 402 |
| Lipscomb | 217 |

Table 2 – Wells reported drilled since January 2004 within the District.

| County | Active Wells |
|------------|--------------|
| Dallam | 90 |
| Hartley | 245 |
| Sherman | 85 |
| Moore | 55 |
| Hansford | 17 |
| Hutchinson | 16 |
| Ochiltree | 11 |
| Lipscomb | 20 |

Aquifer Storage

The District reviewed aquifer storage data provided by the Texas Water Development Board, the Panhandle Water Planning Area (PWPA), and its own estimates based on direct measurements of saturated thickness. Accurate aquifer storage measurements are key to determining managed available groundwater. The District found that Aquifer storage estimates by the Texas Water Development Board, the PWPA and the District can be highly variable for some of the counties. The District and the TWDB staff compared beginning Aquifer storage volumes for the Groundwater Availability Model (GAM) and the District’s estimates from direct measurement data. The TWDB and the District’s total volume in storage estimates differed by only 2 percent aquifer wide. However as the District compared its storage estimates to the TWDB model estimates, the District staff found variance on a county by county basis of -2% to 57% difference. Any percent differences between the District’s measured data and the TWDB GAM should translate into differences in potential managed available groundwater (MAG) values. As the District improves its data set for Aquifer storage, and that information is incorporated into the TWDB GAM, the MAG will become less variable and will become a better

tool for aquifer management. Table 3 shows a comparison of TWDB GAM storage information and 2007 District estimates based on direct measurements.

Table 3 – TWDB GAM Aquifer storage estimates compared to 2007 District Aquifer storage estimates.

| County | TWDB GAM (Acre-Feet) | 2007 District Estimate | Percent Difference |
|---------------------|----------------------|------------------------|--------------------|
| Dallam | 10,290,500 | 16,181,760 | 57% |
| Hartley | 22,498,500 | 18,812,416 | -16% |
| Sherman | 18,202,300 | 16,227,123 | -11% |
| Moore | 8,642,050 | 12,704,563 | 47% |
| Hansford | 21,467,800 | 17,553,715 | -18% |
| Hutchinson | 3,888,000 | 4,194,714 | 8% |
| Ochiltree | 20,246,200 | 19,875,635 | -2% |
| Lipscomb | 18,641,300 | 20,562,944 | 10% |
| Total Volume | 123,876,650 | 126,112,870 | 2% |

Panhandle Water Planning Group Storage Analysis

The Panhandle Regional Planning Area (PWPA) regional water plan estimated that Aquifer storage would decline from 2010 to 2060 for each county based on groundwater use to meet regional and local needs. The PWPA estimated that water remaining in storage from 2010 to 2060 would range from 33% in Moore County to 97% in Lipscomb County. The PWPA storage estimates included areas mostly in Dallam and Hutchinson counties that were not in the District. Table 4 shows the PWPA estimate of Aquifer storage from 2000 to 2060.

Table 4 - Aquifer storage in acre-feet from the PWPA Regional Water Plan (Source: PWPA 2006 Regional Plan- Table 3-1, January 2006)

| County | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 | Percent Remaining 2010-2060 |
|--------------|--------------------|--------------------|--------------------|--------------------|-------------------|-------------------|-------------------|-----------------------------|
| Dallam | 17,604,513 | 14,622,921 | 12,134,853 | 10,126,050 | 8,591,459 | 7,549,367 | 6,779,683 | 46% |
| Hartley | 24,925,026 | 22,140,753 | 19,612,912 | 17,620,595 | 16,366,457 | 15,570,650 | 15,033,727 | 68% |
| Moore | 10,662,411 | 8,866,273 | 7,116,002 | 5,572,033 | 4,394,052 | 3,551,754 | 2,928,227 | 33% |
| Sherman | 19,498,315 | 16,814,464 | 14,188,402 | 11,708,499 | 9,545,592 | 7,794,612 | 6,390,606 | 38% |
| Hansford | 21,693,703 | 20,385,024 | 19,092,753 | 17,850,094 | 16,716,209 | 15,729,410 | 14,852,445 | 73% |
| Hutchinson | 11,112,029 | 10,275,488 | 9,463,673 | 8,736,497 | 8,113,675 | 7,629,968 | 7,245,126 | 71% |
| Ochiltree | 19,795,557 | 18,847,872 | 17,955,425 | 17,118,070 | 16,368,979 | 15,724,576 | 15,156,476 | 80% |
| Lipscomb | 18,640,279 | 18,526,166 | 18,413,261 | 18,305,998 | 18,210,229 | 18,128,137 | 18,055,287 | 97% |
| Total | 143,931,833 | 130,478,961 | 117,977,281 | 107,037,836 | 98,306,652 | 91,678,474 | 86,441,577 | 66% |

Current Demand and Estimated Future Demand

In 2007, Groundwater demand in Dallam, Hartley, Sherman and Moore counties (1,008,820 acre-feet) was substantially higher than groundwater demand in Hansford, Hutchinson, Ochiltree, and Lipscomb counties (236,254 acre-feet). The reason for this demand is the significant development of agriculture irrigation, industrial use and municipal use on the west side of the District compared to the east side. Public water supplies and other potential aquifer users consider aquifer characteristics in their long term water resource planning. Interviews with entity representatives that wish to develop the Aquifer for future water supplies indicate that these entities are searching for water sources that will last far beyond the 50 year window of the joint planning process. These entities have searched out areas within the District that have substantial Aquifer saturated thickness to meet their future water needs. In 2008, the City of Amarillo properly filed notice that it traded water rights in western Hartley and Dallam counties for water rights in Ochiltree County. The District's understanding for this trade is to develop a more secure water resource in Ochiltree County to add to its water rights holdings in Roberts County. Other entities that have plans to develop water rights for potential public water supply have apparently primarily focused on acquiring groundwater rights in the eastern counties of the District. Though these entities have not properly filed notice on where they have acquired rights, the District understands that they have drilled test holes to evaluate aquifer characteristics that are conducive to long term development of this valuable water resource.

In contrast to development of long term water resources for public water supply, companies are relocating to the District to support the growing dairy, confined animal feeding operations, and irrigation industries. These companies have a shorter term vision within the 50 year planning window and are primarily focusing on development in Dallam, Hartley, Sherman and Moore counties.

According to the 2007 State Water Plan and based on the TWDB estimated land area and the District estimates based on the percent of each county within the District, the projected total water demand will decline from 1,213,787 acre-feet per year in 2010 to 857,570 acre-feet per year in 2060. Table 5 shows State Water Plan projected water demand for the counties within the District.

Table 5 – State Water Plan projected water demand (in acre-feet).

| County | 2000 | 2010 | 2020 | 2030 | 2040 | 2050 | 2060 |
|--------------|------------------|------------------|------------------|------------------|------------------|----------------|----------------|
| Dallam | 241,601 | 240,373 | 239,066 | 227,495 | 204,088 | 180,646 | 168,979 |
| Hartley | 250,185 | 246,862 | 243,428 | 231,378 | 207,032 | 182,684 | 170,606 |
| Sherman | 298,495 | 299,079 | 297,604 | 283,100 | 253,874 | 224,658 | 210,178 |
| Moore | 136,462 | 134,816 | 133,356 | 127,949 | 116,207 | 104,313 | 98,828 |
| Hansford | 144,411 | 141,563 | 138,664 | 132,111 | 118,664 | 105,200 | 98,670 |
| Hutchinson | 25,902 | 26,507 | 26,653 | 26,156 | 24,697 | 23,158 | 22,794 |
| Ochiltree | 110,783 | 108,494 | 106,327 | 101,404 | 91,236 | 81,033 | 76,067 |
| Lipscomb | 16,359 | 16,093 | 15,872 | 15,133 | 13,657 | 12,191 | 11,448 |
| Total | 1,224,198 | 1,213,787 | 1,200,970 | 1,144,726 | 1,029,455 | 913,883 | 857,570 |

Source: Volume 3, 2007 State Water Planning Database

The District compared the State Water Plan estimated demand with the District’s 2007 reported groundwater use. Table 6 Shows the State Water Plan estimate for 2010 compared to the District’s reported 2007 groundwater production data.

Table 6 - State Water Plan 2010 water demand compared to the District’s 2007 reported groundwater use (in acre-feet).

| County | State Water Plan 2010 Demand | District 2007 Reported Groundwater Use | Percent Difference |
|--------------|------------------------------|--|--------------------|
| Dallam | 240,373 | 289,806 | 21% |
| Hartley | 246,862 | 329,061 | 33% |
| Sherman | 299,079 | 230,839 | -23% |
| Moore | 134,816 | 159,113 | 18% |
| Hansford | 141,563 | 109,452 | -23% |
| Hutchinson | 26,507 | 36,377 | 37% |
| Ochiltree | 108,494 | 54,265 | -50% |
| Lipscomb | 16,093 | 36,161 | 125% |
| Total | 1,213,787 | 1,245,074 | 3% |

The projected total water demand from the State Water Plan does not include developments in the dairy industry nor the potential for transporting groundwater for public water supplies. The reason that these needs were not assessed at the time of the last planning process is that in 2005 the extent of the dairy industry development and possible public water supply

development in the District was not known. Based on the accelerated drilling activity in Hartley County and to a lesser extent in Dallam, Sherman and Moore counties to service the growing dairy industry need, an increase in water need over the next decade may occur in the four western counties that exceed State Water Plan estimates. Based on interviews from water rights owners and entities in Hansford, Hutchinson, Ochiltree and Lipscomb counties, water demand may increase as a result of groundwater transport out of the District. Quantification of these demands at this time is speculative at best.

Development of Desired Future Condition (DFC) Statements

The District preliminarily developed three DFC statements. The first DFC statement requires 50% of Aquifer storage remaining in the District after 50 years (50/50). The second statement requires 40% of the Aquifer storage remaining in the area comprising Dallam, Hartley, Sherman and Moore counties after 50 years (40/50) and 60% of Aquifer storage remaining in the area comprising Hansford, Hutchinson, Ochiltree, and Lipscomb counties in 50 years (60/50). The third statement requires 40% of the Aquifer storage remaining in the area comprising Dallam, Hartley, Sherman and Moore counties after 50 years (40/50) and 50% of Aquifer storage remaining in the area comprising Hansford, Hutchinson, Ochiltree, and Lipscomb counties in 50 years (50/50). Table 7 shows the preliminarily developed DFCs and their estimated average MAG, and the finally proposed DFCs.

Table 7 – Preliminary DFCs and their estimated average MAG.

| Description | 2007 Pumping Rate | Aquifer Storage (TWDB) | DFC 2058 | Average MAG (preliminary estimate) |
|---------------------|-------------------|------------------------|------------|------------------------------------|
| West Counties 40/50 | 1,008,820 | 59,633,000 | 23,853,340 | 783,139 |
| East Counties 50/50 | 236,254 | 64,243,000 | 32,121,500 | 642430 |

Evaluate Managed Available Groundwater Based on DFC Statements

The District evaluated preliminary MAGs based on their corresponding DFC statements. The District evaluated each of the preliminary DFC statements for their effect on the MAG normalized to an average MAG per square mile basis. Table 8 shows the potential change in pumping based on 2007 production data and estimated average MAG.

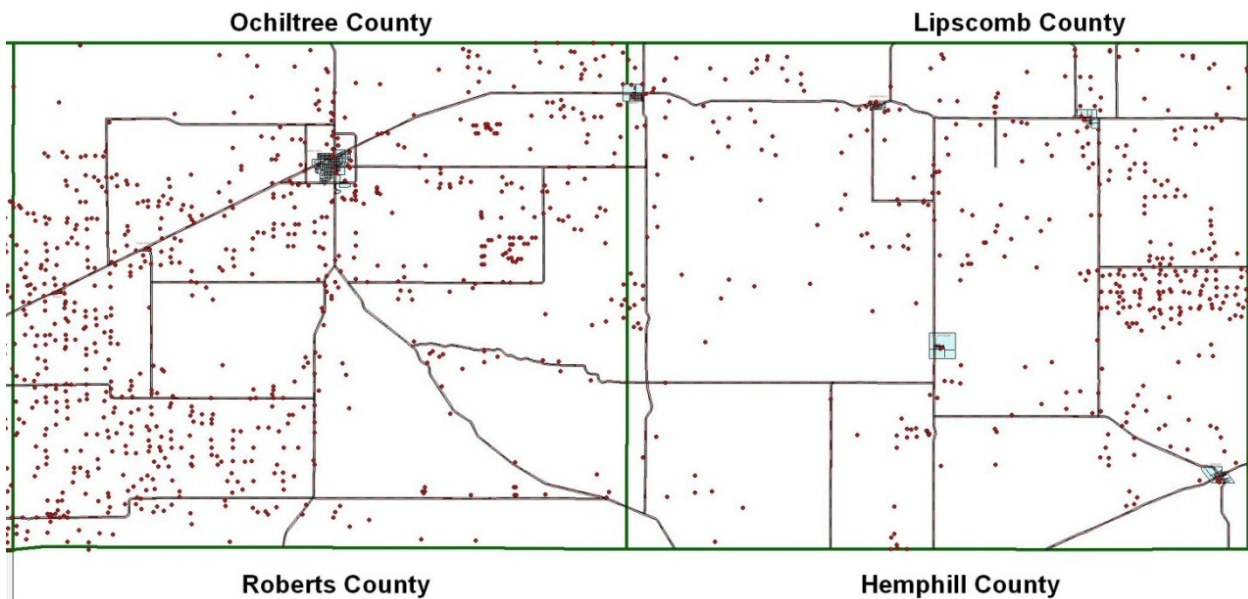
Table 8 - Potential change in pumping based on 2007 production data and estimated average MAG.

| Description | 2007 Pumping Rate | Average MAG | Change in Pumping | Percent Change | Square Miles in Area | Acre-Feet per Square Mile |
|------------------------|--------------------------|--------------------|--------------------------|-----------------------|-----------------------------|----------------------------------|
| West Counties 40/50 | 1,008,820 | 783,139 | -225,681 | -22% | 3,891 | 201 |
| East Counties 50/50 | 236,254 | 642,430 | 406,176 | 172% | 3,014 | 213 |

Desired Future Condition Effects on other Districts

Water-bearing areas of the Ogallala Formation are hydraulically separated from the South Plains except in Roberts County (part of Panhandle Groundwater Conservation District) and Hemphill County (Hemphill County Underground Water Conservation District). The District proposes a DFC of 50% of Aquifer storage remaining in 50 years consistent with the proposed DFC described by representatives of the Panhandle Groundwater Conservation District. The District anticipates that the DFC of 50% in 50 years for Lipscomb county will not have an adverse affect on Hemphill County for the foreseeable future. The area in south Lipscomb County is not conducive to irrigation development and at this time the District has not received notice of any water rights transfers that would indicate development of public water supplies in the immediate future. Figure 3 shows the well distribution in Ochiltree and Lipscomb Counties adjacent to Panhandle Groundwater Conservation District) and Hemphill County (Hemphill County Underground Water Conservation District).

Figure 3 – Well distribution in Ochiltree and Lipscomb Counties.



District Stakeholder Desires

The District held seven Public Stakeholder Meetings during 2008 in part to gather input regarding Desired Future Conditions. During the Spring, meetings were held in Perryton, Dumas and Dalhart. In the Fall of 2008, meetings were held in Darrouzett, Spearman, Dumas and Dalhart.

Generally, the District Stakeholder expressed concerns as follows:

- To be treated equally across District
- If aquifer withdrawal limit reductions are required, provide time to make reductions.
- Do not restrict economic growth in an area that currently has relatively little pumping.
- Protect spring flows and/or the economy based on tourism in the Eastern half of the District.
- Set the DFC for the Western half of the District that would not adversely affect the regional economy and the ability of individual producers to make a living.
- Set the DFC high enough to align with having groundwater supplies left for families to continue to farm the same land.
- Western half of the District did not want their groundwater supply issues to adversely affect the Eastern half of the District.
- Concern about pumping in the areas in Dallam County not within District that could adversely affect the District.

Conclusion

North Plains Groundwater Conservation District proposes to establish an Ogallala aquifer (Aquifer) Desired Future Condition (DFC) for Dallam, Hartley, Moore, and Sherman Counties; and Hansford, Hutchinson, Ochiltree, and Lipscomb Counties in Groundwater Management Area 1 (GMA-1). The District proposes a DFC of at least 40% of the Aquifer to be remaining in 50 years for the area of Dallam, Hartley, Moore, and Sherman Counties and the District proposes a DFC of at least 50% of the Aquifer to be remaining in 50 years for the area of Hansford, Hutchinson, Ochiltree, and Lipscomb Counties within the District. The District proposes two DFCs because the uses or conditions for the aquifer within the District differ substantially from one geographic area to another.

The District proposes the Aquifer DFCs based on the District's evaluation of Aquifer characteristics, Aquifer storage, current demand and estimated future demand; development of DFC statements; evaluation of managed available groundwater based on those statements; evaluation of DFC effects on other Districts, and District stakeholder desires.