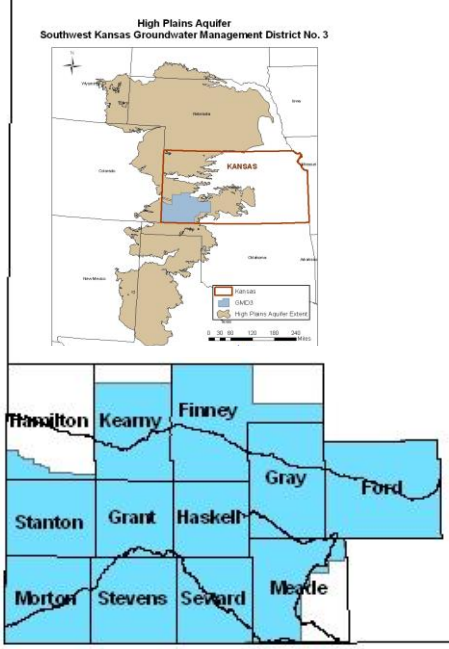
# Revised (2018) (Draft) Management Program

## Southwest Kansas Groundwater Management District Number 3 (GMD3)

**2009 E. Spruce Street, Garden City, Kansas 67846 (620)275-7147**

**URL: HTTP://www.gmd3.org**

**KDA comments 2/5/2018 and staff work thru 4/5/18**

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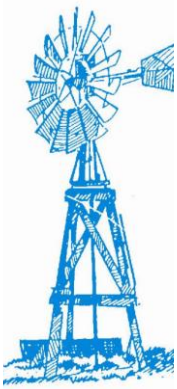

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# I. PURPOSE FOR LOCAL GROUNDWATER MANAGEMENT

**A right to manage groundwater**. Local groundwater is local water storage that is best governed locally for efficient management, investment and enjoyment of groundwater services. Water is the key resource for the present and future prosperity of all. There are other resources which may mean the difference between wealth and poverty, such as oil or gas, but none is like water as a fundamental necessity for our existence and nearly all other economic development. Local management requires the will to manage and sustain useable water inventories with significant assistance from many partners and in a manner consistent with the public interest. Ultimately, all water supply depends on precipitation, storage and transportation. The extent of available future supply depends in large part on the local management program activities to address those factors that are implemented today.

**Groundwater management framework**. The Southwest Kansas Groundwater Management District No. 3 (GMD3) Management Program document is intended to provide a management governance framework over the use and conservation of this critical and declining natural resource. This framework provides a basis for identified formal and informal policy norms and practices adopted to protect the equities, investments, and resource services dependent upon usable groundwater today and for the future of the area condition and Kansas economy. It is a written report describing the characteristics of the district and the nature and methods of dealing with groundwater supply problems within the district.

**Regular updates.** An up-to-date management program document is required by law in order to coordinate with members, local and state agencies and other partners and authorities for solving water supply problems with appropriate rules, strategies, programs and water infrastructure projects. Any update of the GMD3 management program document should be done regularly to incorporate inter-disciplinary issues of local groundwater governance, policy development, efficient cost-effective activities, aquifer protection strategy, resource planning and due consideration of private property rights.

**Resource governance.** There has been a steadily-increasing demand for GMD3 management governance in support of drought resiliency for agricultural production systems and to extend the future useable groundwater supply. There is also a direct correlation between timely rainfall and groundwater pumping in the district. Therefore, there is a critical role of further managing stored groundwater inventory, access to water without waste and supply replenishment strategies to extend and sustain the water supply that fuels the economy.

Groundwater governance can be difficult for many reasons, including:

1. Groundwater is a shared resource;
2. Groundwater inflows and outflows are difficult to observe and cannot be measured directly;
3. Surface and groundwater are interconnected;
4. Aquifer boundaries and characteristics may be locally unknown or poorly defined;
5. Groundwater management requires specialized model tools;
6. Groundwater conditions can vary on multiple time scales;

7. Groundwater use can pit present needs against future needs; especially in declining aquifers;
8. Diverse local, state and federal interests, institutions and authorities require significant coordination activity to maintain productive partnerships that accomplish the purposes of the groundwater governance and management in the public interest.

Program activities identified in this management program document and in separate implementation action plans are developed to address these challenges for the district and for Kansas.

## II. GMD3 MISSION, OBJECTIVES & PRINCIPLES

**MISSION**: Act on a shared commitment to conserve and develop water supply to grow the social, economic and natural resources well-being for current members and future generations in the public interest.

**Kansas water rights.** A water right in Kansas water law refers to the right of a person to take water under control from a public water source for beneficial use, such as from a groundwater source. The western US water doctrine of Prior Appropriation (or "first in time is first in right") has been a part of water management in Kansas since the 1800's (See Appendix for *Kansas Water Law and History Notes*). Prior appropriation was not fully adopted statewide for all usable water sources until the Kansas Water Appropriation Act (WAA) of 1945, whereby ownership of the water is dedicated as public good, but the right to use the public water is a private right created under an application, state grant and user action to apply the water to any of a variety of authorized beneficial uses. One water user can affect another's right of enjoyment of benefits from the resource. So, a system was necessary to resolve who has first right to the available supply and what effects on others may be reasonably tolerated in the public interest.

**GMD3 membership.** In 1972, the Kansas legislature determined it was also a public good to allow for the formation of groundwater management districts by groundwater users and land owners to collectively manage their groundwater supplies as they determined appropriate and included all public and private "persons" into the duties and privileges of GMD membership. In GMD3, user developed water rights are owned by members of the district. Members are persons who own a water right or are a groundwater user of at least one acre foot per year, or who own 40 or more contiguous acres of land in the district. Member water rights are real property rights that are part of a traditional "bundle of legal rights" transferred with land from seller to buyer as an appurtenance to the land, or a water right can be separated from the land and conveyed by evidence of a separate deed.

**The right to manage the local groundwater.** The Kansas legislature adopted the Groundwater Management District Act, K.S.A.82a-1020 et. seq. (GMD Act), granting the right of locally formed districts, through their governing body politic and corporate, to conduct the affairs of groundwater management in the district and to advise other public jurisdictions in the public interest. The GMD Act does not specify how GMD's should govern the activities affecting management of local groundwater resources in harmony with private real property rights and the state supervision of water rights, nor does it provide details on the interplay between federal,

state and local actions, except to affirm that effective groundwater management programs are best developed and adopted locally.

**a. Objectives of the legislature for forming GMDs (GMD Act)**:

1. Proper management of the groundwater resources of the state;
2. Conservation of groundwater resources;
3. Prevention of economic deterioration;
4. Associated endeavors within the state of Kansas through the stabilization of agriculture;
5. To secure for Kansas the benefit of its fertile soils and favorable location with respect to national and world markets

**b. Purposes for which GMD3 was organized in 1976:**

1. To organize and develop the efforts of the entire Groundwater Management District for the proper management and conservation of its groundwater resources;
2. Provide local input into the use and management of groundwater;
3. Provide for the greatest total social and economic benefits from the development, use and management of groundwater;
4. Support research and education concerning proper water management;
5. Work cooperatively with all federal, state, and local units of government to accomplish the objectives of the district and the Groundwater Management District Act and amendments thereto.

**c. GMD3 Management Program Guiding Principles:**

1. Represent all district eligible voters for groundwater management purposes;
2. Promote a culture of conservation;
3. Protect and enhance access to safe and usable water;
4. Pursue the highest value for the groundwater consumed;
5. Develop data and information to support prudent water management decisions;
6. Target management programs to meet local water needs for today and in the future;
7. Justly represent and administer all water rights as real property owned by eligible voters in the district.

## III. ORGANIZATIONAL HISTORY OF THE DISTRICT

In the late 1960's good, creative, local problem-solving folks saw that unregulated groundwater use was hastening the decline of local groundwater supplies. As stated earlier, mandatory permitting for all non-domestic uses was not provisioned by the Kansas legislature until 1978. These local leaders insisted on the adoption of mandatory standards for water rights, use limits and special management area authority in their interest for protecting the health and welfare of Kansans. Good state and local action followed. To get there, a series of informational meetings were sponsored by the Southwest Kansas Irrigation Association in the fall of 1973 to determine the will of the people relative to the formation of a local groundwater management district, also commonly referred to as a GMD. As a result of these meetings a steering committee was formed to carry out the organization of the district according to procedures provided in the GMD Act. On December 4, 1974, the steering committee filed a declaration of intent, along with a map of the proposed district, with the Chief Engineer of the Division of Water Resources (DWR), Kansas State Board of Agriculture, who acting as agent of the legislature to accomplish specific

tasks, consulted with the steering committee to assure a manageable area was determined. On August 25, 1975, the Chief Engineer certified the description of the lands proposed to be included in this new self-funding instrumentality of the State.

**Petition.** The steering committee circulated a petition which was submitted to the Secretary of State for approval. The petition was approved on October 13, 1975 and was followed by an election that was held on February 24, 1976. The election resulted in 1,155 voters in favor and 230 opposed. The Secretary of State was compelled by the election results to issue a Certificate of Incorporation on March 23, 1976. The Certificate of Incorporation has been filed at each county's Register of Deeds Office that is located within the district. An organizational meeting to elect the initial Board of Directors was held in Garden City, Kansas on April 6, 1976. The second Annual Meeting was held March 23, 1977 and now all annual meetings are held on the second Wednesday of March unless appropriately changed with notice.

**Governing body.** GMD3 is governed by a 15-member volunteer Board of Directors that is elected by a general constituency of the qualified voters present at an annual meeting. Each county is represented on the board by one director who must reside in that county. Accordingly, any type of "water user", as defined in K.S.A. 82a-1021(k), may be elected to serve as one of the 12 county positions. In addition to the 12 individual county positions, there are also 3 "at-large" board positions that are designated to represent that single type of water usage. These "at-large" water use types include Municipal, Surface water, and Industrial use. All qualified voters present at an annual meeting may vote on each position up for election.

**District financing.** GMD3 activity is financed by an annual land assessment and groundwater user fee that is levied against landowners and water users in the district. This is accomplished through an annual budgeting process that includes a review of the GMD3 financial status, management program and draft budget for the ensuing year at the annual meeting. A public hearing of the proposed budget and level of assessments to finance the budget is also conducted annually with notice (usually in July). If needed, debt funding is also authorized for GMD3.

**Home office.** The GMD3 office is located in Garden City, Kansas. The Board conducts regular monthly business meetings on the second Wednesday of each month (unless changed for cause) and an Annual Meeting for the election of Board Members on the second Wednesday during the month of March. Public hearings are regularly conducted by the board, or conducted by others on district matters where GMD3 is a participant, to allow input on the budget, management program activities, and other pertinent public interest activities for the district. A detailed set of bylaws has been adopted that are revised by the board as necessary.

**Working committees.** Each year members of the Board are appointed to serve on at least one sub-committee. Each committee addresses issues on an as-needed or ad hoc basis as directed by the Board. The committees are as follows: Executive; Policy and Legal; Finance; Research and Development; Renewable Supplies; and the Annual Meeting committee. In addition, other ad hoc or grant driven advisory committees may be formed and operated as needed to administer grants or develop local water conservation and economic strategies. One example is the Arkansas River Litigation Funds Advisory Committee, which advises the GMD3 board on expenditures from a Western Water Conservation Projects Fund grant from the legislature and the Kansas Water Office, with annual reports to the legislature. These reports are posted at: http://www.gmd3.org/about/special-meetings-and-committees/

## IV. CHARACTERISTICS OF THE DISTRICT

### General Characteristics

The district includes approximately 5,393,229 acres, or approximately 8,425 square miles of land. This includes all of Morton, Stevens, Seward, Stanton, Grant, Haskell, Gray, and Ford Counties as well as parts of Meade, Finney, Kearny, and Hamilton Counties in the southwest part of Kansas and the west central part of the Great Plains region of the United State. Land surface elevations range from approximately 3500 feet above sea level (ASL) in the west to less than 2300 feet ASL in the eastern side of the district. The land surface slopes in an east-southeast direction at a gradient ranging from 5 to 20 feet per mile. The district is closed to most new appropriations from the High Plains Aquifer and new projects change existing rights for use.

| | |
|---|---|
| Number of counties served by GMD3 | 12 |
| Number of established water rights | 12,500 |
| Average annual use authorized | 3.6 million acre-feet |
| Average annual use reported | 2 million acre-feet |
| Estimated annual Domestic use | |
| Average annual recharge from precipitation | Part of 1,224,000 acre-feet |
| Average annual lateral aquifer inflow | Part of above |
| Average annual recharge from return flow | Part of above |
| Average annual outflow | |
| Average annual reduction in storage | 776,000 acre-feet |
| Est. allowable average annual depletion rate over 25 Years (40/25 rule) | acre-feet |

See KGS Water Level Change image in Appendix.

**Source Water.** The most common source of water for district wells is the High Plains Aquifer, which is primarily comprised of the unconsolidated, unconfined Ogallala Formation, older less permeable finer grained Oligocene deposits and unconfined sub-cropping Dakota Aquifer System formations that receive very little recharge. In comparison, less than 100 non-domestic wells are authorized to tap into the confined bedrock Dakota Aquifer System, which is commonly referred to as the "Dakota Aquifer." The characteristics of these aquifers can vary dramatically throughout the District and recharge areas are located at the sub-crop region under the High Plains Aquifer across the central part of the district and direct recharge source areas are generally west of the district at higher elevations in southeast Colorado.

**Water Quality.** The quality of the groundwater in the High Plains and Dakota Aquifers is generally fresh. In some locations, the introduced salinity and/or radio-nuclei levels exceed recommended limits or maximum contaminant levels (MCLs) for drinking water established by the US Environmental Protection Agency (EPA).

**Aquifer Thickness.** The saturated thickness of the principle aquifer, the High Plains Aquifer, ranges from 20 feet to 600 feet within the district, with significant variability in part of this thickness that is productive. Thus, well capacities range from 20 gallons per minute (gpm) to 3,000 gpm. Historic depletion also varies spatially across the district as documented in the Kansas Geological Survey (KGS) High Plains Aquifer Atlas. A 2010 model of the district

indicated that groundwater pumping caused a nearly 30% decrease in aquifer storage from pre-development to 2007, for an average decline of roughly 70 feet. These groundwater declines have created a loss in the groundwater discharging to streams, resulting in lower to no stream flows (2014 Kansas Water Plan). That 2010 GMD3 model is due to be updated.

**Cimarron River Basin.** There are two river systems that interact with their respective alluvial aquifers and the Ogallala Aquifer, the Arkansas River and the Cimarron River. With the exception of about a 20 mile reach of the Cimarron River below Highway 54 where the river leaves the district and the state in Seward and Meade counties, both the Arkansas and Cimarron River systems are generally losing streams west to east across the district. This means that all, or a significant portion, of any flow is lost to the underlying High Plains Aquifer through gravity induced deep percolation. More information can be found at:

http://www.kgs.ku.edu/Hydro/Publications/2005/OFR05_26/OFR2005_26.pdf

**Arkansas River Basin.** There are six surface water irrigation ditch systems that have historically diverted water from the Arkansas River between the Colorado-Kansas Stateline and Garden City. Collectively, these irrigation ditch companies owned by farmer-shareholders control approximately 140,000 acre-feet of senior surface water rights from available Arkansas River flows governed by a federal court decree, vested rights and an interstate river basin compact. Surface water rights historically developed below Garden City rarely receive any river flow for use and lands historically irrigated from surface water now rely on groundwater sources or may not receive any water except for the rare large river flow event. Additional information can be found at: http://www.kgs.ku.edu/Hydro/UARC/index.html

**Pawnee River Basin.** Portions of the headwaters of tributary Pawnee River system are located in eastern Finney, northeastern Gray, and northern Ford Counties of GMD3, though some spring discharge from the base of thin Ogallala deposits provide supply to Horse Thief Reservoir on Buckner Creek in Hodgeman County. A portion of Hodgeman County was originally included in the district. The board agreed to an exclusion petition that resulted in the loss of district services in that county. The alluvial aquifers of these headwaters contain some water supply locally. However, projected yields are too small to be a significant water source for the district.

Both the Arkansas River and the Cimarron River systems (including Crooked Creek) are associated with interstate compact agreements that are both state and federal law. See Kansas Interstate compacts map in Appendix.

**Colorado and Kansas Arkansas River Compact.** The 1949 Colorado and Kansas Arkansas River Compact relates to the waters of the Arkansas River drainage basin primarily above Dodge City to apportion the benefits of John Martin Reservoir and to protect the usability of the basin Stateline flows available at the time of the compact. The compact is administered by an interstate administrative agency called the Colorado-Kansas Arkansas River Compact Administration (ARCA). Their website can be found at:
http://www.co-ks-arkansasrivercompactadmin.org/resources.html

**Kansas and Oklahoma Arkansas River Compact.** The 1966 Kansas and Oklahoma Arkansas River Compact apportions water between the two states as agreed new conservation storage capacity or water transfer amounts for each state divided into six major topographic sub-basins

tributary to the Arkansas River basin from Wichita, Kansas to the confluence with the Arkansas River Mainstem in Oklahoma that together span the entire southern border of Kansas. The Cimarron River sub-basin, that includes Crooked Creek drainage, directly relates to the district as an upstream area. The compact also pledges cooperation between the states in man-made pollution abatements. The Kansas – Oklahoma Arkansas River Commission is the interstate administrative agency that operates this compact, and additional information can be found online at:
https://agriculture.ks.gov/divisions-programs/dwr/interstate-rivers-and-compacts/kansas-oklahoma-arkansas-river-compact.

**Economy**

From the KDA 2016 annual report, agriculture is the largest industry, employer and economic driver in Kansas, accounting for nearly 43 percent of the state's economy and valued at more than $64 billion. More than 229,000 Kansans, or 12 percent of the state's workforce, are employed in agriculture. Kansas is among the nation's leaders in beef cattle, sorghum and wheat. At 28.2 million acres, Kansas has the second-most cropland of any state.

GMD3 member farmers and ranchers not only manage the soils for sustainable production systems but they also work to improve management and conservation of district water resources. GMD3 works to provide leadership in developing the efforts of the entire groundwater management district for the proper management and conservation of groundwater resources and to secure for Kansas the benefit of fertile soils and favorable location with respect to national and world markets.

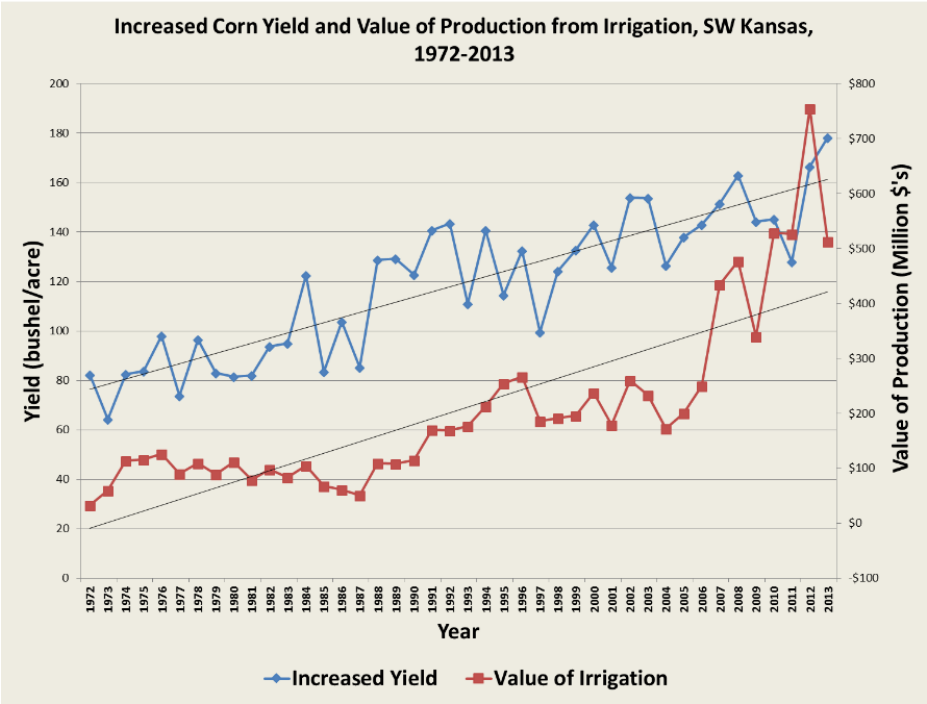
2012 County Farm Facts (most recent data available)

| GMD3 COUNTY | # OF FARMS | FARM LAND | CROP ACRES | CROP MRKT VALUE | LVSTK VALUE |
|---|---|---|---|---|---|
| | | | | ----- $1000 ---- | ----- $1000 ---- |
| Finney | 516 | 760,110 | 370,072 | 140,746 | 552,781 |
| Ford | 664 | 634,240 | 286,263 | 87,004 | 387,072 |
| Grant | 326 | 337,320 | 175,725 | 63,853 | 513,055 |
| Gray | 473 | 546,118 | 273,329 | 109,340 | 582,042 |
| Hamilton | 431 | 610,864 | 217,281 | 51,817 | 215,208 |
| Haskell | 248 | 398,805 | 242,130 | 116,154 | 602,139 |
| Kearny | 337 | 519,424 | 187,892 | 66,321 | 154,747 |
| Meade | 448 | 602,281 | 232,429 | 91,206 | 103,386 |
| Morton | 353 | 441,926 | 178,875 | 42,645 | 76,500 |
| Seward | 342 | 395,981 | 188,729 | 81,688 | 279,966 |
| Stanton | 328 | 414,184 | 204,776 | 76,592 | 105,158 |
| Stevens | 425 | 503,439 | 267,698 | 124,066 | 108,850 |
| Totals | 4,440 | 6,164,692 | 2,413,895 | 1,051,432,000 | 3,680,904,000 |

USDA information on farms, crops and livestock in district counties

**The Corn Standard.** Corn is the most popular irrigated crop in the district according to annual water use reports collected by the Chief Engineer. According to the Kansas Department of Agriculture, the value of irrigated corn produced in southwest Kansas was $582.77 million in 2013 and the total economic income generated by that corn was $842 million. The Net Irrigation Requirement (NIR) for corn ranges from 13.7" in Ford County to 15.4" in Morton County; this is in addition to the average precipitation of only 19 inches (K.A.R. 5-5-12, NIR at 50% chance of rainfall; K.A.R. 5-6-12, Average annual precipitation). Corn is the first irrigated crop in the

district to be provided a limited irrigation risk management option in the federal crop insurance program of USDA Risk Management Agency. USDA irrigated corn yield average in Kansas 1972-2016 was 165 bushels per acre (average 32 million acres harvested) and non-irrigated average 1972-2016 was 46 bushels per acre (average 557 million acres harvested). If corn acres were all dryland the economic impact would be significant. Some years, dryland production is wiped out by drought without the safety-net of irrigation.

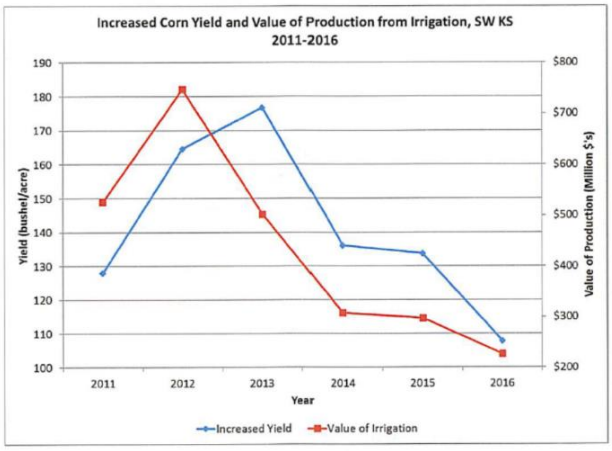


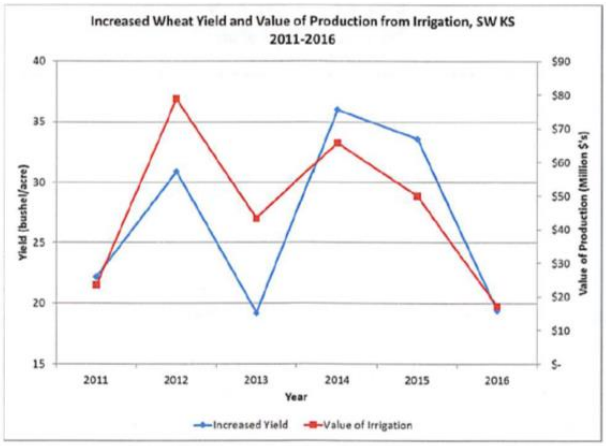

Source: Kansas Department of Agriculture

**Economy decline from irrigated acres decline.** From a Kansas Department of Agriculture (KDA) presentation to the Governors economic advisory council, Dodge City, 2013 when commodity prices were strong, one less irrigated acre in Southwest Kansas will lead to an estimated loss of value to Kansas of $2,200 land resale value and 122.5 bu of corn at $6.78 = $831 and 2 cattle on feed, approximately equal to 1,060 usable pounds of meat or a 2012 wholesale value of $3,080 (assumes an average price of $2.90/lb. of beef). This is a yearly loss of $3,911 per irrigated acre transitioned completely to dryland. There are about 1,500,000 acres authorized for irrigation in GMD3. In the district, value added from irrigated corn and wheat production is, for SW KS, $556,532,840 in 2013. Additional production generates income from agricultural producers and input suppliers, and this income circulates through local and state economies, creating a multiplier effect.

**Market adjustments.** In 2016 according to KDA, the return associated with irrigation (value of production) for corn in southwest Kansas was $226,638,720, while the return to irrigation for wheat was $17,227,200. Combined, the increased return to irrigation from corn and wheat in southwest Kansas in 2016 was nearly $243.9 million. Taking into account generally accepted economic multipliers, the economic impact of this increased production was valued at almost $582.2 million. It is important to note that the value of irrigation is directly impacted by commodity crop prices and dryland yields. From 2014 onward we have seen the combination of

both declining prices and increasing dryland yields, which caused a market adjustment and reduced the return associated with irrigation. However, a change in either the dryland and irrigated yield spread or the relative price would create a notable increase for the value of irrigation. This is evident in the recent year's corn yields and value.




From K. Liebsch, Economist, Kansas Department of Agriculture, February, 2018.

**Beef and Dairy animal agriculture.** Kansas ranked third nationally in numbers of cattle and calves on ranches and in feedyards in 2015 with 6 million head and second in the fed cattle market in 2014 (USDA, 2016). Revenue from cattle production grew more than 36% from 2010 to 2014, with cattle providing $7.75 billion in cash receipts in 2013 (KLA, 2016). Nearly half of the state's agricultural cash receipts in 2013 came from the sale of cattle and calves. Kansas ranked 16th nationally in milk production in 2015 when milk production was valued at $746 million (USDA, 2016). District animal agriculture provides a significant portion of these state numbers, due to reliability of irrigated grains and forage.

The district is one of the fastest growing regions for dairy production in the United States with the advantages of open spaces, favorable climate, irrigation for consistent high-quality forage, and abundant groundwater at a safe depth that separates nutrient management activity from the hydrologic cycle. The district is now home to the largest milk drying plant in North America, located in Garden City.

**The value of water.** There are a number of factors that influence the value of district water supply and use. GMD3 commissioned a study by the Docking Institute of Public Affair's in 2000 to examine through 2020 "*The economic impact of an acre-foot of water on the economy of Southwest Kansas* (2001)." Five scenarios of water utilization and economic impact were developed and analyzed. The first scenario modeled the farming and water utilization practices. This scenario found that excluding government subsidies, the average net present value per section over 20 years (2020) is $ -150,000, while the saturated thickness of the aquifer would decrease by about 30%. Including subsidies from external sources, the study found that on an annual basis, the total economic impact on the GMD3 area from irrigation was estimated at $188,496,000 in 1998 dollars. This equals about $80 per acre foot. Over the course of the 20 year period of the study, the net present value of this impact in current dollars was estimated at $3,769,920,000.

In the remaining four scenarios of the Docking study, the team explored the impact of changing irrigation methods and water requirements (and thus yields) for irrigated crops on depletion and the net present value for irrigators. The study found that the most viable scenario for achieving near zero depletion was one that changed all flood irrigation to center pivot and reduced the water utilization for corn by 50%. Significant, the reduced water for corn would only result in a 10% reduction in yield. However, the cost to the irrigator of these changes would have a net present value per section of -$4,200 annually, or -$84,000 over the course of the 20 year study. The total cost of this near zero depletion scenario to the collective membership of GMD3 would be about $11 million (1998 dollars) annually ($4,200 X 2618 sections). Of course, government subsidies and low interest loans will substantially lower the cost to members of GMD3 and the cost for individual irrigators will vary by specific circumstances related to their operations. An update of the study is due for consideration in 2020.

**Damage claim estimate.** Of the many studies of the economic value of district water supply, the most comparable to the Docking study is the "Kansas' Expert Reports in Support of its Claim for Money Damages for Colorado's Violations of the Arkansas River Compact 1950-94" (1998). Using classic cost-benefit analysis, the experts found that the value of Arkansas River water in 1998 dollars was an average $514 per acre foot for all uses (irrigation agriculture, industrial, and municipal).

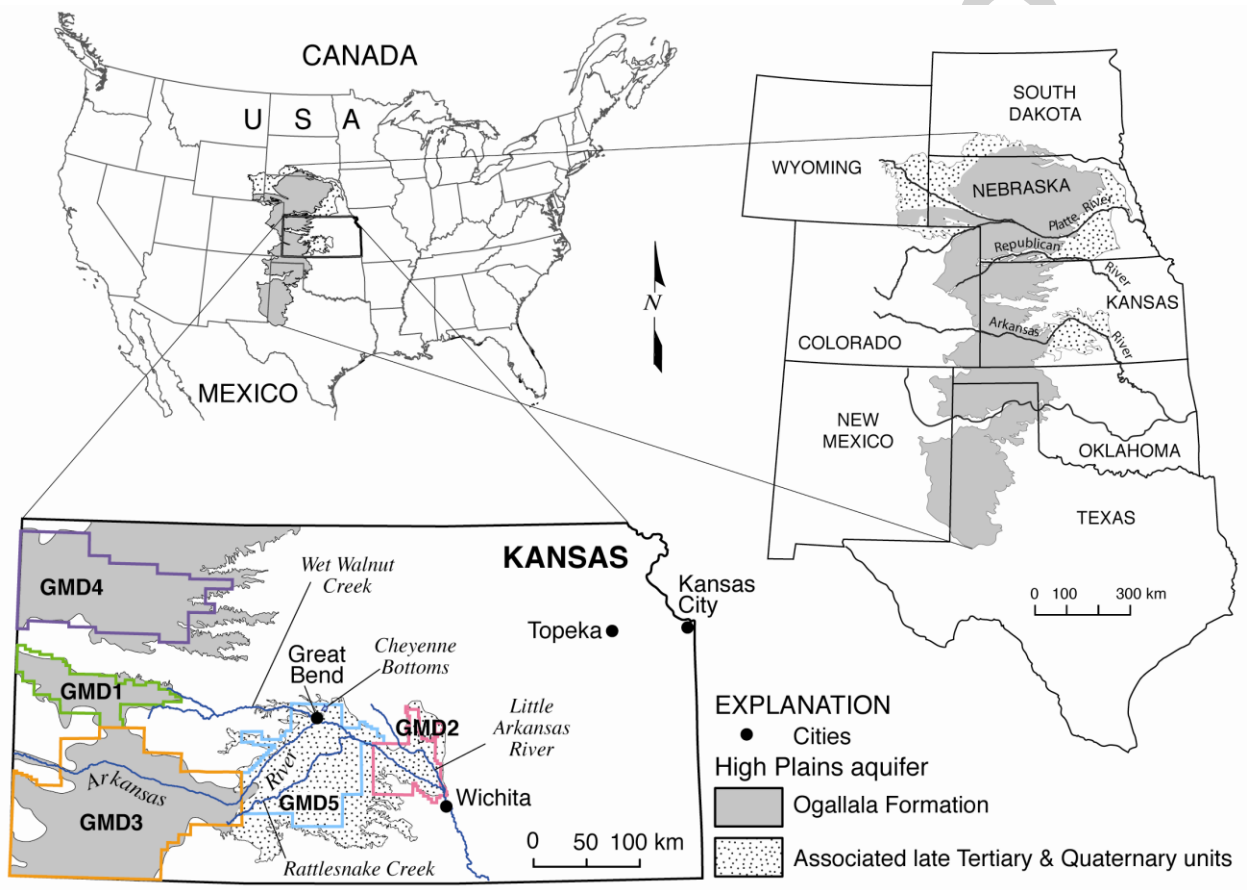
**Estimate deficiencies.** A deficiency under classic cost-benefit analysis in the damage claim approach occurred in the inability to identify any present value on some 400,000 acre feet of groundwater found absent from district aquifer storage. The missing water itself was considered to have no present value as a lost future supply when projected market values (in 50 years) were discounted to present value. The resulting present value of the sizeable missing future supply was determined near zero. But groundwater use has elements of both market and non-market services and product. Monetizing and quantifying the services of groundwater for the district should consider natural intrinsic values that result in groundwater existing in the future and not just consider it a free good. If we only measure groundwater value by its production cost to meet near-term needs, the value will always appear cheap until we get close to depletion or usability depletion, for which we did not protect the resource and the loss of both market and non-market values are evident.

**Usability factor.** All models for economic value estimates employed in the district to date make no assumptions to address water quality change or water usability depletion. Water usability depletion is when normal uses of historical supply is lessened or impaired by a decline in the water quality, causing a material depletion in the useable value of the water. This depletion in water value is influenced by an increase in water and a higher cost necessary to achieve similar value services. For example, membrane filtration water treatment normally required to remove radio-nuclei contaminants not only requires significant energy expense but also eliminates about 15% of the water as waste permeate disposal through deep injection into geological formations.

**Replacement costs.** Replacement cost analysis is another way of valuing stored water inventories in the district and the value benefit of waste reduction costs. With options for alternative sources for supply significantly limited beyond waste reduction activity locally, water importation figures prominently is a key bulk water source that would cause this value analysis

approach likely to result in the highest value estimates. More study of alternatives and partnering with energy management projects are needed.

**Energy cost to pump water.** It takes a great deal of energy to heat, treat, pump or move water. Groundwater pumping in the district uses a great deal of energy. Total energy required to pump groundwater from thousands of individual groundwater wells across the district is estimated at _____ gigawatt hours, putting all energy needs in terms of electricity. Actual energy use includes Natural Gas, Propane, and Diesel fuel sources.




KGS Map of the Ogallala/High Plains aquifer. Many recent maps can be found in the Kansas Geological Survey High Plains Aquifer Atlas, at: http://www.kgs.ku.edu/HighPlains/HPA_Atlas/

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## Ogallala/High Plains Aquifer Characteristics

The Ogallala/High Plains Aquifer consists mainly of a heterogeneous assortment of sand, gravel, silt, and clay of Tertiary and Quaternary age that were deposited by sluggish streams that flowed eastward from the Rocky Mountains. The aquifer sediments overlie an eroded bedrock surface of Permian and Cretaceous age. The Tertiary Ogallala Formation makes up the main part of the aquifer, though aquifer dewatering is creating more semi-confined behavior of the aquifer in the district. The Ogallala Formation is a coarse-grained unit that is highly productive from water-saturated intervals. The oldest part of the Miocene Ogallala Formation in Kansas is ~ 12 million

years old. The older Oligocene deposits (a.k.a. White River Group/High Plains Aquifer, 26 million years or older) are finer grained than the Ogallala, not nearly as productive for water and roughly coincide with the area of the thickest Tertiary deposits in SW Kansas. They also coincide with the area of the greatest water-level declines (from KGS). Because of the similarity in composition, the older Tertiary sediments are difficult to distinguish from the younger Quaternary sediments.

The High Plains Aquifer in the district varies widely in type of material, thickness, and layer continuity. Individual beds generally are not continuous and within short distances may grade laterally or vertically into material of different composition. Hydraulic conductivity and specific yield depend on sediment types and therefore also vary widely both vertically and laterally. Some layers are cemented and are referred to as mortar beds and caliche. Although the aquifer is generally unconfined, confined and semi-confined conditions may occur locally. Thick shale layers are present in areas of the High Plains Aquifer, like in parts of Seward and Meade counties, where significant saturated formation thickness may only provide small amounts of water to wells and the density of wells is very low.

The thickness of the unconsolidated sediments varies greatly due mostly to the uneven bedrock surface. Saturated thickness ranges more than 300 feet as illustrated in the Kansas High Plains Aquifer Atlas (Kansas Geological Survey 2016). The areas of greatest thickness are found in the southern portions of Stevens, Seward, and Meade Counties.

**Groundwater rate of travel.** Regional groundwater flow is generally from west to east at an average rate of about 1 foot per day or less under the normal regional tilt in the static water table. Locally in some areas, a higher rate of groundwater flow can be estimated. Well pumping in the Ogallala aquifer can significantly affect groundwater travel rates where water level gradient is increased near a pumping well and flow can exceed 300 feet per day (KGS). Depth to static water elevation is highly variable and can exceeds 400 feet in the district.

In some areas, such as the Arkansas and Cimarron River corridors, the High Plains Aquifer is hydraulically connected to overlying alluvium. In the case of the Arkansas and upper Cimarron River corridors, the alluvium is differentiated from the Ogallala/High Plains Aquifer on the basis of the greater permeability of the alluvium and underlying lower permeability zone, which results in differences in water levels between the aquifers. The Ogallala/High Plains Aquifer is also connected to the underlying Lower Cretaceous Dakota Aquifer in some locations.

**Bedrock Aquifer Characteristics**

The Dakota Aquifer system is comprised of sandstones and shale that typically yield much smaller amounts than the yield of wells in the Ogallala/High Plains Aquifer. The Dakota Aquifer underlies and is in hydraulic connection with the Ogallala/ High Plains Aquifer in much of the southern part of GMD3. Additional Dakota Aquifer information can be found at: http://www.kgs.ku.edu/Dakota/vol3/ofr961a/man02.htm.

In the northern part of the district, low permeability shale and chalk overlie and hydraulically isolate the Dakota Aquifer from the overlying High Plains Aquifer. Some wells in northern Finney County may be completed in geologic voids in the Niobrara Chalk formation and are referred to as crack wells that typically produce a good amount of water until the crack or void is

dewatered. For additional geologic information on groundwater formations above the Dakota, see: http://www.kgs.ku.edu/Dakota/vol3/ofr961a/man03.htm

The management program must recognize the rapid change laterally from good hydraulic connection to isolation as for a water rights local source of groundwater supply to be preserved and/or protected. Cretaceous age formations may be absent in the southernmost part of the district where Permian bedrock formations directly underlie the High Plains Aquifer. For additional information with additional study needs, see: http://www.kgs.ku.edu/Publications/Bulletins/IRR8/05_deve.html

The Morrison Formation is a distinctive sequence of Upper Jurassic sedimentary rock providing some water supply in the district that may be included as part of the High Plains Aquifer system where hydrostatically connected. It is composed of mudstone, sandstone, siltstone and limestone and is light gray, greenish gray, or red. The lower sandstones are relics of the rivers and floodplains of the Jurassic period.

The Upper Permian age red beds may contain sandstones with some usable groundwater locally, and may also have water quality concerns that require careful monitoring and management to prevent water usability depletion of fresher groundwater supplies. Further investigation of potential uses of Permian age aquifer water for irrigation can be expensive, and some geological testing and completion of deep wells for irrigation have occurred as shallower sources become depleted and oil and gas production tests indicate some limited deeper water sources are available. Efforts to evaluate the usability, reliability and feasibility of these potential sources together with newer technologies to treat poor quality water from marginal sources to usable standards are necessary as part of the district development and management of additional supply.

**Partnerships with Kansas Corporation Commission and the petroleum industry.** Kansas regulations require the petroleum industry to protect fresh and usable aquifers from contamination by confirming minimum depths for surface casing in a petroleum exploration borehole. The surface casing is a pipe that is inserted into the borehole being drilled during oil or gas exploration and sealed by injecting cement under pressure to fill the space between the casing and the borehole. The primary function of the surface casing in the petroleum industry is to prevent saltwater from entering a usable aquifer from lower zones intersected by the borehole to protect public water supply. But concern can also exists when old wells established when surface casing depths were short or not fully cemented in from top to bottom may allow usable fresh water from an upper formation to flow uncontrolled to a deeper unusable formation. From an example occurrence recently in northeastern Haskell County, additional study is needed to assure the protection of usable district groundwater supply.

Water production and disposal in connection with oil and gas activity typically involves very poor quality water. Some related groundwater management concerns include to protect fresh or usable water supply and to identify ways to better utilize the non-fresh water resources of the district for energy management and added water supply using activities that are technologically and economically feasible. Kansas law requires the state to permit such priority use of poor quality where feasible ahead of authorizing fresh water sources. The successful implementation of this policy supports the district groundwater use culture of conservation under the management program.

**Aquifer Pore Spaces**
In recent years, the issues surrounding geological pore space ownership and/or management rights have been raised across the western US in discussions generally connected to oil and gas operations for carbon capture and sequestration into subsurface geologic formations. Similar questions have also been raised concerning aquifer pore space ownership and management rights in areas of water rights administration, federal reserved water rights, disposal projects of treatment waste and in artificial recharge storage rights of fresh water for later recovery using the owned aquifer formations that include pore space. In Kansas, the geological formations in the subsurface are generally owned by either the surface estate or the mineral estate unless severed by lease, deed or right of way.

**Pore Space Ownership.** The general questions for aquifer formations and artificial use of aquifer pore spaces include: Should aquifer pore space ownership be considered as part of the mineral estate? Should aquifer pore space be owned by the surface estate? Should aquifer pore space be considered part of the bundle of private property rights attached to the surface estate? Are the pore spaces in Kansas aquifers privately owned but publicly supervised in the public interest, as in most rivers, surface water reservoirs, drainage and other water supply concerns? And, are there eminent domain concerns for artificial public use of privately owned aquifer pore spaces that may be subject to takings and due compensation issues as in other public surface water storage projects?

**Pore Space Management.** For the geological formations having both natural and artificial aquifer qualities, the allocation and management of groundwater has been traditionally delegated by congress to the regulation and control of each state. Similarly, for the purpose of the local groundwater management right under the Kansas GMD Act, aquifer pore space management by the district is considered necessarily a part of the right delegated to GMD3 by the Kansas legislature and subject to the management program in the public interest. This is based on the theory that no owner of either the mineral estate or the surface estate should be allowed to hold improvements to the management of water supply in natural water courses, including aquifer pore spaces, for ransom. Connected pore spaces as a natural subsurface water course and/or storage infrastructure provides water supply and management improvement benefits both to the public and to the owner of aquifer formations and pore space so long as the surface estate is not denied access, unless otherwise addressed in private agreement. The right and necessity for the governing body of GMD3 to supervise the natural and the artificial diminishment and/or replenishment of aquifer pore spaces is a critical part of Kansas groundwater management policy and activity in the public interest.

**Precipitation and Groundwater Replenishment.**
The climate of southwestern Kansas is semiarid, characterized by moderate precipitation, low humidity and high evaporation. Annual precipitation increases to the east across the district and typically ranges from 16 to 24 inches. Most of the precipitation falls during the growing season, April through September. Drought conditions can yield as little as 4 inches of annual rainfall. Rainfall variability and drought conditions may be overcome using groundwater. Open water pan evaporation rates average 68 inches annually.

**Recharge.** Potential sources of aquifer recharge or replenishment include precipitation, surface water deep percolation (including the Arkansas and Cimarron Rivers and irrigation ditch areas), return flow from irrigation use, lateral groundwater flow, and flow from adjacent aquifers.

Though some small scale private importation projects occur on the fringes of the district, no large scale water importation sources and projects have yet been developed.

**Aquifer depletion rate.** The rate of depletion of district aquifers generally decreases with increased precipitation. For the High Plains Aquifer, the maximum allowable rate of depletion when new water permits were issued in the district has been 40% in 25 years. Recent figures from the GMD3 groundwater model indicate an overall decline in supply in excess of 30% since pre-development (50 years) conditions. However, that estimate is considered short of actual district High Plains Aquifer depletion.

Local replenishment rates are affected by soil properties, land cover, land use and proximity to . Natural regional replenishment estimates are low, typically less than one inch annually. Recharge may be higher locally, such as beneath river and ditch corridors, irrigated land, and sand dunes. An overall shortage and decline in sufficient recharge is projected to cause billions of dollars in future lost economy. Recent estimates from the Kansas Geological Survey indicate about 800,000 acre-feet net loss occurs annually on average beyond what is returned or replenished through lateral aquifer flow, return flows, and natural groundwater recharge.

**Weather modification.** Management program support of a Western Kansas Weather Modification Program (originally called "Muddy Roads" project) to increase precipitation and suppress hail losses occurred historically each year for counties in the district who elected to participate financially. Recently, all member counties discontinued participation due in large part to budget restrictions and crop insurance risk management coverage addressing potential crop loss. Therefore, GMD3 has suspended weather modification support.

A number of other regions and groundwater management programs around the country continue to operate weather modification programs and new studies to quantify the effectiveness in program operations are ongoing. GMD3 will monitor such programs and study results for consideration in future management program revisions.

**Water Use and Decline.** GMD3 has some of the highest-intensity groundwater use areas in the state and total use in the district is nearly half of total groundwater use annually in Kansas. This water use, combined with low groundwater recharge from rainfall and low inflow from outside the district has created large declines in water storage that will not recover without new sources for aquifer replenishment yet to be developed. **The resulting historical programs for the Ogallala/High Plains Aquifer water supply by GMD3 has been one of controlled decline and distributed demand to manage shared groundwater access under reasonable limits for economic growth.**

However, the Ogallala/High Plains Aquifer remains a highly productive water resource for the people within the district and for Kansas. Technology improvements for use efficiency help improve the value of supply and maintain economy with less water use. It is important to recognize that as use efficiencies and deficit irrigation practices increase, the return flow and recharge amounts to local groundwater decreases without new sources of supply.

Maps, model references and graphics related to wells, water use and water levels are included in the Appendix.

## V. GMD3 PROGRAMS

**Elements of a Groundwater Management Program**

1. Working relationships with local, state and federal regulatory agencies;
2. Harmonizing the purposes of the GMD3 Management Program with state administration of water rights, water planning and groundwater quality protection;
3. Facilitating planned surface water and groundwater conjunctive use operations;
4. Monitoring of groundwater levels and storage inventory;
5. Mitigating conditions of overdraft by encouraging conservation and exploring opportunities for additional sources of supply;
6. Collaborating to achieve a well construction, abandonment, monitoring and plugging program;
7. Development of groundwater replenishment sources;
8. Demonstrating leadership in the construction and operation of groundwater contamination cleanup, recharge, storage, conservation, water recycling, and extraction projects;
9. Identifying and partnering to manage and protect wellhead and recharge areas;
10. Minimizing the migration of contaminated groundwater;
11. Controlling saline water intrusion into fresh groundwater supplies; and,
12. Reviewing water, aquifer and land use plans and coordinating with water and land use planning agencies to harmonize activities with the management program and assess activities which create risk to members and the management program.

To address the 14 water supply problems identified in this management program document and to address other aspects of GMD3 member rights and interests, the following programs are identified.

**GMD3 Water Rights Administration Program**

1. **GMD3 Water Rights Administration Guiding Principles:**

   A. Water supply – Engage members to conserve present water use benefits and support growing the future district usable water supply for the health, safety and welfare of all citizens.

   B. Closed aquifer area supply dedicated to existing water rights – As the Ogallala/High Plains Aquifer has been closed to new water rights, aquifer inventory becomes fully and completely dedicated, except for new domestic use, to existing real property rights owned by district eligible voters.

   C. Drinking water - Safe drinking water is a fundamental necessity of every person and will be considered and managed for future supply by the GMD3 and its partners.

D. Contribution to future supply - An unexercised right to enjoy an acre foot or more of groundwater from a declining aquifer supply in the district that is physically and lawfully divertible from an existing operable well has a present conservation value that GMD3 can recognize as a contribution to future district supply. Alternatively, available groundwater deferred for later use in a subsequent year by an eligible voter may be considered, subject to a consent agreement with the board.

E. Communications - Good and effective communications between GMD3, its members and state and federal regulators are necessary for productive partnerships that implement the management program.

F. Mutual benefits and good will - Encourage all water users and land owners to make decisions, agreements or stipulations affecting their real property water rights that promote mutual benefits and goodwill in the use and conservation of the groundwater supply in the district for a reasonable future period of time.

G. Water right application or plan evaluation - Administrative review of each application or request for a consent order that may adversely affect the groundwater supply to a well (critical well) owned by any GMD3 eligible voter should identify and disclose to the eligible voter the evaluations, basis and considerations of the Chief Engineer, rules implementing the groundwater management program, and what may be needed to satisfy prior rights to the supply today and for a planned future period of time.

2. **GMD3 will review** water right applications and considerations of the Chief Engineer for surface and groundwater and any operating plans for consent agreement with the Chief Engineer affecting supply from within its boundaries to insure compliance with the management program and board policies.

3. **GMD3 will recommend** to the Chief Engineer or other appropriate local, state or federal officials any actions, rules or terms and conditions deemed necessary in consideration of the norms, practices and goals of board governance by right to manage the supply and implement the management program in the public interest.

4. **GMD3 will work with members and the Chief Engineer.** This work is to address uncertainties of water right administration and future supply to achieve a full review and resolution of each set of proposal or complaint concerns, using a 25 year prospective evaluation period. A goal will be to see that resource and water right considerations are made available to potentially affected members along with options for resolving concerns through a facilitated process of consent agreement to be recognized by order of the Chief Engineer. This will occur as needed to secure member water supply, including any needed trigger points, mitigation measures or forbearance agreements that may be negotiated between informed members for added confidence and value in the determination of member real property rights to present and future groundwater supply.

5. **GMD3 will assist in the preparation of applications.** Assistance may be for a permit to appropriate water for beneficial use, for other such water-rights related member project planning and paperwork, but it shall be the responsibility of the proposer to review all such information and to submit same to the Chief Engineer as required by law and as advised by their own independent legal counsel and/or technical expert.

6. **GMD3 will monitor annual water use from within the district.** GMD3 will work with and assist the Chief Engineer in improving the reporting process to correct any deficiencies found necessary to support implementation of the groundwater management program.

7. **GMD3 will provide on-site diversion inspection services to members.** This is appropriate, as installed flowmeters and other devices have been required by order of the GMD3 board and/or adopted by rule of the Chief Engineer since the early 1990s on every non-domestic well in the district to assure measurement services to members can occur and the purposes of the groundwater management program has good information to use.

8. **GMD3 will provide collaboration.** GMD3 will endeavor to work collaboratively with members, the Chief Engineer and other state and federal officials, interests, institutions and authorities on any water rights, water supply or special management planning and program activity which might affect the district supply, members or the management program operations and the public interest.

9. **GMD3 will provide water right consent agreement and rule waiver recommendations.** As local groundwater supply in district managed aquifers decline, the value of usable groundwater will go up. The pressure on water users to seek waivers of rule standards to improve their enjoyment of groundwater supply will also increase. The Board of GMD3 may include the following considerations in their deliberations and recommendations concerning the management program and standards governing groundwater supply.

   A. Municipal and Domestic Drinking Water Supplies.

      Member drinking water supply evaluation and monitoring consensus can be a necessary consideration in any proposal as steps to ensure quality drinking water is available locally for people and animals is recognized as a necessary element of the groundwater management program in the public interest. No modification to historic terms of groundwater use should occur that contributes to unreasonable or unsafe drinking water supply conditions, including deteriorating drinking water quality (Water Usability Depletion).

   B. Maximum Allowable Rate of Aquifer Depletion.

      For groundwater management evaluation purposes, available groundwater supply of the High Plains Aquifer is subject to a maximum allowable rate of depletion not exceed 40% in 25 years as a limit that was adopted by GMD3 on July 12, 1978 and fixed by the Chief Engineer by rule for the district, and calculated by

GMD3 in advising the Chief Engineer in the public interest. This method secures for the public the maximum beneficial use of the natural water supply of the district High Plains Aquifer.

C. Culture of Conservation.

GMD3 member activity promoting present use efficiency while preserving usable groundwater in storage for future supply should receive due consideration for contributing to the GMD3 groundwater management program in the public interest.

Groundwater conservation includes any action or activity that materially improves future groundwater supply from a declining source being used today. Planned or identifiable conservation activity routinely occurs in GMD3 informally, or it can be formally established and enforced in a management plan with corrective controls in a defined groundwater management area (GMA), including an IGUCA, LEMA, special rule area or WCA.

D. Groundwater Conservation Reporting.

GMD3 members with water conservation activities may voluntarily submit annual water conservation reports for their water rights in a manner similar to state water use reports and receive due consideration for contributing to the GMD3 management program in the public interest.

E. Water Right Priority Contribution.

GMD3 member-owners of senior water right interests who stipulate conditions, provide forbearance agreement or otherwise withhold priority against other users in a local source of supply should be recognized as contributing to the mutual benefits and good will considerations of other members and the GMD3 management program in the public interest.

F. Modifying Historical Terms of Groundwater Use.

Changing terms, limitations or conditions of historical groundwater use caries statutorily prescribed considerations that include groundwater management program considerations. GMD3 members seeking modified terms of use through waiver of change policies or negotiated water management plans and include their neighbors, who have reviewed the considerations of the Chief Engineer required under K.S.A. 82a-711 and K.S.A.82a-706b, and who may have reached agreement on what may be needed to satisfy prior rights for 25 years to follow, should be recognized as contributing to the GMD3 management program in the public interest.

G. Economic Use Value.

Managing water as an economic good is an important way of achieving efficient and equitable groundwater use without waste. Plans or proposals that significantly

increase aquifer use value while improving decline rates should be recognized as contributing to the GMD3 management program in the public interest.

H. Alternate Supply Development.

Proposals to conserve High Plains Aquifer water by seeking an economically and technologically feasible lessor quality alternative groundwater source should be recognized as contributing to the GMD3 management program in the public interest.

I. Groundwater Inventory Estimate Improvement.

Information provided by members that improves knowledge of usable supply estimates, including donating geological test well logs and other data, should be recognized as contributing to the GMD3 management program in the public interest.

J. Water Imports and water transportation.

Where the demand for water within the district far exceeds long term groundwater supply, any member pursuit of additional sources of water to supply water needs or for managed aquifer recharge of groundwater supply should be recognized as a critical part of the long-term strategy for securing water services to the district, the state and the region of the United States in the public interest.

**Outreach, Advocacy and Public Education Program**

GMD3 is the groundwater management district established to promote the management, conservation and use of the district groundwater resources and stabilize and improve agribusiness benefits relative to national and world markets for the welfare of southwest Kansas and for all citizens of Kansas. GMD3 has a basic responsibility to represent and inform members on local, statewide, adjoining states and national issues affecting the interests of property owners and water users (members) of the district.

1. Through pro-active involvement and dedication of resources, GMD3 seeks to shape and influence public policy and legislation affecting local groundwater beneficial use and supply, district member interests, and the operations of the district management program to meet water needs for today and for future generations.
2. GMD3 will continue to enhance and expand partnerships and working relationships with key elected and appointed officials to advance Southwest Kansas perspectives on proposed legislation and regulations affecting existing and potential district water resources at both the state and federal levels.
3. Public support will be required in order to achieve the various program goals outlined in this document. GMD3 will expand its efforts to actively engage the public through website and other social media, including a YouTube channel, with a goal of reaching and engaging younger generations of water users and potential public and private partners. On-site project signage, resource education stations, community public water awareness features and water

benefit promotions may be constructed through cooperative leadership assistance from GMD3, with emphasis on the wide dissemination of information.

**State Water Planning Coordination Program**

1. GMD3 will work with the Kansas Water Office, the Kansas Water Authority and each of the two Regional Advisory Committees (RAC's), whose respective areas together generally comprise the district, to add value to committee deliberations and recommendations to the state water planning process and will work to further the implementation of the long term legislative goals and objectives for Kansas water in a manner consistent with the district management program. The Regional Goal Action Plans developed through the state Water Authority planning process will advise the GMD3 board in conducting management program activities.
2. GMD3 will work with the Associated Ditches of Kansas, the RACs, the Kansas Aqueduct Coalition and other local, state, federal and legislative partners to achieve a consistent perspective related to appropriate water planning and compact administration risk matters, including restoring dedicated state funding for studies and evaluations necessary to explore and develop multi-purpose water transfers and assure compact administration purposes.
3. GMD3 will work with RAC members across the state to enhance understanding of any differing perspectives of common water supply interests or concerns across Kansas.
4. GMD3 will work with existing interests in basins having significant low or negative value high flow surface water events that carry water otherwise lost each year from Kansas to set a priority on contingency planning and compact administration risk management to secure a high level of supply protection to meet needs across the state serviceable from water development and transportation projects.
5. GMD3, working through its Renewable Supplies Committee, will support state committees and task force commissions for KDOT/T-Works comprehensive infrastructure planning to include water transportation infrastructure considerations. The renewable supplies committee will recommend to the GMD3 board identified priority activities from the Kansas Water Vision and Kansas Water Plan for enhancing renewable supplies to the district and for Kansas (e.g. January 22, 2018 letter from GMD3 President Kirk Heger to Dr. Dan Devlin, Kansas Water Resources Institute, Tracy Streeter, Kansas Water Office and Gary Harshberger, Chairman, Kansas Water Authority transmitting 23 requested or recommended Water Vision activities).

**Interstate Aquifer Management Coordination Program**

1. Water supply concerns extend beyond district boundaries at the Stateline and court cases under review on issues of interstate aquifer allocation are a reality. GMD3 will work with other local, state and federal partners to improve water management and pursue opportunities for partnerships and communicating in other states under the management program. GMD3 has reached out in providing invitations to state officials in Kansas, Colorado and Oklahoma to encourage discussion of interstate aquifer management improvements for the mutual interests in collaborative groundwater management of each multi-jurisdictional aquifer.

2. Some interstate program coordination activity is reasonable under GMD3 conservation leadership to seek closure of the Arkansas River, the Cimarron River Alluvial Aquifer and the High Plains Aquifer to additional groundwater appropriations across the entire district in the public interest. Groundwater interring the district or other portions of river basins is generally considered underflow. The awareness and protection of underflow supply is an important consideration for partnerships that secure and protect new, existing and future supply, identify potential replenishment sources and for developing multi-state management initiatives.
3. Successful Interstate partnerships to manage the quality and quantity of existing, and new groundwater replenishment and underflow sources should be investigated with reliable data and recognized as contributing to the GMD3 management program in the public interest. Sister state policies that base groundwater management on land ownership may require GMD3 collaboration with land owners in other states to secure management program purposes.

**Models Improvement Program**

Each model of district aquifers and wells, water resources or economy is: a necessary management tool; is a work in progress; and is important to the success of the district groundwater management program. Each is a tool designed to represent a simplified version of reality. The reliability of the tool depends on how well the model approximates field conditions, and extreme events or conditions may be beyond the calibration of a model.

1. GMD3 will work with state and other partners to apply the appropriate resources to use and improve important analytical and numerical models that elevate the district groundwater knowledge base and improve application evaluations and management considerations for GMD3 members and partners. For water rights administration, this may include collaboration with KDA to develop a "BASIC GROUNDWATER HYDROLOGY AND EVALUATION PROCEDURES MANUAL" for GMD3, using examples from the New Mexico Office of the State Engineer. This will provide a framework where analytical tools, such as a Theis calculation, and numerical tools, such as the GMD3 groundwater model, can be properly accessed and considered to the benefit of all concerned.

2. New aquifer information and data provided to GMD3 members and partners, including member testhole contributions and aquifer tests, should be recognized as benefiting model updates and the recalibration of supply and economic models needed for implementing the management program in the public interest.

**Investigations and Research Program**

GMD3 shall maintain an active interest in the following topics in addition to identified goals in chapter V for the district.

1. ***Managed Aquifer Recharge.*** GMD3 will encourage managed aquifer recharge or replenishment through both natural and artificial means as a practice to increase the amount

and/or quality of water that enters a groundwater inventory of the district. Kansas regulations broadly define groundwater as "water located under the surface of the land that is or can be the source of supply for wells, springs, or seeps, or that is held in aquifers or the soil profile" (K.A.R. 28-16-28b(dd)). Although the state has no formal groundwater quality standards, application of the groundwater recharge use to many classified streams is intended to prevent "statistically significant increase[s] in the concentration of any chemical or radiological contaminant or infectious microorganism in groundwater resulting from surface water infiltration or injection" (K.A.R. 28-26-28d(b)(5) and 28-16-28e(c)(5)).

Managed aquifer recharge to unconfined district aquifer pore spaces will allow for the efficient and conjunctive management of surface water, groundwater and reclaimed water sources. This program initiative can maximize storage capacity of district aquifer pore space, improve management of seasonal surplus water supplies, reduce evaporative losses and reduce depletion draw down levels in targeted areas. Managed aquifer recharge projects may include managed natural infiltration areas, infiltration basins, infiltration galleries, vadose zone infiltration wells or aquifer injection wells.

2. ***Water Transfers - Importation*.** Western Kansas and the Great Plains region offers the nation a large food production area which has not yet reached its production potential and is losing established economy as aquifer levels decline. The major limiting factor in preserving and developing this potential is water. Since presently available water supplies are inadequate to fully develop or maintain the area's production potential, water from other areas should be made available if the existing economy is to be preserved or the natural increase of future development is to occur.

   Importation of water from areas of surplus supply seems to be technically feasible if the economic and political aspects of such ventures can be resolved. Some opportunities may exist with pipelines previously used for other purposes and now abandoned are considered as a method of water delivery. Some of the problems are legal in nature and deal with issues such as inter/intra basin transfers. Any significant importation of water for irrigation use will by necessity be a larger scale project and will require the coordination of many water-related entities and authorities to maintain productive partnerships that accomplish the many steps to water transportation and the energy that will be necessary to power water transportation. Other smaller-scale in-state transfers will also take considerable coordination and planning.

   GMD3 shall take a leadership role with partner agencies, organizations and foundations to accomplish the long-range planning and study projects which may become economically feasible under future dollars and which offer potential for the importation of water into southwest Kansas to meet future resource service needs in the district.

3. ***Water Exportation***. The board shall involve itself with any proposed direct exportation of groundwater from the district boundary to any area or location outside the district to insure that all management program purposes are met, and seeking opportunities to meet the needs for present and future water supply in adjoining areas in the public interest. Exported water use may be assessed a higher user fee than for in-district uses or evaluated for net use between imported supply and exported out of state supply.

4. ***Federal Farm Program***. As we look at the farm bill through the lens of the current farm economy, innovation and technology will remain essential for district farmers and ranchers to continue producing more food and fiber with less water. The federal farm bill research and other programs have a significant influence on the implementation of the GMD3 groundwater management programs for district members and partners.

    A. GMD3 will engage farm bill development and implementation along with industry and other partners to guide national funding and program commitments in support of the district groundwater management program.

    B. GMD3 will partner in the work of USDA Agriculture Research Service Ogallala Aquifer Program whose goal is to sustaining rural prosperity across the Southern High Plains and the district in seeking solutions to problems from declining water availability. See: https://www.ars.usda.gov/research/project?accnNo=429690

    C. Water conservation programs like those enveloped in the EQIP program should incentivize and reward water conservation. Using historic water usage only encourages maximizing groundwater usage prior to enrollment, which is contrary to the district Groundwater Management Program. Those who are already working to conserve have a larger burden to achieve the same gains. GMD3 will participate in farm bill partnerships and programs that demonstrate and encourage use of new water conservation, use efficiency technologies and crop varieties that are revolutionizing groundwater management on the High Plains, such as mobile drip irrigation, new soil moisture probes, and other project level sensor and data communications for project water managers to increase resource and economy sustainability.

    D. Risk management is a key influence of the farm bill on the district groundwater management program. Input and potential partnerships with RMA and others should occur to further develop useful risk management products for limited irrigation policy coverage and supported for farms and regions suffering from limited well yields or areas where intensive water management are called for while not forcing unnecessary irrigation in declining groundwater areas.

    E. GMD3 will advocate for flexibility in the use of field level crop bases to encourage crop changes that conserve water use over program elements that economically force members to continue high water use crops to preserve valuable crop bases.

5. ***Brackish water use technology and feasibility.*** Brackish water or briny water is water is more saline than fresh water, but not as much as seawater. It may occur in the district in brackish fossil aquifers or in Arkansas River surface water from Colorado or in Cimarron river flows from the district into Oklahoma. Brackish waters are viewed recently as a potential and viable resources to alleviate water scarcity and overcome water budget deficits for some project uses. Kansas law requires consideration of such water sources during

permitting where technologically and economically feasible. The evaluation of various desalination technologies will be encouraged as one of many options to conserve and manage district surface and groundwater supply.

6. ***Local comprehensive and environmental planning support.*** GMD3 participation and outreach support of planning efforts by local authorities and their targeted interests and control over water related economic development planning and environmental conditions is necessary and desirable to effectively implement the groundwater management program in the public interest. Coordinating with other local government entities provides efficiency of resource governance in support of members and the leadership of cities, counties and special districts affecting GMD3 management to ensure conditions for member health, safety and welfare are maintained.

7. ***Water reuse support.*** Water recycling and reuse projects have been a natural part of water resource management activity for projects in the water short GMD3 environment. Efforts to increase water use value is an important response to dwindling local supplies and increasing water costs and one that can effect local historical return flows that may be an important source for other water rights. GMD3 will encourage and assist in developing feasibility studies and researching water recycling projects as requested by members or when grant opportunities become available to support this management program activity. For example, the City of Garden City recently sought and received a Reclamation funding grant to develop a strategic plan for reuse of effluent water resources in the City and vicinity.

**Data Collection Program**

1. The data collection needs of GMD3 are expected to be very broad as various plans and programs develop into implementation. Data needs will necessarily range from water quantity and water quality issues, to research and investigation needs, to land ownership records and socio-economic and use value needs as necessary to implement the groundwater management program. This could include at any time additional supply, water use, cropping, soils or well and water flowmeter data needed to support improved supply, water use efficiency, conservation efforts and program compliance.

2. GMD3 will improve data collection software and hardware tools for efficient data collection and information mining and maintain communications with various outside data sources, including: a water well and water flowmeter inventory designed to show the location and status of each non-domestic well; installed water flowmeter type and performance reliability data; map based data concerning area groundwater inventories; water quality information that is available or can be collected; a land ownership and mailing list data base for member communications, and enforcement purposes; and climate data for the region that is necessary for any irrigation scheduling programs or research.

3. GMD3 will communicate and cooperate with local, state and federal interests for data exchange and cooperation to accomplish the purposes of district groundwater management in

the public interest. Such cooperative efforts with partner organizations can be an efficient use of GMD3 manpower, technical and financial resources.

**Water Quality Protection Program**

In reference to the problem stated in Chapter V, section 7 & 8, GMD3 shall implement and maintain the following water quality protection activities:

1. ***Existing Pollution Problems.*** Any known pollution problems within the district, or outside of district boundaries that pose a direct threat to groundwater within the district, may be researched and evaluated or re-evaluated by staff. If staff deems it necessary to seek further control measures, whether it be in conjunction with other federal, state or local water-related agencies, or as its sole responsibility, staff will then present its recommendations to the board for consideration of appropriate action.

2. ***Potential Pollution Problems.*** The water quality program goal will be to prevent any future degradation of groundwater quality (water usability depletion) by attempting to identify all potential sources of pollution, and address or mitigate these before they create significant water usability depletion of district groundwater inventory.

3. ***Oil and gas industry monitoring***. GMD3 should consider accessing data on oil and gas activity in the district for staff review of information with appropriate state officials to screen for historically improperly constructed or plugged oil and gas wells that threaten loss of usable groundwater supply.

4. ***General monitoring***. GMD3 could also conduct random visual inspections of oil and gas leases, drilling, completion and plugging operations, feedlots, landfills and other waste dumps, storage facilities for fuels and chemicals, chemigation systems, abandoned or improperly maintained wells and any other agricultural or industrial site that staff considers to have the potential to cause groundwater usability depletion.

5. ***Abandoned water supply wells***. GMD3 may consider working with KDHE in their permitting of temporarily abandoned water wells under the Groundwater Exploration and Protection Act and provide any needed assistance to members for the management of wells to protect both well equities, groundwater usability and on-site public safety.

6. ***Groundwater gage network for Quantity and quality***. GMD3 has developed a district monitoring well network and obtained water samples that were analyzed for contaminants. GMD3 may advance that work to set up a network of observation wells in any area that additional water level and water quality data is needed to support the management program. For example, proposed additional Cimarron River alluvial underflow development adjacent to the district in Colorado may affect the water supply to existing uses in the Cimarron National Grassland in the district as a need for groundwater gaging data in that local source at the Stateline.

## VI. WATER SUPPLY PROBLEMS & ACTIVITIES

In over 500 monthly meetings, the locally elected volunteer Board of Directors of GMD3 has considered identified district water supply problems and the nature and methods of addressing those supply problems with help from professional staff, consultants, state staff and other partners in groundwater management. Even with the significant progress realized in water conservation and efficient use, individual well yields and the number of irrigated fields have declined dramatically in many areas. Reduced pumping rates and unproductive wells are no longer topics of futuristic, academic discussion; these conditions are real and current events in an increasing area of western Kansas. Reduced pumping rates also indiscriminately and adversely impact livestock feeding operations, dairies, ethanol plants, and municipal and industrial users, making it more difficult for them to meet demands for water.

Today, many different forms of plans for water use, conservation and additional supply are proposed or implemented at every level; from a single irrigated field plan, dairy project, public water supply program, and recharge plan, to a district wide action plan or multi-jurisdictional water management activity. This District-wide management program document of the groundwater management governing body contains selected water supply problems and subsequent activities to address them that will require action plans. Activities for action plans are identified in blue font and underlined. Existing program activities are also listed in a General Programs section.

An action matrix for each problem or program activity will have timelines and measurable goals generated for board use as documents separate from this program document to be available at the GMD3 office and posted on the GMD3 website. Any needed local policy, state rule reform, state consent agreement or other instruments of agreement needed to implement elements of the management program will be considered and requested to the appropriate official following the public hearing and final adoption of the revised management program document by the Board of Directors of GMD3.

**Problem 1: Threatened Water-based Economy**

The Chief Engineer of the Kansas Department of Agriculture, Division of Water Resources (Chief Engineer) was statutorily charged to make water available for appropriation in 1956 and the Ogallala/High Plains Aquifer was appropriated beyond a sustainable level prior to the formation of GMD3 (1976). After district formation, demands for local management tools generated a response by the legislature to make recorded water rights mandatory (June 1, 1978). **The resulting historical program for the Ogallala/High Plains Aquifer water supply by GMD3 has been one of controlled decline and distributed demand to manage shared groundwater access for economic growth.**

All Kansans rely heavily on agriculture-based water use occurring within GMD3 to sustain the local and state economy. Irrigated corn and wheat in SW KS contributes more to the Kansas economy than the Gross Regional Product (GRP) of 82 of Kansas's counties and contributes more jobs than 65 of Kansas's counties. This is due in large part to the available affordable groundwater supply. The development of the Ogallala/High Plains Aquifer has secured a reliable supply of food, fuel, and fiber to world markets. Local irrigated grain and forage supplies

and an arid climate have made southwest Kansas an attractive location for livestock and dairy industries. Many Agriculture related industries have located in the district in order to be in close proximity to the benefits and advantages of irrigation and climate, allowing the economy to grow significantly over the past 60 years. So too has the efficient management of project water use grown to produce more economy with less water use. The district economy can be sustained and grow where water flows and is carefully managed.

In recent years, good, creative, local problem-solving folks have concluded the time is ripe to pursue a major water appropriation and transfer project (GMD3 2013 letter to state water planning officials). Their reasoning is based on groundwater modeling of southwest Kansas aquifers, the result of which indicates a grim water supply future unless southwest Kansas gains access to an alternative and sustainable water supply. Very low natural aquifer recharge rates are a given fact and modeling indicates about 50 percent of the two million acre feet used annually in southwest Kansas may be sustainable from natural and return flow sources.

**Delayed action.** There does not appear to be any useful purpose in delaying water transfer action until either the unyielding laws of hydrology naturally reduce water use, or the legal principles of priority and administrative water regulation artificially reduce water use, to achieve a balance in supply. In the end, the wait will seem relatively short, and the inevitable result will be reduced water use that will wither the numbers of farms and substantially reduce the production of economic value and farm commodities. Consequent decimation of local western Kansas economies and communities will follow, which in turn will have a similar adverse impact on the Kansas economy, and national security.

**Capital investment.** A major water transportation project or group of projects must be pursued while production income, property values and the economic system are in place to support the capital investments. The challenge of bringing the additional supply to fruition may be daunting, but the project is no more economically, hydrologically, legally or politically speculative at this initial application stage than the initial challenge that confronted others elsewhere prior to construction of existing water transfer projects that now transfer water for agricultural, municipal, industrial, waterpower and aquifer replenishment uses.

**Economic Growth.** Continued district economic growth is dependent upon having a reliable water supply for irrigation use. Significant declines in the Ogallala/High Plains Aquifer threaten the economic future of the people and equity interests within the district. A 2013 report to the governors economic advisory board by the Kansas Department of Agriculture said that transitioning western Kansas irrigated land to dry land costs the economy nearly $4000 per acre per year in lost economic value. So for example, eliminating aquifer depletion through rapid reductions of pumping limits to safe yield levels could force the transition of a majority of irrigated acres to dry land. Though admittedly extreme, such rapid change would cause economic collapse that would not be in the public interest. A more gradual managed conservation approach is required while other options for replenishing supply to a high level of use and sustainably can be developed. Both conservation of natural sources and development of new sources of supply are considered critical by the GMD3 Board to provide the future water necessary for the district to maintain its role in the Kansas and national economies.

**Water import powers.** The power to construct works for the importation of water into declining groundwater areas by GMD's is a part of state policy, though no major water importation projects have yet been encouraged by state leaders nor constructed by any Kansas GMD. Change is necessary for Kansas in this regard and actions to support this need were identified in the *Vision for the future of water in Kansas* and later by the GMD3 board, who provided a set of renewable supplies actions in a January 2018 electronic letter to the Kansas Water Authority. These actions combine the action items of the state Water Plan with the considerations of the GMD3 as documents separate from this document and in furtherance of the management program in the public interest.

**Action response.** In response to the actions of GMD3 water transportation advocacy in 2013, the US Army Corps of Engineers and the Kansas Water Office conducted a Planning Assistance to States (PAS) grant project to update prior feasibility work from a 1982 water transfer study with financial and participation partnership with GMD3 in 2014. The original 1982 High Plains Study transfer element "B" investigated the feasibility of transferring water from the Missouri River to the High Plains. The results found half again more water available from the Missouri River than in the 1982 study. New information renewed the work to investigate large transfers and GMD3 will continue working with partners to evaluate all potential transfer sources that can offer new economic opportunities and restore ecological services across the state. State-wide water leader conversations were captured in an award winning 45 minute documentary supported by GMD3 entitled *Feast and Famine: Securing Kansas Water Needs* that can be viewed online. See: http://kansasaqueductcoalition.com/

**Lost opportunity cost.** The significant value of water will have its cost effect on Kansas and the district, whether as a lost economic opportunity cost or as an investment cost to secure a new sustainable supply. A study to investigate *The Economic Importance of Water Availability in Kansas* was conducted and released in 2015 by Dr. Tim James and his team at Apparat Analytics, LLC, with assistance from GMD3 and the Kansas Aqueduct Coalition. The study found that in the 50th future year from 2013, the expected annual loss to the Kansas economy due to insufficient water supply may be $18.3 billion, expressed in 2015 dollars. $10.4 billion of this annual Gross State Product loss will be from the district. The GMD3 area used 2,188,548 acre feet of groundwater in base year 2013 and was projected to use 903,726 acre feet in 2062. The projection for the district suggests 10.1% less economy state wide than it would be with sufficient future water supply.

**Fewer Kansas jobs.** The report projects there will be 123,961 fewer jobs than would otherwise be available in the district and $5.3 Billion less wages paid that year. Economic values are estimated based on: Reduced availability of water in GMD3 in 2062; Non-substitutability of water to compensate for the loss; and Non-adaptability of producers and consumers. For these reasons, GMD3 will continue work to extend the existing Ogallala/High Plains Aquifer resource to provide time for adaptations in water use to occur and renewable supplies are identified and considered.

**Interstate authority for water transfers.** The Kansas and Oklahoma Arkansas River basin compact authorizes water transfers from southern Kansas sub-basins subject to other provisions in that agreement, presenting an opportunity to conserve surface water otherwise lost from Kansas each year. Work continues to form an in-state multi-jurisdictional project management

model and to develop multi-interest partnerships across multiple states to organize an investigation of costs and benefits of both in-state transfer options and the consideration for a major water transportation system to manage energy and surface water from eastern sources to western States crossing GMD3.

**Activities for Problem 1: Threatened Water-Based Economy**

1. Explore water storage options for water importation projects.
2. Develop and file at least one application to appropriate excess surface water otherwise lost to Kansas supply for transport, storage and use across the state, with reasonable future milestones for completion of planning, permitting, construction of diversion works and water transfer infrastructure for aquifer and ecological restoration services for GMD3 and all project partners.
3. Work with the Kansas Water Office, state legislators, transportation infrastructure experts and other partners to add water transportation to the list of state water planning and transportation priorities.
4. Develop multi-interest partnerships across multiple states for the consideration for a major water transportation system. Collaborate with members to identify best planning and management practices to meet their water supply needs for a specific time frame.
5. Work with partners to conduct studies and programs that replenish groundwater.
6. Support the development of market based income alternatives to irrigation water use that can preserve project level profitability and sustain funding of government

**Problem 2: Reasonable Economic Limit Well Evaluations.**

The state water right application and review process includes a vitally important set of groundwater management program considerations of water availability, new effects on depleting supply and effects to existing wells. The outcome of application review and impairment investigations can profoundly affect the future success of the groundwater management program and any local benefits from prior groundwater conservation efforts.

It is accepted that the Kansas Water Appropriation Act (WAA) endowed the Chief Engineer with certain statutory duties to grant and protect water rights according to the doctrine of prior appropriation under prescribed considerations. The prescribed considerations include the determination that any estimated effects will not exceed reasonable economic limits. The problem occurs in the lack of criteria for determining where the well evaluation line of an unreasonable economic effect may be crossed within the district.

The Chief Engineer must grant applications for water rights or changes to water rights only if the water is available beyond what is needed to satisfy earlier water rights, and a determination is made at that time whether doing so may result in impairment of existing water rights. With regard to whether a proposed use will impair a use under an existing water right, groundwater impairment includes the unreasonable raising or lowering of the static water level or the unreasonable deterioration of the water quality at the water user's point of diversion beyond a reasonable economic limit (K.S.A.82a-711).

**Reasonable economic limit.** Even though the Kansas statutes do not define what water right impairment is, impairment may result from the adverse impact created by the action proposed in an application or use flexibility plan on points of diversion of other groundwater rights (wells). Excessive future groundwater-level drawdown at a well may adversely affect or prevent the exercise of the groundwater right(s) associated with a well. Therefore, part of the impairment evaluation involves estimating the drawdown at wells in the proximity of a proposed groundwater diversion over time and determinations as to reasonable or unreasonable economic and unreasonable physical draw down. This is important in declining groundwater areas of the district where owners of senior water rights may not tolerate new well effects and file an impairment complaint. The following concepts aid in the discussion and evaluation process and are adapted from *Guidelines for the Assessment of Drawdown Estimates for Water Right Application Processing, New Mexico Office of the State Engineer Hydrology Bureau Report 05-17, May 10, 2017(Tom Morrison, et.al.).*

**Drawdown Allowance.** In a process for review of new proposals affecting water use in the GMD3, preventing any level of new impact on a well is impractical, as this would result in the denial of all applications including those causing relatively small or de minimis impacts. A drawdown allowance is used to define the relatively small impact due to a proposed diversion that may be allowed to occur on wells in which economical and/or physical constraints are exceeded. These will be determined in a separate guidance document or by rule.

Wells in which economic and/or physical constraints are exceeded due to adopted evaluation period criteria are referred to as "critical wells." Wells may become critical due to the use of existing water rights alone or the combined effects of dynamic drawdown, existing uses, and proposed uses if one or more of the drawdown constraints are exceeded. The drawdown allowance can be used as a screening tool to identify wells that require additional evaluation.

**Economical Drawdown Constraint.** The economical drawdown constraint is calculated based on the percent of initial water column that can be lost before the well losses economical viability. In the absence of more reliable data, a value of 70 percent of the initial water column may be assumed as the economical drawdown constraint where from a theoretical (hydraulic) standpoint, it is impractical to pump a well in an unconfined aquifer at a drawdown that exceeds two-thirds of the thickness of the water-bearing formation (Groundwater and Wells, Third Addition, Johnson Screens, 2007, page 429).

**Physical Drawdown Constraint.** Physical hardship is the loss of the required well yield due to excessive water level decline. The physical drawdown constraint is the difference between the depth to the current static water level (or depth to the potentiometric surface) and depth to the lowest practical pumping level (LPPL). The LPPL depends on the availability of well completion information such as the depth and thickness of the water bearing zone or confining unit, pump setting, and screen setting.

For non-domestic wells in an unconfined aquifer, the LPPL may be assumed to be 60 feet above the base of the water column, if the screen interval or pump setting is unknown, unless this assumption is unreasonable. The LPPL for non-domestic wells in a confined bedrock aquifer may be assumed at the base of the upper confining unit unless this assumption is unreasonable (Sterrett, 2007). If the total drawdown extends below the LPPL that well becomes a critical well.

**Domestic wells.** Due to the relatively low volume of water produced by domestic wells, and other construction factors, some wells may be constructed with pumps set within the screen interval or close to the bottom of the well. The LPPL is typically assumed to be 20 feet above the base of the water column for domestic wells unless a different value is supported. At least 20 feet may be necessary to maintain submerged conditions, to allow a pump setting above the bottom to avoid sediment problems, and to allow for dynamic drawdown and other components (length of pump and net positive suction head).

**Graphical pictures of economical and physical well evaluation constraints are provided in four illustrations in the Appendix.**

In a closed aquifer area, any application evaluation process should be consistent with the overall conservation, and economic activities of the management program to avoidable objectionable new or additional groundwater depletion of local sources of supply ("chasing water") while promoting true groundwater conservation and including impairment protection for member real property rights.

**Activities for Problem 2: Reasonable Economic Limit Well Evaluations**

1. Seek clarification on the question of prior appropriation as the basis for state administration of member owned water rights, unless rights are voluntarily relinquished.
2. Establish guidelines for the assessment of aquifer drawdown estimates and reasonable economic limits for the water right application and use flexibility review process to ensure water right changes or new liberties will result in satisfied members for a reasonable future period of time.
3. Limit use rule waivers to areas estimated to not decline in supply by more than 40% in 25 years unless nearby affected prior right owners stipulate terms of agreement.
4. Coordinate with the chief engineer to ensure members potentially affected by a request to the chief engineer are informed of those considerations and the management program considerations for their information and evaluation purposes, and allowed to express any concerns or provide any forbearance agreements that offer regulatory confidence in the public interest.
5. The exception in rule allowing moves less than 300 ft will be revisited to consider well effects and procedure on how concerns of member water rights can be satisfactorily resolved.

**Problem 3: Promoting a Culture of Water Conservation.**

**Groundwater Conservation.** Under the district management program, groundwater conservation includes any action or activity that materially improved or improves the future supply from a declining groundwater source. A key response to the problem of obtaining a culture of conservation is to become aware of local groundwater conditions, review of well and aquifer information and a process to exchange member water concerns. Groundwater conservation is an important source of water for future supply and water conservation activity has been occurring in many forms within the district.

**Local action.** GMD3 initiated management activity in 1976 after significant aquifer development had already occurred and water levels were dropping. The legislature made recorded water rights mandatory June 1, 1978. GMD3 then adopted a revised management program on July 12, 1978 to implement a maximum allowable appropriation standard from potential depletion rates of 40% in 25 years and this so called 40/25 rule was adopted in state rules and consistently applied in most of the subsequent application review process for water rights.

**District calculations.** GMD3 conducted such water availability calculations and informed the Chief Engineer for each application. The Chief Engineer relied upon GMD3 calculations to grant or deny new groundwater rights in the district. Guided by the local right to govern the future of water use in the district, board action and standards for development and maximum allowable depletion rates were determined by GMD3 in the High Plains Aquifer and enforced by the Chief Engineer. This includes recent GMD3 action to close the High Plains Aquifer to new water rights with some small use exception. Those small use exceptions may require review and update to avoid nullifying member conservation efforts.

The GMD3 Board believes both the conservation of existing aquifer supply and the development of renewable surface water sources to recharge aquifer areas are equally key and necessary elements in solving the problem of dwindling water storage and threatened economy in the district.

**Water Conservation leadership.** GMD3 will continue to support and provide leadership for water conservation initiatives in coordination with other local, state and federal partners to extend the groundwater supply inventory of the district. Recent examples include:

Conservation Reserve Enhancement Program (**CREP**) working with many partners to retire water rights and transitions irrigated agriculture on soils unsuitable for dryland farming to native grassland;

Agricultural Water Enhancement Program (**AWEP**) with USDA to transition irrigated acres to dryland agriculture (completed);

Regional Conservation Partnership Program (**RCPP**) with USDA which incentivizes adoption of advanced irrigation water management through telemetry technology, remote soil moisture and flowmeter monitoring;

Conservation Innovation Grant (**CIG**) program with USDA that evaluates mobile drip irrigation with the goal of getting it listed for federal implementation assistance;

System Optimization Review (**SOR**) with DOI-BOR (Reclamation), which evaluated the irrigation ditch systems along the Arkansas River corridor for potential efficiency improvements;

Local Enhanced Management Area (**LEMA**) discussions to consider local mandatory groundwater conservation strategies with corrective controls in priority areas of the district;

Water Conservation Area (**WCA**) considerations to assist members developing reasonable voluntary conservation plans with groundwater decline corrective controls

that are consistent with the groundwater management program and an order from the Chief Engineer;

**Good stewardship**. There are groundwater conservation actions and activities of individual members within the district implemented as a matter of good practice and resource stewardship. Some voluntary water conservation efforts being implemented in the district include:

- No-till farming methods which improve soil moisture retention.
- Crop selection and rotations that require less water than historically needed.
- Improved irrigation system efficiency technology.
- Enrollment in sponsored programs of GMD3, the state and the federal government, such as the Conservation Reserve Enhancement Program (CREP) and Regional Resource Partnership Program (RCPP).
- Local conjunctive management of surface water and groundwater.
- Voluntary conservation, including non-use of wells.
- Reuse of wastewater.
- Use of lessor quality water where economically and technologically feasible.

**Conservation factor.** Informal voluntary groundwater conservation efforts generally go undocumented and there is little standardized data to quantify the extent of water conservation now occurring in GMD3. Of the 3.6 million acre feet of annual rights to the declining district groundwater inventories, generally about 45% is not used for various reasons, including voluntary groundwater conservation activity and depleted aquifer pore spaces that cause diminished well yields. The conservation factor of any water conservation activity requires a separation of inevitable non-use from depleting supply or well performance, from projected supply that otherwise would be consumed.

**Beneficial unused groundwater water rights.** An unexercised right to enjoy groundwater from a declining aquifer supply that is physically and lawfully divertible from an existing operable well has a present conservation value that is beneficial under the management program. Efforts to invest present use value to grow future use value by abstaining from present use is real groundwater conservation under the management program of GMD3. GMD3 recognizes real groundwater conservation, when identified, as a contribution to future district supply in the public interest.

**Conservation Record.** Water right owners or water users that utilize water conservation activities may benefit by documenting them and/or to submit annual water conservation reports as a matter of record to their water rights in a manner similar to state water use reports and make their water conservation a matter of record. This can aid in receiving future due consideration for participation in LEMAs, WCAs, as well as contributing to the GMD3 management program in the public interest.

**Minimum conservation criteria for rule waivers.** GMD3 has set well spacing standards that, among other things, distributes water extraction geographically across aquifer areas. This policy avoids over-concentration of pumping from the more productive aquifer pore space zones to the detriment of prior rights to storage in those pore space zones. To preserve this purpose and to establish water conservation as a necessary consideration in each application or plan proposal

seeking an administrative rule waiver in the district, the GMD3 Board is adopting a minimum conservation standard of reducing local decline rates by one percent per year. This standard will be achieved through board review of public interest consideration for members seeking rule waivers, water conservation plans and other programs and partnerships. This can result in a minimum overall reduction in annual decline by 22% in 25 years. This will achieve a minimum 63% reduction in the current rate of decline in 100 years to help an economy reliant on having a future water supply.

**Deferred Groundwater Use/Aquifer Maintenance Credit/ Water Bank.** Some members see recent water use history governing allocations in conservation programs and are managing their future allocations through more present use accordingly. Groundwater stored in some aquifer pore spaces in the district is considered not available for any new non-domestic appropriations unless offset by existing unused pumping authority. A deferred groundwater use or aquifer maintenance credit programs may provide a tangible incentive to conserve groundwater and counter the fear of diminishing future rights from diminishing present use.

**Special GMA corrective control tools for conservation.**

**Revising Authority.** GMD3 and other Kansas GMD's pursued forming special GMAs for implementing corrective controls in 1977, but found a lack of local and state authority. Local or state permitting of all non-domestic water use was not required in Kansas at that time. The GMD3 Board immediately requested a state moratorium on new rights in problem areas of Kearny and Finney Counties from the state chief engineer to allow work on the over allocated and water short areas.

**IGUCA.** Legislation was successful in 1978 to gain state required permitting of water use and to get authority for GMD's or a group of members to initiate corrective controls in a special Groundwater Management Area (GMA) as a request Chief Engineer shall conduct to form an IGUCA. The IGUCA tool in a GMD, once requested, involves a prescribed review process that includes conducting one or more public hearings for a fact finding process and an order for corrective controls as guided by the GMD right to manage, as a matter of public interest. This tool was extended by the legislature for the chief engineer to initiate under his own investigation in areas outside of GMD's. A number of IGUCA management plans have been ordered to implement mandatory corrective controls onto water rights in designated areas across the state.

**LEMA.** After a decade of development work by Northwest Kansas GMD4, the Legislature added a GMA tool in 2012 to assist GMDs in the problem of achieving a culture of conservation by providing institutional structure for LEMA plans to be developed and requested locally by a GMD board for investigation, orders and enforcement by the state. Such conservation plans can add temporary or permanent voluntary or imposed corrective controls onto existing water rights in a designated area as deemed necessary by the governing body of the district.

A LEMA empowers local leaders to address local groundwater concerns without added outside controls. Local water right owners and other members of GMD3 can come together to seek ways to reduce the rate of groundwater decline in their region. The GMD3 board has the authority to adopt a plan and seek formation of a LEMA as a recommendation to the chief engineer who must consider only the LEMA plan for adoption without altering it or applying other constraints

onto it. Volunteer consent agreements for which GMD3 is not a party does not limit a GMD3 LEMA plan based on LEMA law.

**Board LEMA guidance.** GMD3 adopted a policy that a LEMA management plan proposal should be recommended to the GMD3 board by members as a priority GMA to be further managed with infrastructure development and/or corrective controls in the public interest. Basic steps for establishing a GMD3 LEMA involve formulation of a plan generally accepted by area members, presentation of the plan to the Board, Board adoption of the proposed plan, Board request for a LEMA to the Chief Engineer, two prescribed public hearings considering the proposed plan, and a decision order of the Chief Engineer approving, returning, or rejecting the LEMA.

**LEMA Plan.** A LEMA plan presented to the board for adoption shall include: 1) A clear groundwater management goal; 2) A basis for the proposed boundaries; 3) Evidence in the record of plan development that multiple alternatives were formulated for setting added groundwater controls on member water rights, including use of the principle of prior appropriation; 4) Reasoning for the use or rejection of each alternative; and, 5) The recommended strategy for determining the will of the eligible voters of the district having property rights within the proposed LEMA boundary.

GMD3 staff will support the development of LEMAs by members and will coordinate with other local, state, federal interests, organizations and authorities to consider impacts and assistance for members to achieve the goals, including evaluating effects on present and future property valuations and economy in the public interest.

**Special Rule Areas.** A GMA with special groundwater management concerns may be identified by management program activity and requested administrative rules to address unique groundwater management concerns. These may be quantity, quality or use practice concerns that require administrative tolerance standards to manage efficient groundwater use and protect useable supply in the public interest. An example of this is the provision in a GMD3 rule of the Chief Engineer (K.A.R. 5-23-4(c)) for a water quality control area in parts of Seward and Meade Counties. The potential for upwelling of naturally occurring saltwater in Permian Age formations to up-well into the overlying connected Ogallala Aquifer formation threatens district water supply usability and impairment of water user rights and supply.

**WCA.** In 2015, the Legislature provided for water right owners statewide to develop their own formal Water Conservation Area (WCA) to facilitate documenting voluntary conservation efforts. State offices worked with the legislature and stakeholders to create a negotiation process of forming a WCA for voluntarily agreed-upon management plans between water users or groups of water users and the state Chief Engineer.

**WCA Private Agreements.** A consent agreement for a WCA becomes a consent order of the Chief Engineer and is not considered a water right or a permit, though subject to all Kansas water laws and rules. WCAs are intended to implement corrective controls as a voluntarily plan that does not alter the base water right(s). The WCA law also allows for flexibility in exchange for conservation, provided that existing water rights and the right of GMD3 to conduct the management program are protected. A consent agreement ordered for a WCA effectively sets aside the area water rights in deference to negotiated terms that must be carefully evaluated

ahead of the order to insure any flexibilities for pumping wells will not have any adverse effects on other members water rights.

**Reserved right to manage.** Because a private negotiation process to form a voluntarily agreed-upon management plan and WCA is between water users or groups of water users and the Chief Engineer, such agreements are not binding to a non-party of the agreement. For example, any WCA plan and order of the Chief Engineer that may contain agreed to groundwater use credits or allocation benefit should the GMD3 adopt a future LEMA plan or other GMD3 management action is not binding on GMD3 unless it is a party to an agreement. Any actions or plans of the district governing body to adopt a future LEMA plan is the sole discretion of the governing body reserved here under the right to manage as a matter of state policy.

Through board resolution 2017-2 and notice to the Chief Engineer, GMD3 has requested promulgation of the rules required to implement the WCA law. For more state information on the program, see: http://agriculture.ks.gov/divisions-programs/dwr/managing-kansas-water-resources/wca

**Supplemental wells.** Prohibiting the addition of wells to water rights or proposed plan flexibilities between wells that are for the purpose of restoring groundwater extraction capacity has historically been a board groundwater management policy concern and a culture of conservation element of the management program in declining groundwater areas. Additional wells or moving wells or allocations to restore extraction capacity require carful evaluations to preserve conservation efforts and limit adverse economic effects.

**Surface water management for groundwater conservation.** The significant demand annually for water and the tens of millions of acre feet of available aquifer storage space available to store additional supplies in the district to meet future water needs in Kansas. Nearly eight time the annual amount of groundwater used today in Kansas leaves the state as river flow annually. So, the conservation and management of available surface water presents a need to evaluate and develop the leadership needed to find the opportunities as an integral part of the groundwater management program activities for the district and for Kansas. Available surface water is a limited time offer that should be managed as a preferred supply over groundwater to meet demand and to replenish groundwater inventories before it is lost out of state, unless water quality, flow event details and infrastructure circumstance dictate otherwise.

**Growing the market for conservation.** Growing the culture of conservation involves a strategy of reaching out to specific demographic or industry groups and locales, which have comparatively low rates of participation and engagement around water conservation and efficiency. As more members participate, vendors can develop economies of scale and more cost-effectively run active and passive programs. "Expanding the tent" naturally increases programs' impact, as participation rates increase across the district. While programs might lose their potential for scale as more members participate, the proportion of the population engaged increases.

**Changing Institution and Social Norms.** Market forces of necessity ultimately drive change. But activity to change social norms can help cultivate to a community of expectations around active participation in water conservation and efficiency. Such norms will allow greater participation in rebates and incentive programs regardless of the cost. They will also lead to

higher impact numbers across the board as members engage due to a common understanding of the importance of water use. Much like in growing the market for conservation, changing social norms will lead to an increase in the proportion of district members reached.

**Education.** A key response to the problem of obtaining a culture of water conservation is awareness of district hydrology, review of information and the exchange of member water interests and concerns. River system and onsite water management tools will be explored with members, supported by local, state and federal partners. More administrative consideration can be provided during each surface water and groundwater related project proposal review to inform members and non-members in management program considerations of water supply and water service outlook. Additional description of this issue and proposed activities are provided under Problem 11 – Pubic Education and Involvement.

**Activities for Problem 3: Promoting a Culture of Water Conservation**

1. Facilitate and support member development of LEMA proposals.
2. Support water right corrective controls and other activities to establish decline rates and seek to slow aquifer decline rates locally by a minimum of 1% per year.
3. Implement a "Master Irrigator" style program of onsite water management and conservation education with federal partners through USDA and other supporting partners as piloted by the North Texas Groundwater Conservation District.
4. Develop a voluntary tool for user documented annual water conservation reporting.
5. Promote and cooperate on water re-use projects.
6. Work with partners to promote use efficiency through new technologies.
7. Coordinate with the KDA-DWR in the development of rules and regulations for the WCA program to ensure implementation achieves water use reduction and flexibilities do not adversely impact neighboring use or aquifer conditions.
8. Work with partners to limit use of special permits that may offset conservation benefits.
9. Develop a Deferred Groundwater Use/Aquifer Maintenance Credit program within the district to defer groundwater use, encourage real water conservation and mitigate the fear of diminishing rights from diminishing use.

**Problem 4: New Water Use Flexibility in Depleting Aquifer Areas**

As water levels drop, concerns rise in GMD3 over the effects of changing well pumping limits and the potential for adverse impacts on future supplies of existing property rights. A process for the evaluation of reasonable economic and physical constraints is considered in problem No. 2 and described briefly for GMA review in problem No. 3. Each groundwater use plan that is not based solely on the prior appropriation doctrine must, by state groundwater management policy, provide deference to the right of GMD3 to determine the destiny of the groundwater use under the district management program in order to be consistent with public interest, as described in Problem No. 14.

**Adding pumping pressure under flexible use.** For declining aquifer areas, new use flexibility of base water right conditions between wells is a situation that presents a significant potential for objections from neighboring water right owners and risk that no real conservation is achieved. For example, if less groundwater is pumped, and less return flow and recharge occurs, the net

effect locally can be no real water conservation. The management program activities seek to assure that real conservation occurs as defined in problem No. 3 for special GMAs that require corrective controls, and to limit the occurrence of "paper authority" on poor wells (incapable of providing the water) moving to remaining good wells (a concept termed "chasing water" to the bottom) in a manner that results in no conservation and/or the addition of physical well hardships. New use flexibility may provide a net increase in water supply to the plan owner(s) if adequate evaluation of expected use and decline rates occur.

**Tradeoffs.** The challenges include sufficiency of the tradeoffs for net future supply improvements. For example, the potential new groundwater utilization provisions in the statewide WCA law for a plan and WCA order of the Chief Engineer presents similar groundwater management concerns as did the permit policies and practices of Kansas before the GMD Act that resulted in inadequate review standards and rapid groundwater depletion rates.

**Adding local management limits.** As an example of this concern, the state-wide WCA law limitations include that a WCA management plan may allow, in any given calendar year, the water use of an individual water right or rights to exceed the annual quantity limit of the base water right or rights participating in the management plan, provided the water use not exceed the total annual authorized aggregate quantity and rate of all the water rights participating in the management plan in any given year. For GMD3 depleting aquifer areas, this WCA limitation is no real limitation and not adequate by itself to meet the needs of the public interest under the management program. Careful evaluation procedures are needed for new use flexibilities proposed in any special GMA in GMD3.

**Activities for Problem 4: New Water Use Flexibility in Depleting Aquifer Areas**

1. Develop the evaluations under Problem Number 2.
2. Ensure that all neighboring water right holders whose wells may be adversely affected by a plan are notified of each proposed change to aquifer use liberties.
3. Establish standards for evaluating plans for true conservation and other corrective controls.
4. Ensure members are provided all chief engineer and management program considerations ahead of GMD3 and state decisions to give opportunity for members to learn, express concerns and provide any needed concerns or agreements, terms, limitations or conditions to be consistent with the management program.
5. Seek rules needed to implement WCA law consistent with other state water policy, including the GMD Act and the GMD3 management program.

**Problem 5: Improving On-Site Water Management**

On-site project water management begins with the management of preventable waste of water. Managing preventable waste of water is to a certain extent a reduction in return flows and a reduction of evaporative waste. Management of preventable waste is changing as the implementation of new technologies move the standards for considered reasonable losses for various water projects. Soon after becoming incorporated, GMD3 became the primary agency responsible for setting a standard in curtailing waste of water violations, and now sharing this activity with DWR. A corrective course of action is normally established on the same day a waste of water complaint is received, if waste is determined.

**Chief Engineer ordered conservation plans.** GMD3 assisted in implementing state mandated water right water conservation plans to encourage that producers can obtain better management and find opportunity for decreasing water use and avoid waste. Nearly 2000 such plans are in force for water projects in the district. GMD3 also became the first groundwater management entity in Kansas to mandate the installation of water flowmeters on all non-domestic wells in 1992. The flowmeter program became fully implemented with all flowmeters installed by 1996. Seeing a need for increased enforcement of flowmeter requirements, the Board of Directors increased flowmeter service inspections by over 200% during 2002 without increasing funding.

**Flowmeters.** Flowmeter verification test data gathered by GMD3 indicates in total, the installed flowmeters over-record actual groundwater diversion by a percent or two. Based on this data, flowmeter data from the district may indicate some 20,000 to 40,000 acre feet of groundwater use is over measured on average annually. On-site results can vary significantly depending on many hydraulic and meter maintenance variables. New sensor and data access technologies are providing new conservation and water management opportunities.

**Enforcement.** The enforcement of local, state and federal permits, water rights administration and sanctions on district members are a part of the groundwater management program and require significant communication and coordinating of data. GMD3 has supported or provided leadership while working with partner officials on various initiatives to improve resource data, environmental planning and water right compliance, such as: mandatory flowmeters; flowmeter verification tests; mandated water conservation plan compliance audits; groundwater use monitoring; requesting appropriate sanctions to include future water allotment reductions for violations of water right limits; irrigation place of use compliance audits and a memorandum of understanding with the Chief Engineer to provide certain change compliance monitoring. GMD3 works with members, the Chief Engineer and other officials to enforce groundwater use controls and to ensure appropriate enforcement policies are implemented in a fare manner between members consistent with the purposes of the management program.

**Activities for Problem 5: Improve On-Site Water Management**

1. Visit and perform an inspection of 25% of all non-domestic flowmeter sites and/or wells within GMD3 each year with appropriate compliance follow-up as needed.
2. Promote on-site technology implementation to encourage active project level management of Tomorrows Aquifer Supply Collaborative (TASC) with neighbors.
3. Perform flowmeter verification tests.
4. Conduct water level and water quality measurements.
5. Provide GMD3 enforcement assistance to further implement the management program.
6. Represent the GMD3 information properly through effective coordination and communications during enforcement sanctions issued to members.

**Problem 6: Arkansas River IGUCA and the GMD3 management program**

GMD3 pursued forming a special groundwater management area (GMA) for corrective controls in 1977 and found a lack of local and state authority to do so. The GMD3 Board immediately requested a state moratorium on new well permits in parts of Kearny and Finney Counties for

work to gaining authority for corrective controls for the over allocation of the available water resources problem in that area and avoid additional water right development of deficit supplies.

**IGUCA request.** Legislation was successful the following year in 1978 to gain authority for initiating corrective controls through a discovery process of the Chief Engineer. The Arkansas River IGUCA was requested by the GMD3 board in 1984 to replace the 1977 moratorium and to extend corrective controls from the Colorado and Kansas Stateline along the river corridor all across GMD3. The Upper Arkansas River IGUCA was ultimately formed after significant public process, testimony and recommendations of the board and members and an order of the Chief Engineer was issued in the public interest. See map of the IGUCA area in the Appendix. Additional state information on the Upper Arkansas River IGUCA is available at: http://agriculture.ks.gov/divisions-programs/dwr/managing-kansas-water-resources/intensive-groundwater-use-control-areas/arkansas-iguca

**IGUCA review and modification.** As of this management program revision, the Arkansas River IGUCA area within GMD3 today affectively carries only one remaining restriction not already superseded by districtwide program rules: a restriction on relocating wells that may decrease the distance to the river channel by more than ten percent (10%). Several modifications have occurred in response to new water law as interpreted by the Chief Engineer without benefit of public process or GMD3 recommendations.

The GMD Act (K.S.A. 82a-1036) sets criteria for the Chief Engineer to act on his own authority for IGUCAs outside of GMDs. It is well established that one or more of those circumstances now exist across the entire GMD3 area. To remain consistent with the right granted to GMD3 and the purposes of state policy in the GMD Act, any revision or formal review of intensive groundwater use control area orders affecting the Arkansas River IGUCA controls in the district include the recommendations of the groundwater management program governing body.

**Activities for Problem 6: Arkansas River IGUCA**

1. Establish the river channel area within GMD3 as a Critical Aquifer Replenishment Area through partnerships, signage, and program guidelines.
2. Review and evaluate provisions of the Arkansas River IGUCA in the context of the GMD3 management program and identify needed revisions or elimination.
3. GMD3 will work with all administrative authorities on IGUCA issues as the originator of the IGUCA request and governance of the groundwater management program.

**Problem 7: Arkansas River Corridor Management.**

**Land ownership and management.** The problems of managing water in the upper reach of the Arkansas River corridor in Kansas historically may be due in part to the lack of delegation by the Kansas legislature to any person or office, local or state, to manage the state owned land in title as a navigable stream defined and conveyed to the state by the federal government at the time of statehood; a federal doctrine called "navigability for title." This doctrine of law holds that if a waterway was used for commercial activity at the point of statehood, the state received ownership of the stream bed and banks as owner in title, and this ownership is intertwined

together with the history of river flow in the basin. The navigable stream considerations for property boundaries and easements in the district are important for resource and infrastructure improvements under the groundwater management program.

**Property boundaries.** Proper boundary determination involve the history of water resources development in Colorado and Kansas and these areas significantly influence periodic determinations in Kansas of the bed and banks up to the "normal high water mark" by the Secretary of state and other officials, or for County river maintenance lines after high flow events that were approved by the Chief Engineer. A commonly accepted set of administrative boundaries is needed for water and other natural resources management, including flood control.

**Resource degradation.** Over time, the occurrence of reservoir storage and re-regulation of river flows in the Arkansas River basin, direct diversion development, groundwater development and water use efficiency changes in the basin have caused fewer and less intense rain runoff flows, river banks to narrow, diminished beneficial recharge to adjacent aquifers, cottonwoods and tamarisk salt cedar to proliferate and water quality to decline; all of these are problems throughout the basin. In Kansas, the "navigable stream" status of the river system complicates property boundaries, resource degradation and groundwater management issues, recognizing that one can't manage or protect what one cannot define. There are mounting water management and supply concerns all along the basin. Opportunities exist for collaborative initiatives to provide management assistance in the district that can address a number of groundwater management related problems, including drainage and flood protection, storage, recharge, surface water and other problems.

**ARCA.** After half a century of water management disputes and litigation between Kansas and Colorado entities over Arkansas River basin water development activity, a compact was formed between the two states and ratified by congress in 1949. The Arkansas River Compact Administration (ARCA) formed under that compact agreement provides an interstate forum of resource management. The compact agreement is both state and federal law in both states, and factors heavily in the management considerations of the Arkansas River corridor in the district. The portion of the river basin included in compact development and administration applies to the entire basin from headwaters near Leadville, Colorado, down basin to below Dodge City, Kansas. There are no significant surface water tributaries to the river below the Stateline in the district. See compact map in the Appendix.

Some of the water management concerns that influenced the two states to enter into a compact agreement also influenced the adoption of the GMD Act in Kansas in 1972 and the formation of GMD3 in 1976. Immediate action was taken by GMD3, working with local and state partners to address special GMA needs as discussed earlier in Problem No. 3 and Problem No. 5. Significant additional need and opportunity exists for GMD3 to continue collaborative work with other local, state and federal interests, institutions and authorities to address the unique water resource needs of Arkansas River basin water management concerns within GMD3 and upstream of the district that affect water supply under the management program.

**GMD3 Upper Ark GMA.** The portion of the basin above Garden City to the Colorado and Kansas Stateline, including the IGUCA, ditch service area and tributary underflow, is considered the GMD3 Upper Ark GMA for the purposes of the district management program. For this area,

local runoff events upstream, reservoir deliveries and historical return flows from irrigation water use and other activities upstream generally maintain river flow year round to a point near the Kearny–Finney County line above Garden City. The problems of river sediment accumulation and poor water quality occur in this river reach.

**Upstream reservoir development.** The loss of historically large spring freshet flows that flushed the river system down the basin has left few options for affordable local solutions to river basin problems under a highly regulated river flow regime. Sediment load transported to points of river flow delivery and diversion cause accumulation of river sediment load that fills the floodway, increases flood risk and restrict surface water diversion and operating capacity of distribution systems. The river's poor water quality also creates water usability depletion of the water resources of the GMA, affecting the fertility of soils receiving irrigation water within river water delivery areas and in adjacent groundwater use areas. Under such conditions, land valuation is diminished and water quality threatens public health and the health of the local economy.

**Water Quality in the GMD3 Upper Ark GMA.** Arkansas River basin Stateline flow entering the state and district as High Plains Aquifer underflow is generally of good quality. However, water entering the state in the Arkansas River basin river corridor is high in contaminants, including sulfate salinity and uranium. In addition to concerns of other contaminants, high radio nuclei levels have a significant effect on water treatment costs to restore water usability for public water supply and other systems. Estimates from the Kansas Geological Survey of the weight of uranium coming into Kansas annually from Colorado via the Arkansas River are concerning.

| Year | Annual uranium load, metric ton/yr | Annual uranium load, ton/yr | Annual uranium load, lbs/yr |
|---|---|---|---|
| 2012 | 1.80 | 1.98 | 3,960 |
| 2013 | 1.61 | 1.78 | 3,560 |
| 2014 | 3.77 | 4.15 | 8,300 |
| 2015 | 6.01 | 6.63 | 13,260 |
| 2016 | 7.47 | 8.23 | 16,460 |
| 2017 | 9.10 | 10.03 | 20,050 |

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This low water quality replenishes and contaminates the Ogallala Aquifer through infiltration of river flow and deep percolation from the river bed and ditch service areas. The saline nature of the water reduces its usability and reduces crop yields. Mitigation efforts are employed to dilute the river water with fresher local groundwater in the ditch service areas. The declining surface water and groundwater quality also greatly increases the operation and maintenance cost of irrigation systems due to its corrosive effects on water diversion works.

**Public drinking water supplies.** Within GMD3, the cities of Lakin, Deerfield, Holcomb and Garden City have experienced a decline in water quality due to infiltration of river water near their city well fields. District member City of Lakin recently had to construct a nanofiltration water treatment facility at great local expense to get their drinking water within the Environmental Protection Agency's (EPA) maximum contaminant limit (MCL) for uranium. The

community must now bear an ongoing water usability depletion cost of millions of dollars. The water extracted from the Deerfield and Holcomb wellfields has been within safe drinking water standards. However, it has been deteriorating and water usability is depleting. Those cities will have to develop a treatment or alternate solution in the future.

**Reclamation partner study.** GMD3 worked with the US Department of Interior, Bureau of Reclamation (Reclamation) and Kansas Water Office to evaluate public water sources in the river basin above Garden City to help plan for the future, considering the deteriorating water quality and declining aquifer levels. The 2012 study included the cities of Coolidge, Syracuse, Kendall, Lakin, Deerfield, and Holcomb to identify possible solutions, including construction of new facilities, infrastructure, and collaboration efforts. The 2012 study identified need for added study and identified local potential options for future public drinking water supply. GMD3 remains committed to monitoring the river water quality and to seek collaborative programs and practices that can address the declining usability of river flow and adjacent aquifer degradation in the basin to assist affected communities and individuals in mitigating water usability depletion in the Arkansas River basin.

**Vested Surface Water Rights.** Due in large part to a highly variable and routinely water short Arkansas River flow within the GMD3 Upper Ark GMA, Kansas conservatively determined the 1880's vintage surface water vested rights of the 6 remaining ditch companies above Garden City under the 1945 Water Appropriation Act; generally basing the annual quantity limit of each to just two acre feet per acre of land serviced, rather than based on the annual diversion records demonstrating vested supply needed from the river. Little, if any allowance appears to have been provided for historical transit losses during normal ditch system operations. The conservatively determined vested right limits have resulted in ditch supply deficiencies at times when more abundant river flows have occurred and demands for irrigation water were not satisfied in the ditch service areas.

**Lake McKinney.** An exception to the conservative vested right determinations based only on acres irrigated involved a ditch system with an off-channel privately owned storage reservoir known as Lake McKinney near Lakin, Kansas. Records indicate the past reservoir storage at one time was over 30,000 acre feet and stretched for nearly 7 miles. At the time of vested right determination for the associated ditch system, all water deliveries had to pass through the lake, and loss needs associated with Lake McKinney operations factored into the determination of the vested right. The capacity of Lake McKinney has since been significantly reduced due in large part to declining available river flows in the 1970s and improvements to facility infrastructure that have increased operating efficiencies. Lake McKinney remains an important local groundwater management feature as deep percolation losses aid in replenishing area groundwater supplies.

**Shared supply shortage.** The method of surface water vested right determinations in the GMD3 Upper Ark GMA has been useful in management work to share the shortage of a water short river flow supply in the Kansas portion of the basin. However, it remains a significant management problem in the conjunctive use of available surface water and groundwater within the areas of the irrigation ditch companies, whose patrons are also groundwater users and members of GMD3.

**Wet river condition.** Ditch companies in the GMD3 Upper Ark GMA have been permitted for up to an additional acre foot per acre under wet river system conditions only under certain terms that by practice have included a minimum flow at Garden City and Dodge City and no overall increase in determined ditch rights. This occurred due in part recognizing the historical cumulative ditch diversions under wet river conditions that occurred while also providing supply to other vested and pre-compact water rights below Garden City.

**GMD3 Lower Ark GMA.**

The river reach below Garden City and adjacent areas of the IGUCA is considered the GMD3 lower Ark GMA under the GMD3 management program. River flow at the Garden City USGS river gage is now a rare occurrence beyond local public infrastructure discharge. Groundwater development and loss of surface flows that replenished adjacent aquifer supplies occurred prior to the formation of GMD3, making it necessary to employ groundwater management activities immediately upon the formation of GMD3 to mitigate problems, limit additional appropriations and the relocating of wells closer to the river channel.

**Lost flushing river flows.** Over time, the GMD3 Lower Ark GMA river reach has lost the seasonal flushing flows from upstream spring runoff events and groundwater development has nearly eliminated aquifer losses to the river between Garden City and Dodge City. The rare river flow event that does occur now deep percolates into adjacent aquifers as critical aquifer recharge storage. The lack of river flow also creates similar land management and flood protection problems as in the GMD3 Upper Ark GMA.

There are existing vested rights (pre-1945) and pre-compact (1949) water rights in the portion of the Arkansas River IGUCA between Garden City and Dodge City that are authorized a cumulative rate of diversion of more than 200 cubic feet per second (CFS). Since the formation of the district, only a few large extended river flow events have occurred in the reach of the GMD3 Lower Ark River GMA to Dodge City to supply those demands. In an attempt to meet pre-compact water supply needs in both the GMD3 Upper and Lower Ark GMAs, state permits have authorized up to an additional acre foot per acre for existing surface water ditch company irrigated acreage in the GMD3 Upper Ark GMA without exceeding the total authorized amount of all vested water rights of said irrigation ditch companies, and only when 200 CFS average flow is measured at Garden City and continuous river flow is measured to the Dodge City river gage. This GMD3 Lower Ark GMA 200 CFS flow criteria at Garden City can be used to assure that a river flow supply will be provided to pre-compact water rights in the GMD3 Lower Ark GMA when such rare river flows

**Garden City river gage criteria:** a pre-compact supply minimum for considering Kansas ditch system use flexibility and post compact use or storage in Colorado. A pre-compact supply minimum for considering surface water diversion flexibility Kansas Associated Ditch system and any post compact use or storage enhancements in Colorado 200 CFS average daily flow at Garden City and continuous flow to Dodge City river condition (GC200 to DC Condition) is considered a reasonable standard practiced recognized by GMD3 for management program planning and for decisions affecting post compact development of the waters of the Arkansas River basin. Work to improve post compact management of the waters of the Arkansas River basin may benefit from recognizing this administration and management standard.

**Activities for Problem 7: Arkansas River Corridor Water Management.**

1. Address water usability depletion from Arkansas River basin water quality declines.
2. Maximize the resource services and benefits of high river flow events for aquifer replenishment, well augmentation or other uses.
3. Support compact compliance verification needs.
4. Maximizing general public good from available river flows and river resources.
5. Conduct calculations to estimate Stateline underflow and change in Arkansas River basin underflow from Colorado.
6. Restore beneficial use of unused ditch rights.
7. Follow up on the work performed with Reclamation in 2012 to further develop a drinking water plan for the population along the poor water quality Arkansas River corridor.
8. Develop criteria for a water usability factors and value losses from declining water quality.
9. Identify new usable water sources and technologies that can enhance the usability of poor quality water sources.
10. Conduct further study to define, manage and protect the paleo-river channel aquifer and mitigating water quality supply into the district.
11. Explore the merits of adding the Hamilton County portion of the river basin corridor into the GMD3 management area to provide representation and management services.
12. Monitor water quality change at Stateline groundwater gages.
13. Monitor and assist, as appropriate, similar activities addressing basin concerns in Colorado.

**Problem 8: Cimarron River/Crooked Creek Surface Water Management**

The Cimarron River basin surface water management problem in Kansas is one of preserving renewable recharge source for groundwater benefits. The Cimarron is a sub-basin of the much larger Arkansas River basin, with much of the Cimarron River basin located in Oklahoma down to its confluence with the Arkansas River Mainstem near Tulsa, Oklahoma. The upper portion of the river system affecting GMD3 originates upstream in New Mexico, the extreme western Oklahoma panhandle, the extreme southeast corner (about 14 miles) of Colorado and into Southwest Kansas. Except for the very upper portion in New Mexico where snow runoff provides base flow, this river is known as the Dry Cimarron River.

**High Plains Aquifer recharge from intermittent flows.** The Dry Cimarron River is not completely dry but sometimes its water disappears entirely under the sand as groundwater or underflow in the river bed. The river rarely flows as it first crosses the Kansas border into GMD3 and the Cimarron National Grassland (National Grassland). Here, the shallow groundwater table allows for flow from periodic runoff to occur across the National Grassland and Morton County. US Forest Service manages the National Grassland and is a member of GMD3 by state statute. The river alluvial aquifer of the National Grassland supports ponds for stockwater, fish, wildlife, and a local cottonwood forest. This condition disappears fairly soon downstream as the river alluvial aquifer connects with the deeper Ogallala/High Plains Aquifer at depths below what plants can access, and the Cottonwood forest disappears. The permeable nature of the alluvial sands and gravels of the river system and tributaries below the National Grassland create rapid loss of flow during runoff events as recharge into the High Plains Aquifer. As groundwater

mining has occurred in the district, the point where the groundwater table and the river bed meet has moved downstream and extending the reach of the Dry Cimarron River east.

**Review of surface water applications.** All surface water flow events in GMD3 are critical water storage events under the management program of the district. Surface flows and surface water storage, ponding in playa lakes and other natural or manmade surface features are important local sources of recharge to the High Plains Aquifer that necessitate management strategies to improve and protect the quantity and quality of source water services to the district. Improving recharge efficiencies, conducting application review and providing appropriate comments and recommendations on all surface water permitting will occur under the management program in the district.

**Base flow maintenance in the lower Cimarron basin in GMD3.** In the lower portion of the Cimarron basin within the district, a base flow of the river reappears where the regional High Plains Aquifer water table meets with the bed elevations of the Cimarron near the 54 Highway Bridge northeast of Liberal, Kansas. Basin base flow also occurs along the Crooked Creek tributary in Meade County, supported by mixed water quality groundwater discharge to the Creek, which meets with the Cimarron just downstream of the district.

**Water Quality in the Cimarron River.** Unlike the fresher runoff events that periodically flow from the National Grasslands to provide groundwater recharge, the quality of Cimarron River water below the Highway 54 Bridge in Seward County is poor. This is due in significant part to a flow comprised of three sources: regional aquifer discharge, wastewater discharge and saline springs flowing through natural mineral deposits of red Permian age formation below the High Plains Aquifer that contain large amounts of minerals. The quality of the water comprising river flow declines further downstream as the quantity increases and the river leaves the district to cross the Stateline into Oklahoma. The USGS river flow record for a gage site near Forgan, Oklahoma indicates about a 20 CFS base flow discharge from the groundwater sources.

**Kansas and Oklahoma Arkansas River Compact (compact).** The compact agreement for the Cimarron River Sub-basin applies to Oklahoma as both an upstream and downstream state and to an area in Kansas mostly within the district. The exception is about a 13 mile reach immediately upstream of the district and Forest Service Grassland, in the southeast corner of Colorado. Both Colorado and Oklahoma are open to additional new river alluvial aquifer and High Plains Aquifer groundwater development, which is a concern for GMD3 as being an area closed to most new appropriations of water. The compact is primarily a water quality compact through limits on conservation storage. The compact commission is a principle forum for interstate water management communications and record.

The compact provides for an additional 5000 acre feet of conservation storage of surface water available for development in the Kansas portion of the Cimarron sub-basin and an additional 5000 acre feet in Oklahoma, with the Colorado portion of the sub-basin not included. Groundwater is not specifically addressed. However, surface water conservation storage effects on the sub-basin hydrology pales in comparison to groundwater depletion effects in the Sub-basin on both surface water flows and groundwater influence. Now that GMD3 is closed to new development, the ongoing groundwater development in sister states within the sub-basin may have a significantly impact on GMD3 future supply, including alluvial groundwater levels into

the Cimarron National Grasslands. Additional interstate aquifer development in adjacent states may also adversely impact interstate groundwater supply to the district. Of special concern is the continued up gradient development in Colorado and Oklahoma. Mutually agreeable management strategies across either Stateline are preferred to aggressive appropriations for importation of judicial complaints for relief.

**Activities for Problem 8: Cimarron River/Crooked Creek Surface Water Management**

1. Recognize the river channel area within GMD3 as a Critical Aquifer Replenishment Area through partnerships, signage, and program guidelines.
2. Address water usability depletion from Cimarron River basin water quality declines.
3. Maximize the resource services of high river flow events for aquifer replenishment, well augmentation or other uses for the general public good.
4. Support compact compliance verification needs.
5. Maximizing from available river flows and underflow resources.
6. Conduct calculations to estimate Stateline underflow and change in Cimarron River basin underflow from Colorado.
7. Install a groundwater gage in the Cimarron National Grasslands to collect data on Stateline alluvial underflow into Kansas and the district.
8. Calculate river basin Stateline underflow and evaluate effects of new water resource development in Colorado and Oklahoma on GMD3 supply and management program.
9. Establish or confirm lines of communication with water officials in multiple jurisdictions and host meetings locally to exchange information on any additional compact and resource management needs.
10. Monitor and assist, as appropriate, similar activities addressing basin concerns in Colorado and Oklahoma, and Work to develop additional agreements with other states to support interstate cooperation on water management.
11. Comment on surface water permit applications impacting the management program.

**Problem 9: Water Quality Protection.**

**Risk tradeoffs.** Groundwater overdraft can create new water quality problems or make existing groundwater pollution worse. In addition, replenishment supplies that are lower in quality have a low usability factor that creates usability depletion of existing supplies in a manner that may reverse risk benefits to risk liability. As aquifer levels decline from use, natural and manmade pollutants can concentrate in the remaining groundwater, making it unsafe for irrigation or drinking without costly treatment. In some cases, wells must be shut down.

A multi-component groundwater management program should include interventions to address soil, well condition and water quality of surface and groundwater sources. Such programs can include regular groundwater quality monitoring, investigation, education about risks to groundwater, resources to limit water contamination (e.g., tools for appropriate pesticide and fertilizer application, wastewater disposal), and water allocations and taxes. Backflow prevention is an essential first step in averting manmade point source contamination of groundwater.

**Pollution.** Pollutants can come from a variety of sources and can enter groundwater aquifers through land surface spills or contaminated surface water sources. Groundwater contamination is often costly to remediate; prevention is therefore the key. To keep groundwater supplies clean

and safe, some required actions include sustaining groundwater elevations over time, regulating pollutant discharges to surface and groundwater, and a thoughtful consideration of appropriate land uses in recharge areas.

**Well construction.** Inadequate well construction standards can be another leading cause of groundwater contamination. During the late 1970s and early 1980s it became apparent that wells being constructed in the Arkansas River alluvial river valleys needed to be built with permanent barriers preventing poor quality river water from reaching the lower High Plains Aquifer. Studies have shown that improperly constructed and/or plugged wells have created conduits allowing river water that is of lessor quality to migrate along the outer wall of the well casing and invade lower aquifer zones. Similar criteria are required to prevent contact between confined and unconfined aquifers.

**Salt water upwelling.** In addition, the Permian age formations of the lower High Plains Aquifers found in some areas of Meade and Seward counties contain high concentrations of naturally occurring chlorides or other undesirable water constituents. Soon after discovering this concern in the mid-1980s, GMD3 adopted well construction restrictions in a special Groundwater Quality Management Area in parts of both Meade and Seward Counties, as well as rules for testing to limit the movement of the contaminated groundwater into fresh water zones.

**Activities for Problem 9: Water Quality Protection**

1. Maintain water quality special rule areas as needed to protect water quality and avoid water usability depletion.
2. Collaborate with the KDHE, Kansas Corporation Commission (KCC) and other partners to assure well construction, well maintenance and nutrient management practices that best protect water quality and usability.

**Problem 10: Exploration of Deep Permian Aquifer Use.**

As the value of water increases and local supplies diminish, some members are losing the ability to access water from the declining Ogallala/High Plains Aquifer and are looking deeper to often semi-brackish quality groundwater aquifer sources to supply their projects. GMD3 has spacing requirements for the confined Dakota Aquifer. More evaluation and policy development is needed for the safe development of other deeper aquifers. There is a benefit to accessing this water, but care needs to be taken to ensure that cleaner shallower water is not contaminated, or that the deeper aquifer water consumption does not produce land subsidence, and that it does not cause impairment of existing water rights. For these reasons, standards should be developed regarding Permian aquifer exploration and development.

**Activities for Problem 10: Exploration of Deep Permian Aquifer Use**

1. Investigate concerns of old oil and gas well short surface casing construction potential for uncontrolled exchange between aquifers of differing water quality that may cause water usability depletion of the High Plains aquifer.
2. Work to identify quality and quantity concerns in Permian aquifer formations.
3. Review spacing and well construction requirements for developing Permian aquifers.
4. Identify and promote technologies that make poor quality water more usable.

**Problem 11: Availability of Energy.**

It is critical to have affordable and reliable energy available for water use projects in the District. Any regulatory plan that may adversely affect future access to affordable energy for use by GMD3 eligible voters should be evaluated by GMD 3 staff for the effects on the groundwater management program, including: implementation of Clean Water Act, Endangered Species Act, Federal Energy Regulatory Commission actions, Kansas Corporation Commission actions, and SW Power Pool operations. GMD3 staff should review regulatory plans under the GMD3 groundwater management program for appropriate resource allocating and market planning in the public interest. Information will be provided to members and partners for management program concerns and energy supply. Advocacy will occur for appropriate resource planning in support of meeting energy needs today and for future groundwater management program needs.

**Activities for Problem 11: Availability of Energy**

1. Advocate for safe, reliable, secure, and affordable energy infrastructure to meet water management and farm profitability needs.
2. Support private efforts and utility cooperative partnerships aimed at assuring an adequate present and future supply of affordable energy.
3. Inform members and partners of unreasonable regulatory schemes affecting affordable energy, needed supply planning, and fair market conditions.

**Problem 12: Public Education and Involvement.**

In order to achieve the various programs and goals outlined in this document, GMD3 recognizes that public education and support will be required. GMD3 will work with members and partners, local, state and federal interests, institutions and authorities to educate and inform the public how Kansas groundwater matters; raise understanding of district water resources; describe GMD3 program and brand activity; inform on water use, future supply, water conservation, water management, and public interest concerns. It is important to provide education during regular communications between the GMD and their membership, including notice letters regarding water right and water use activities that may affect them.

**Activities for Problem 12: Public Education and Involvement**

1. Host or participate in meetings with local water users and land owners to inform on management program activities, water supply declines and use benefits, future water availability, and groundwater conservation tools and benefits.
2. Create information on video and other media formats for distribution to improve water supply and management awareness and understanding.
3. Use weekly radio interviews to notify the public of district activity.
4. Support members, partners, schools, clubs, and civic groups with presentations or other public information when needed.

**Problem 13: Defining Public Interest.**

The term "public interest" is referenced throughout state and federal law. The problem of defining what acts or activities may be consistent with the public interest can vary as a difference of context and open to interpretation. GMD3 accepts the public interest purpose of the Kansas legislature for the right of its members to direct district groundwater management through its governing body. To that end, GMD3 is committed to conduct significant coordination activity with diverse local, state and federal interests, institutions and authorities to maintain productive partnerships that accomplish the purposes of the local groundwater governance and ensure the programs and regulations are consistent with the policies, norms and practices that define the public interest as delegated from Congress to Kansas for allocating groundwater and from the Kansas legislature to GMD3 to manage district aquifers. Revision of regulatory schemes affecting the local groundwater management program will require consideration of public interest by the district governing body and may include consideration for revising or preserving the management program document per K.S.A.82a-1029 to insure the rights, powers and investments of GMD3 as intended under state law.

**Activities for Problem 13: Public Interest**

1. Represent the district public interest for all present and future member water needs.
2. Follow due process for revising and implementing the management program and the needed administrative rules and guidance to ensure that activity in the district affecting water use, supply and the economy occurs in the best interest of the GMD3 eligible voters and public.
3. Work with local, state and federal interests, institutions, legislators and congressional delegations to educate and convey what is in the public interest regarding water based economy, water supply, water transportation infrastructure and finance needs.

**Problem 14: Funding.**

The GMD3 management program is funded primarily by a water user fee per acre foot authorized annually by water rights and a land assessment per acre of land on tracts of 40 or more acres. Infrastructure improvement projects may be funded through issuance and servicing of bonds through a special election process. GMD3 may work on projects that require state or federal government grants or public fund transfers. These projects may include incentive based conservation programs that provide payment to users who conserve water or improve efficiency, studies to help communities and other water users develop future management plans and water transfers. GMD3 actively pursues grants and fund transfers from partners to support projects that implement the management program in the public interest.

**Activities for Problem 14: Funding**

1. Support the state Water Plan Funding recommendations of the Water Vision Funding Taskforce.
2. Seek grants from outside sources to supplement GMD3 fees to implement management program activities.
3. Pursue an interstate study partnership of funding sources to develop information on potential large water transfer projects that can benefit the district

4. Develop bond funding alternatives and public private partnership (P3) pathways to accomplish program goals for expensive and ambitious sustainable supply projects, such as for water transfers into the district.
5. Work with state officials to strengthen revolving loan program options for financing water infrastructure construction projects.
6. Investigate the amount of groundwater diverted and exported from the district.

## VII. CONCLUSION

All activities of GMD3 are conducted with due consideration and appreciation for the diverse local, state and federal interests, institutions and partner interests. The management of groundwater in the district under the right delegated by the Kansas legislature to GMD3 to determine our destiny with respect to the use of the groundwater, and the powers provided to accomplish this activity are fully retained here, and are to be implemented in a manner consistent with state and federal law through the elected Board supervision implementing and protecting the adopted Management Program, Board by-laws, Board resolutions, state administrative rules and orders adopted for the district and the actions of the Board to provide guidance and services under practice documents, contracts or other instruments of cooperative partnership and intergovernmental agreement.

**APPENDIX**

## Kansas water law and planning history notes

**John Peck** provides a water rights and planning history outline in his writing on drought concern and Kansas water law: ***Legal Responses to Drought in Kansas,*** Kansas Law Review, Vol. 62, No. 1141, 2014, University of Kansas - School of Law.

### Legislation

A. Pre-1945 water statutes: Drought not mentioned specifically, but perhaps can be inferred as one of the background reasons for some legislation:

1. 1866 (irrigation companies empowered to construct canals)
2. 1886 (stream water may be used for irrigation by appropriation, and first in time is first in right)
3. 1889 (ditch and canal companies empowered to condemn water rights)
4. 1891 (waters west of 99th meridian to be devoted first to irrigation use, subject to domestic, 2nd to industrial use; irrigation districts may be created)
5. 1899 (irrigation companies empowered to condemn to aid in establishing reservoirs, lakes, or ponds for water storage)
6. 1917 (Kansas Water Commission established to investigate problems of, *inter alia*, domestic water supply and irrigation; to establish river gaging stations; to make general plan for development of river basins; repealed 1927)
7. 1919 (Division of Irrigation created in State Board of Agriculture, under control of commissioner of irrigation; duties of commissioner included gathering data, visiting sites, and making quarterly reports to state board)
8. 1927 (legislature abolished Water Commission and Division of Irrigation; Division of Water Resources (DWR) created to take over duties) [chief engineer position created]
9. 1933 (Chief Engineer made head of DWR)

B. The 1945 Water Appropriation Act: Activity related to and resulting from 1930s drought: Richard Pfister, WATER RESOURCES AND IRRIGATION, PART IV OF ECONOMIC DEVELOPMENT IN SOUTHWESTERN KANSAS, KU School of Business (March 1955)

1. 1940 (Governor appointed committee and held conference to study problems and make recommendations; committee report recognized need for a state plan to control the water resources)
2. 1941 (legislature repeals part of 1886 Act and established administrative procedures for handling applications for water appropriations)
3. 1944 (*State ex rel. Peterson v. Kansas State Board of Agriculture*, 158 Kan. 603, 149 P.2d 604 (1944) (affirmed common law doctrine of absolute ownership for groundwater; concluded that the chief engineer had been given no power over groundwater allocation))
4. 1944 (Governor appoints committee to study state water law, which produces "The Appropriation of Water for Beneficial Purposes: A Report to the Governor" (Dec. 1944) recommending adoption of Doctrine of Prior Appropriation)

5. 1945 (legislation adopts the Water Appropriation Act (WAA)) [Now all Kansas water rights to follow one doctrine and unused water is dedicated to the people of the state subject to beneficial appropriation as provided in WAA]
6. 1956 (clarify water rights as changeable real property that must tolerate reasonable economic effects between users)
7. 1972 GMD Act (legislature dedicates local groundwater management rights)
8. 1978 (legislature restrict all non-domestic use without first obtaining state permission and adds Intensive Groundwater Use Control Area provision in GMD Act)
9. 1986 (mandated annual water use reports by March 1st each year subject to fines)
10. Water right management tools developed since then.

Kansas Water Planning Acts

1. 1917 (Kansas Water Commission established to investigate problems of, *inter alia*, domestic water supply and irrigation; to establish river gaging stations; to make general plan for development of river basins; repealed 1927)
2. 1955 (Kansas Water Resources Board and executive director established)

a. Charged with working on and working out a state water plan of water resources development.
b. Background: "The State of Kansas had no sooner recovered from the spectacular floods of 1951 when it plunged into one of the most severe droughts in Kansas history from 1952 through 1956. This sequence of disasters led to legislative creation of the Kansas Water Resources Board in 1955 as a move to try to do something to avert or at least alleviate future crises through aggressive planning.

3. 1963 (State Water Plan Act, 82a-901 *et seq.)*
4. 1981 (Kansas Water Resources Board replaced by the Kansas Water Authority, the Kansas Water Office, and the director of the Kansas Water Office)
5. 1984 (State Water Resource Planning Act: major amendments to K.S.A. 82a-901a, *et seq.*)
6. 1985 (K.S.A. 82a-906 amended to provide dynamic planning process, under which KWO presents annual water plan and recommendations to the legislature)

End of History Notes.

## Maps and groundwater model information

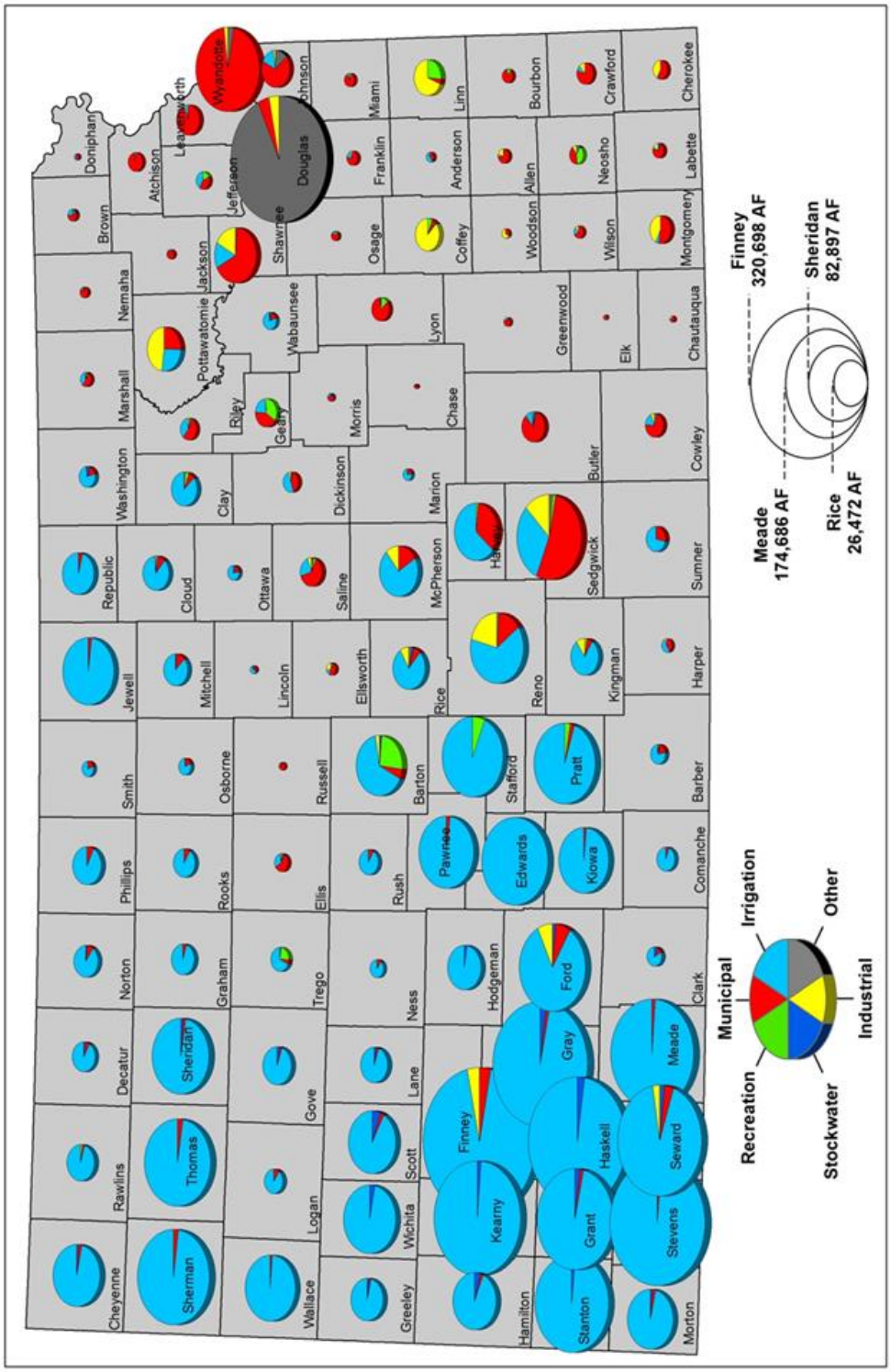
The following maps display the pumping density distribution, the percent loss in saturated thickness, and the remaining saturated thickness of the High Plains Aquifer in Kansas. The High Plains Aquifer Atlas can be found at:
http://www.kgs.ku.edu/HighPlains/HPA_Atlas/Water%20Rights%20and%20Water%20Use/index.html

The most recent GMD3 groundwater model information can be found at the following urls:

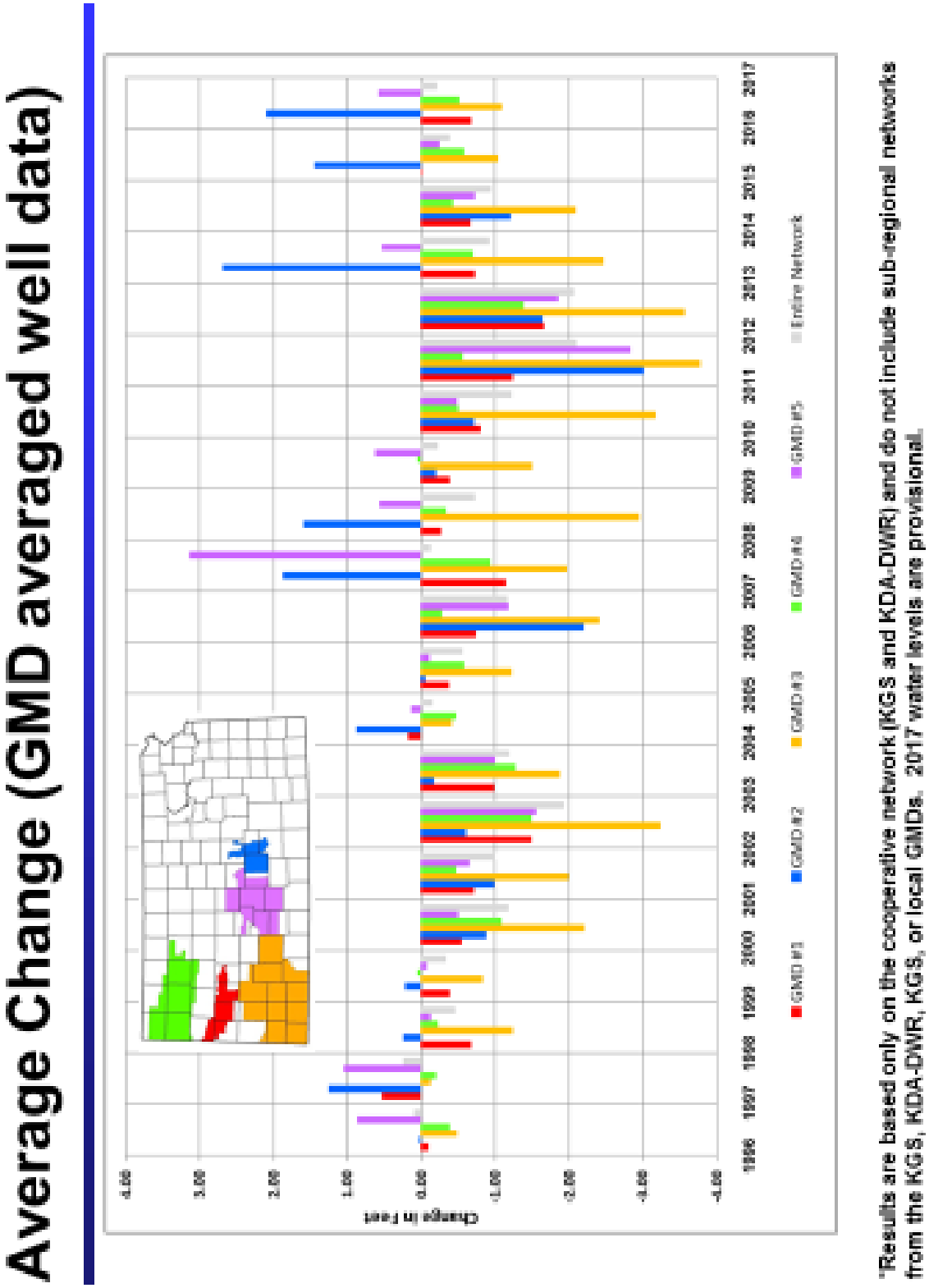
GMD3 Ground-Water Model: http://www.kgs.ku.edu/Hydro/Publications/2010/OFR10_18/

GMD3 Model Future Scenarios: http://www.kgs.ku.edu/Hydro/Publications/2012/OFR12_3/

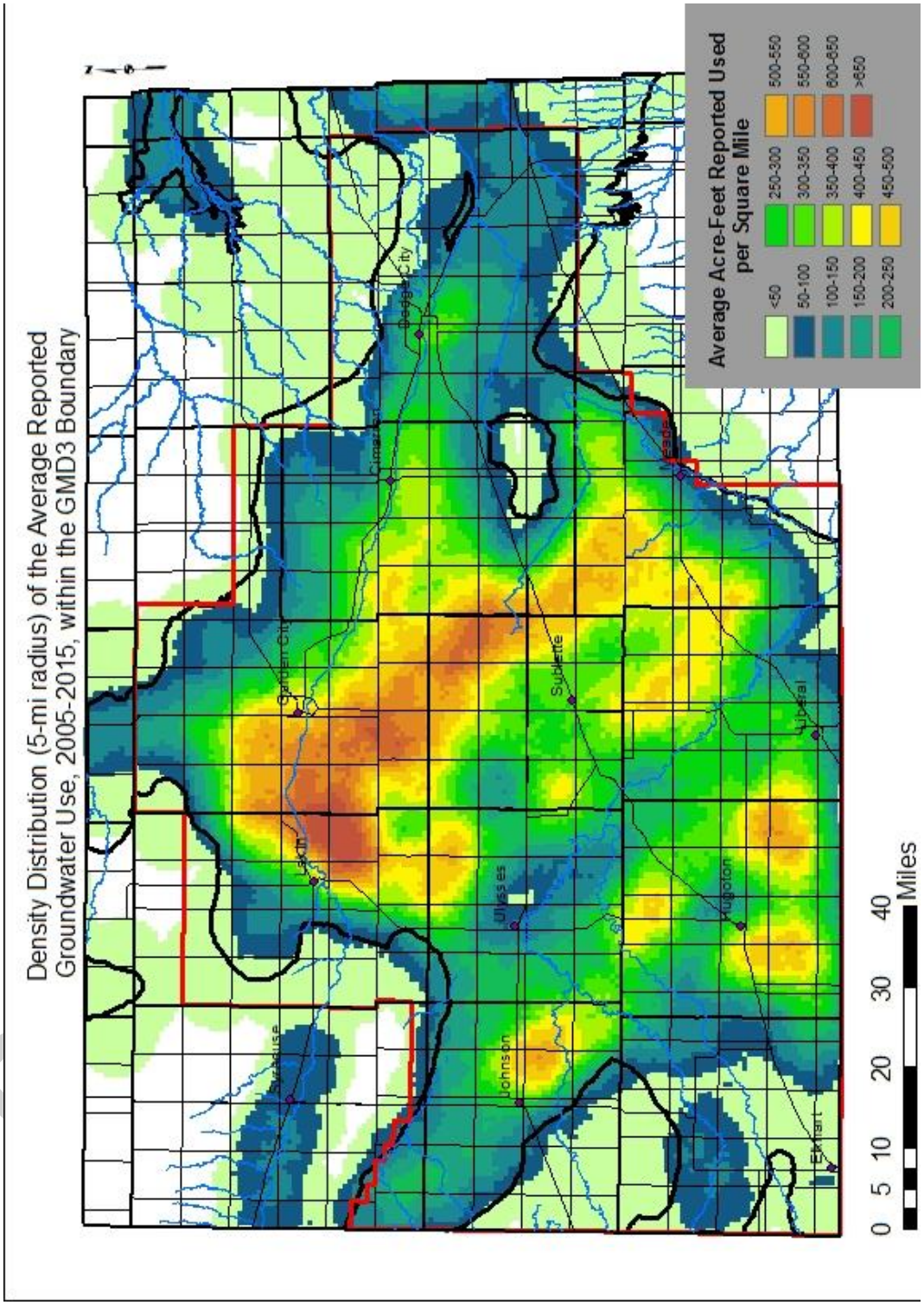
Potential economic impacts of water-use changes in Southwest Kansas:
http://www.tandfonline.com/doi/abs/10.1080/19390459.2013.811855



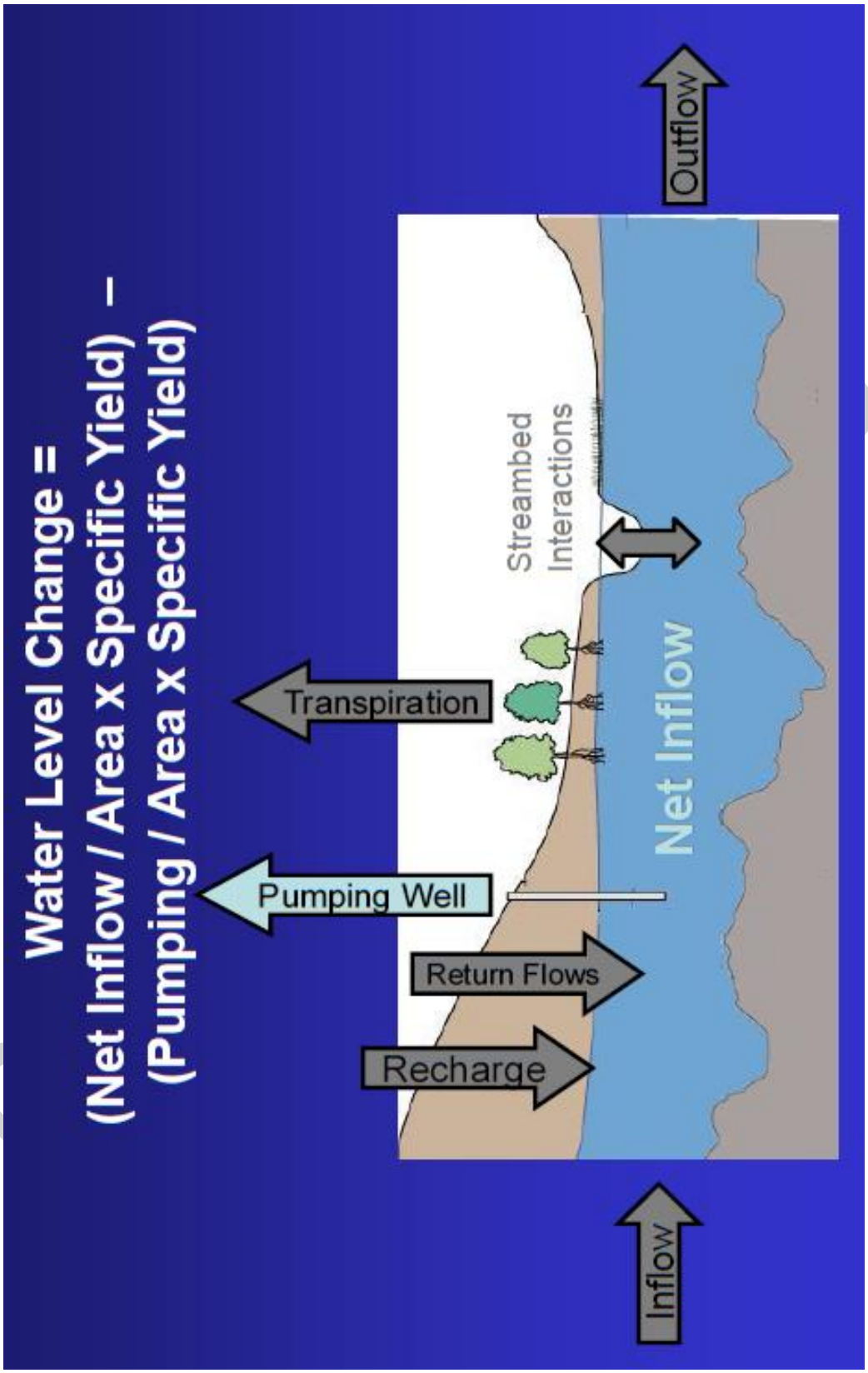

Average annual reported water use 1995 to 2014 influenced by the precipitation patterns and available groundwater. “Other” use is primarily flow through hydropower. Source: KGS



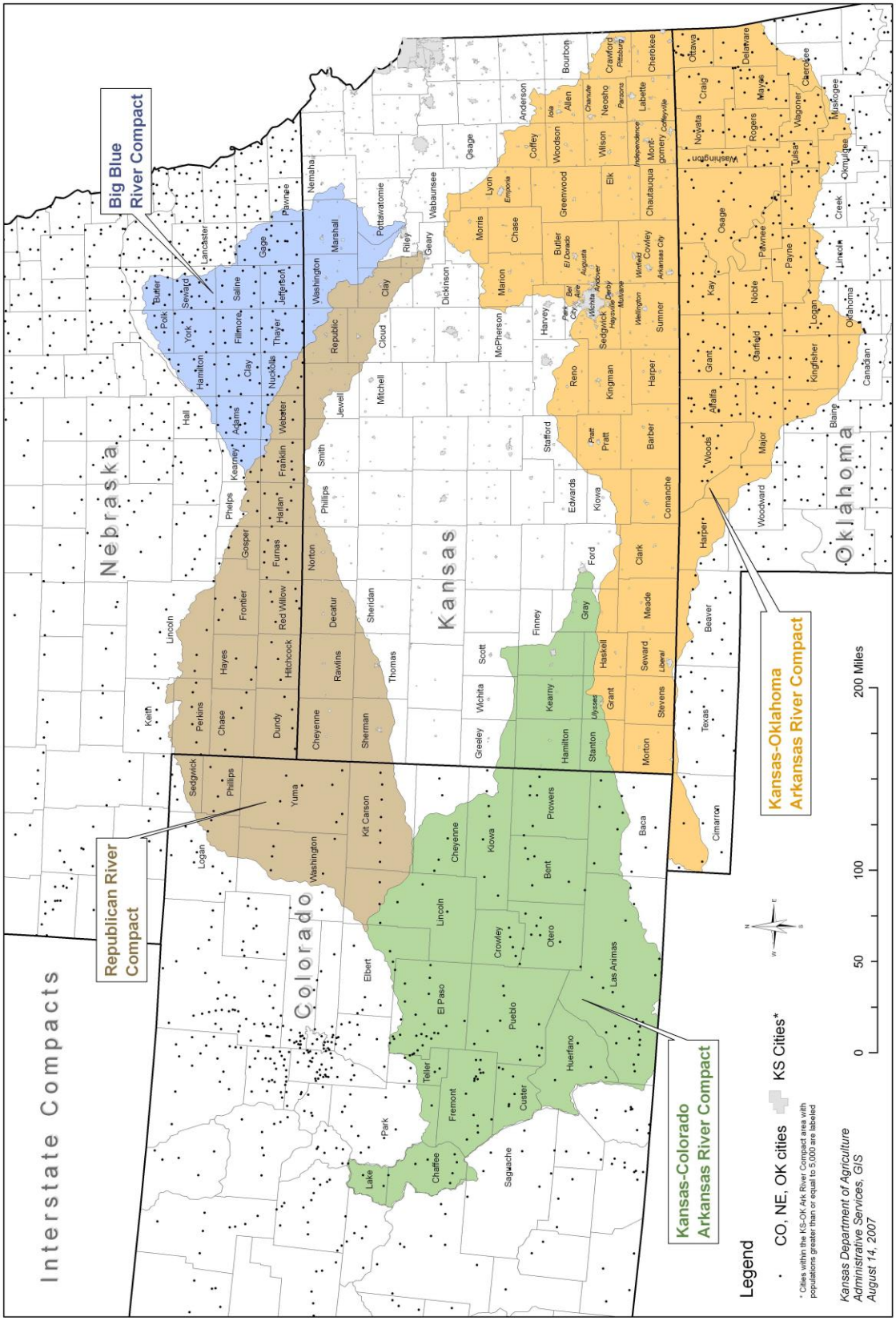

Average annual water level change (ft) of each GMD, 1996 through 2017, KGS



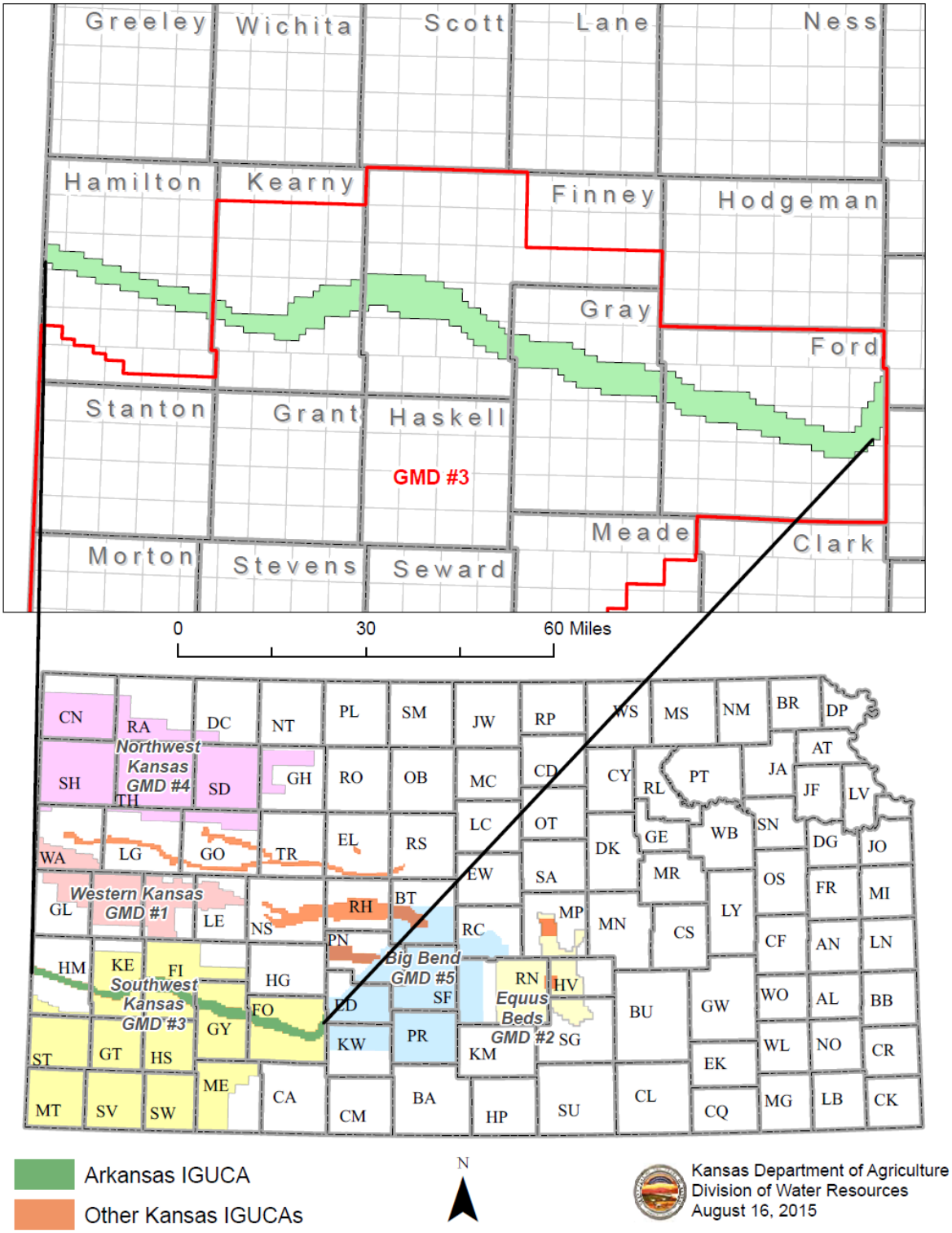

Pumping Density of the High Plains Aquifer in Kansas.
Source: Kansas Geological Survey,

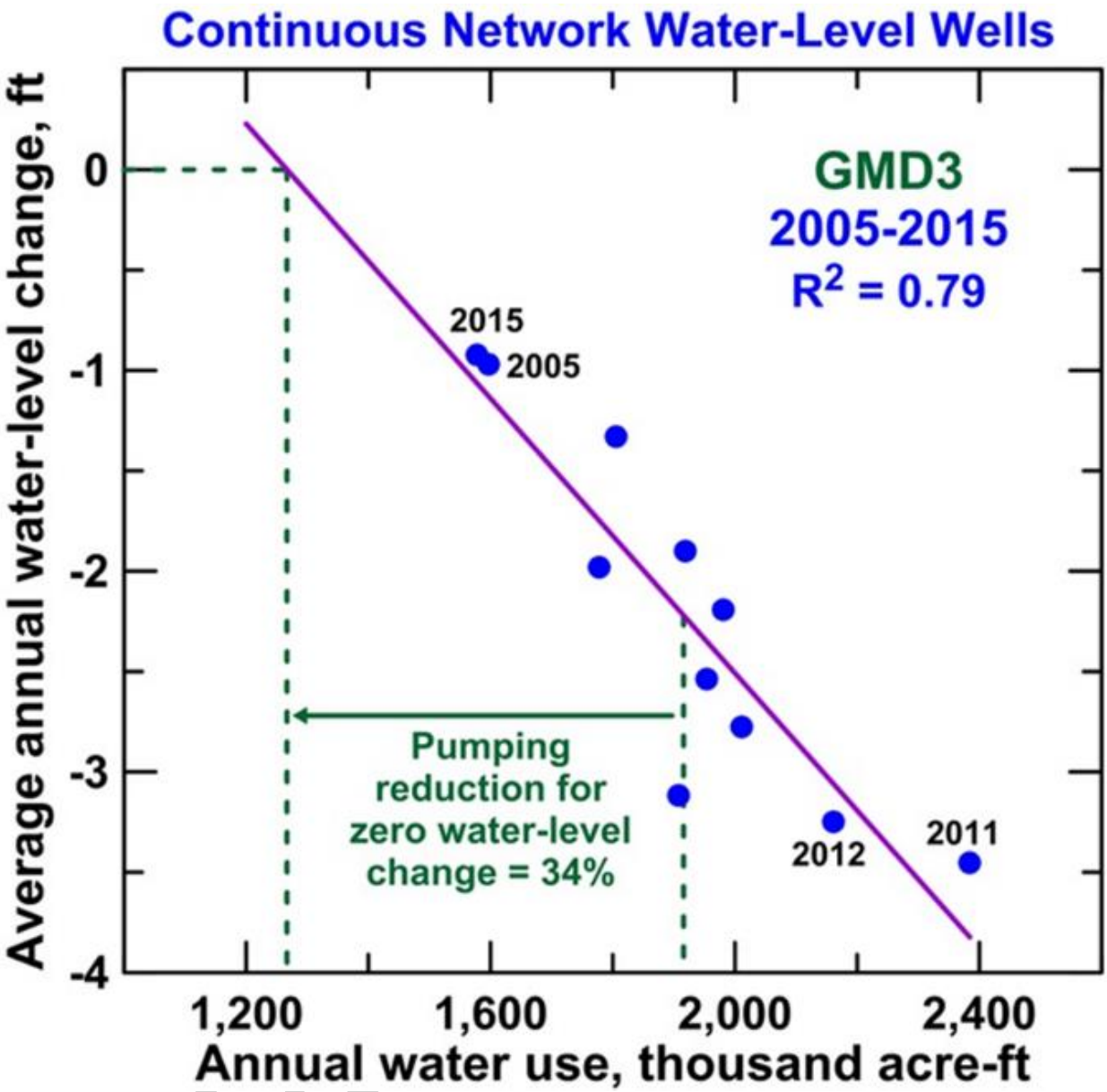



Source: Kansas Geological Survey

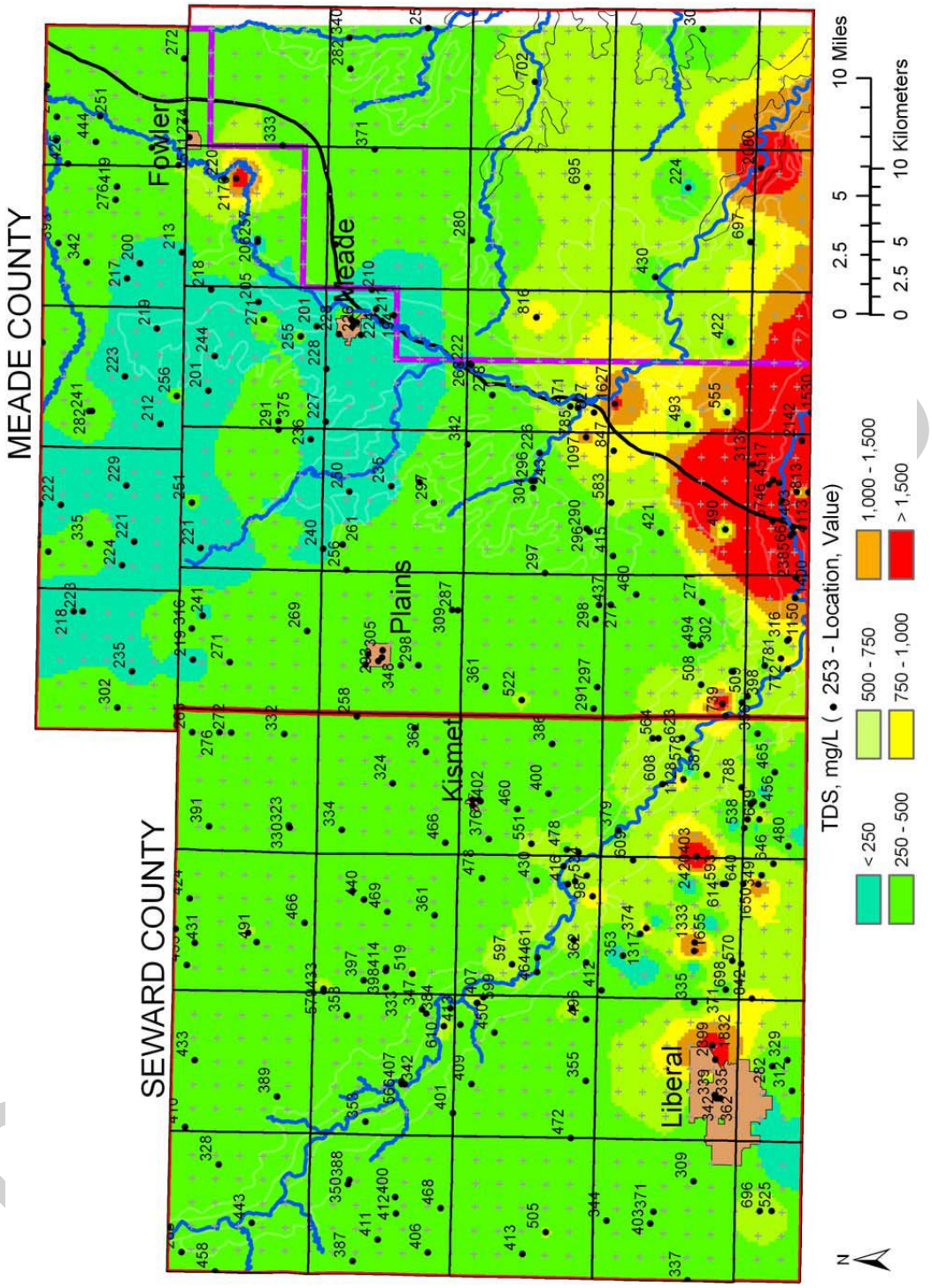

Interstate Compacts
Big Blue River Compact
Republican River Compact
Kansas-Colorado Arkansas River Compact
Kansas-Oklahoma Arkansas River Compact
Nebraska
Kansas
Colorado
Oklahoma
Legend
CO, NE, OK cities
KS Cities*
* Cities within the KS-OK Ark River Compact area with populations greater than or equal to 5,000 are labeled
0
50
100
200 Miles
Kansas Department of Agriculture
Administrative Services, GIS
August 14, 2007

# Arkansas IGUCA

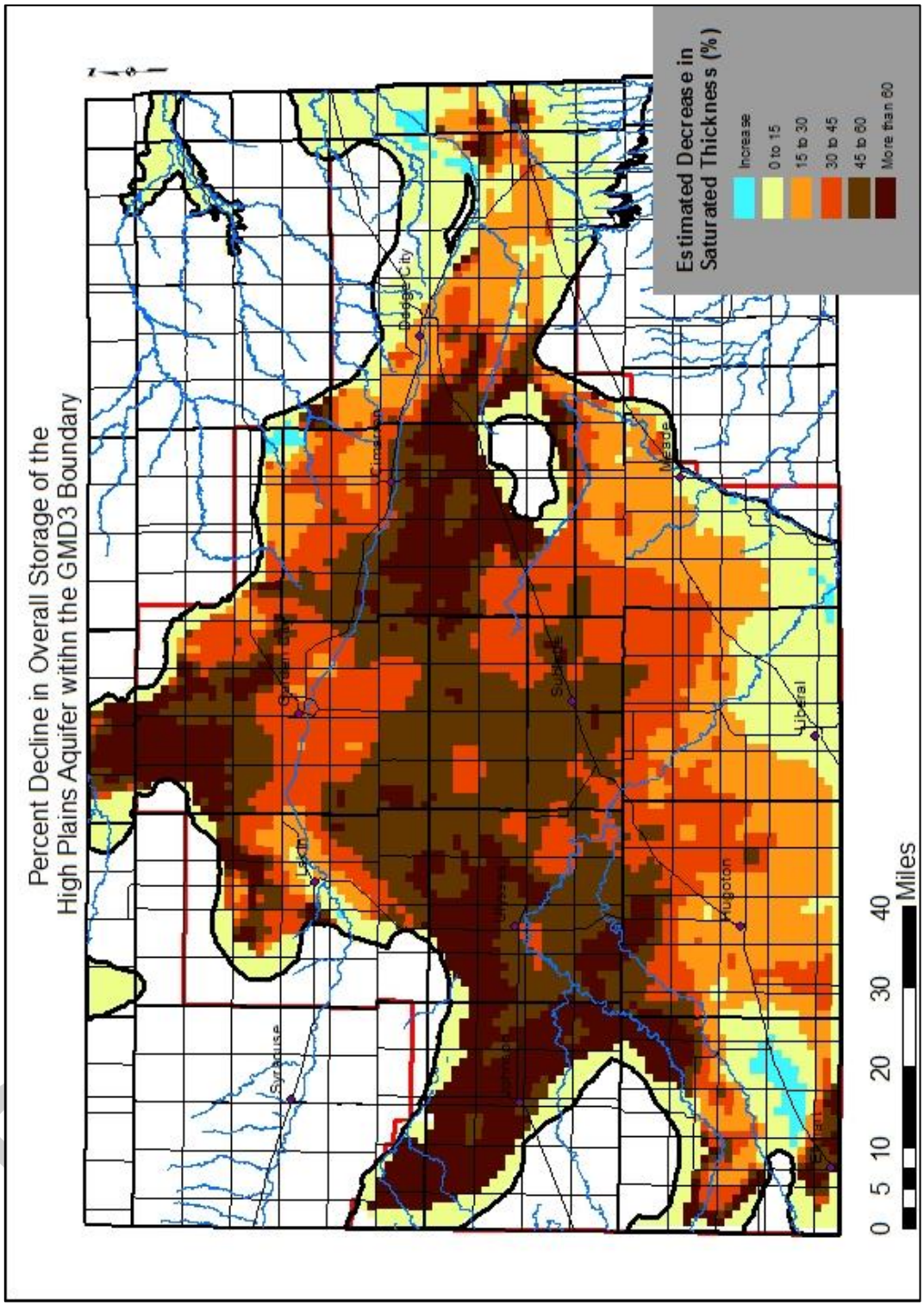




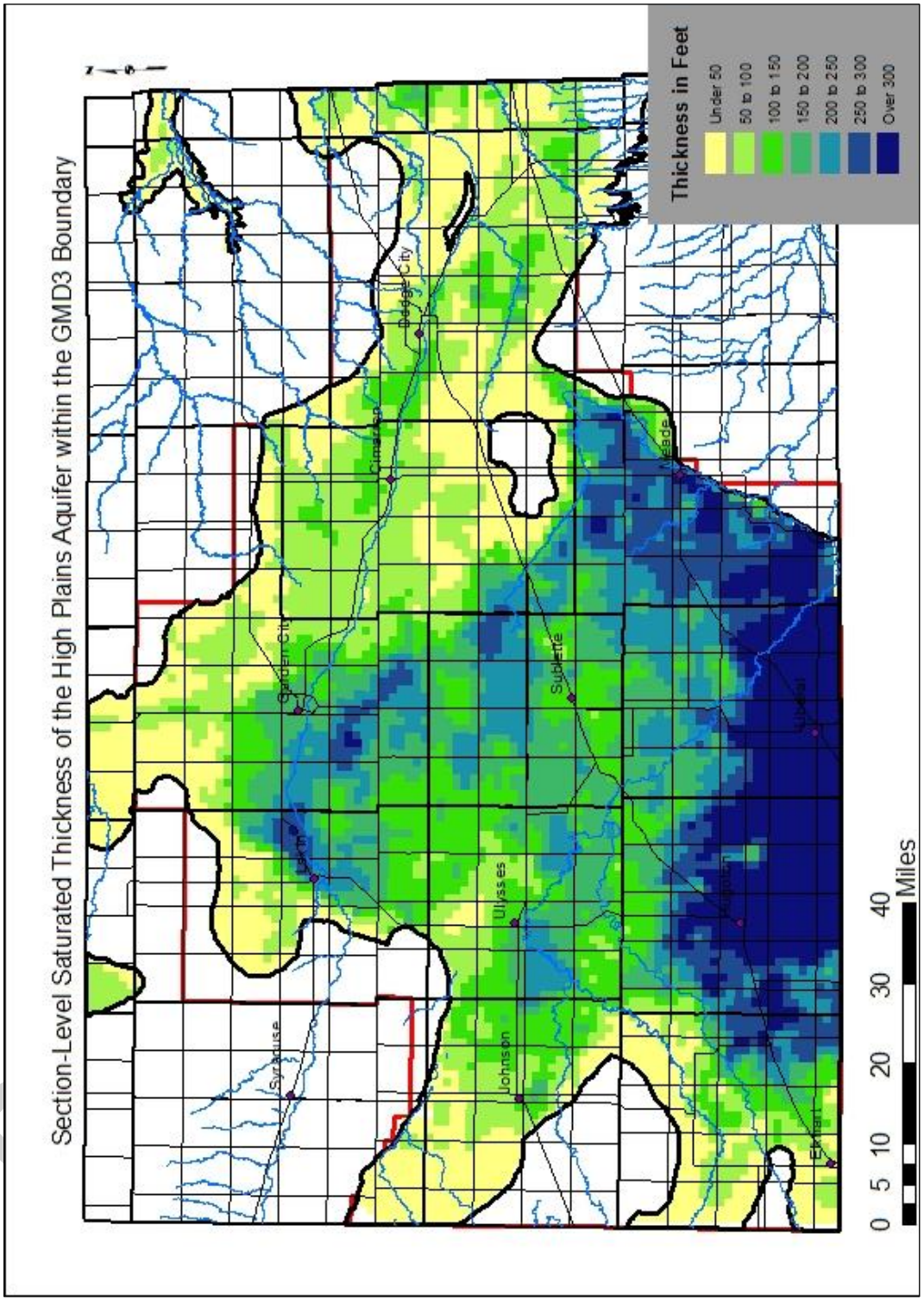

**From: Isolating High Plains Aquifer Change, KGS**



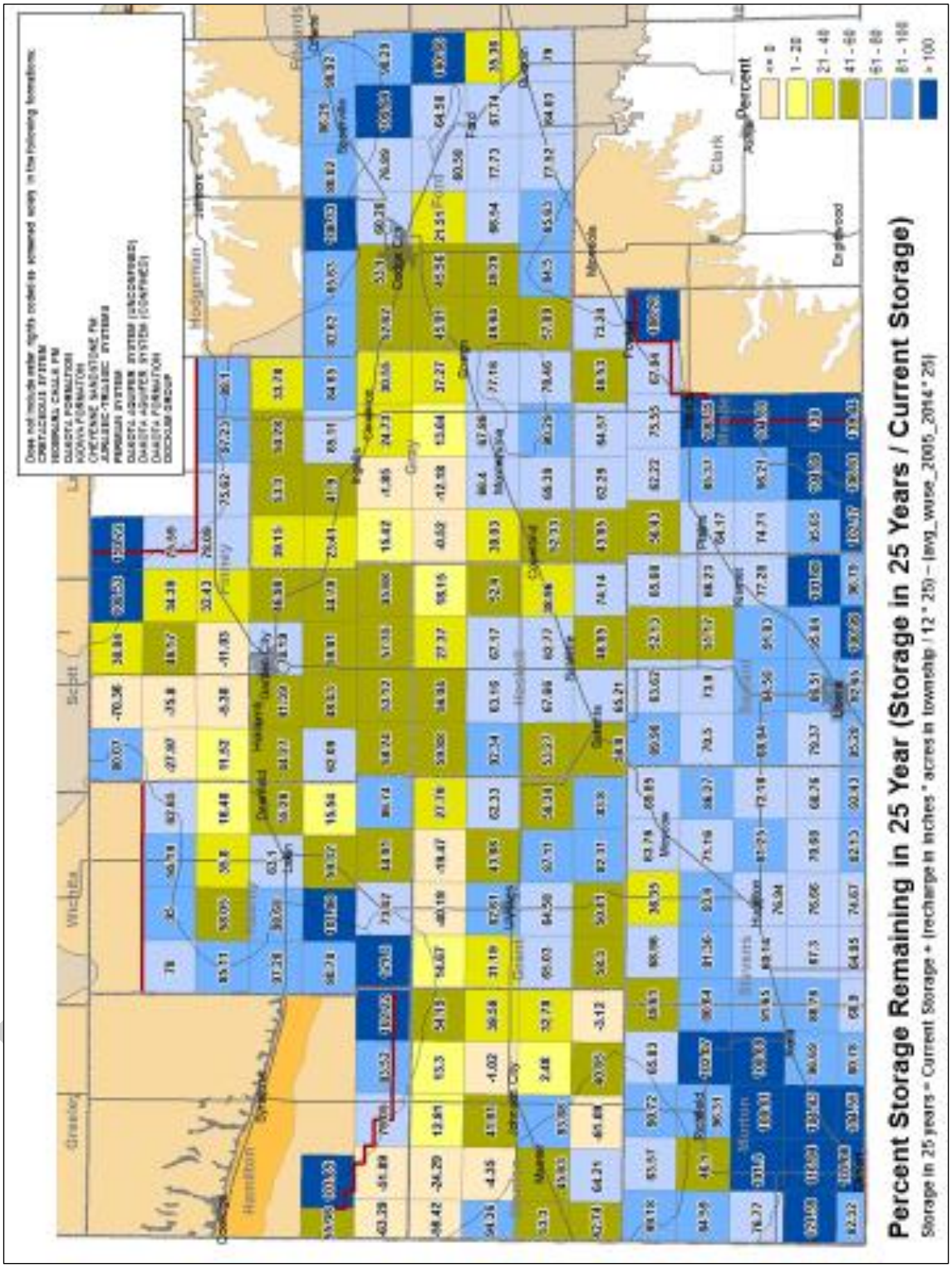

Distribution of chloride concentration in ground water in aquifers in Seward and Meade counties. The blue line extending from northwest to southeast Seward County and through southwest Meade County is the Cimarron River. Most of the blue lines in northern, central, and southeast Meade County are streams that are part of the Crooked Creek drainage basin. The vertical red line is the boundary between Seward and Meade counties. The purple line within Meade County is part of the eastern boundary of GMD3. The black line extending from southwest to northeast Meade County represents the eastern extent of the saturated part of the High Plains aquifer in the figure. From KGS Open File Report 2005-27.



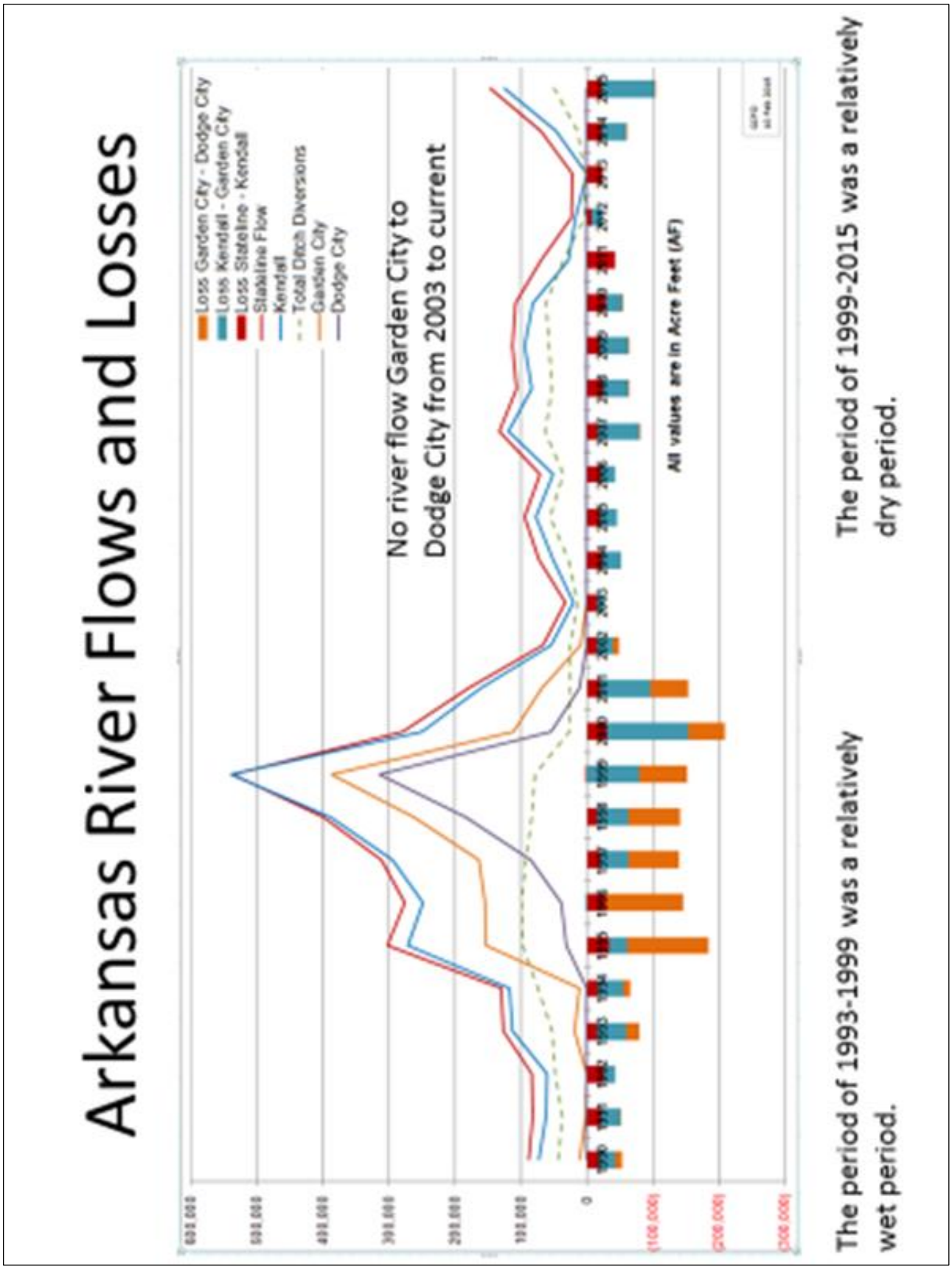

Section level percent decline in storage (since 1950) of the High Plains Aquifer in GMD3.
Source: KGS, http://www.kgs.ku.edu/Publications/pic18/index.html



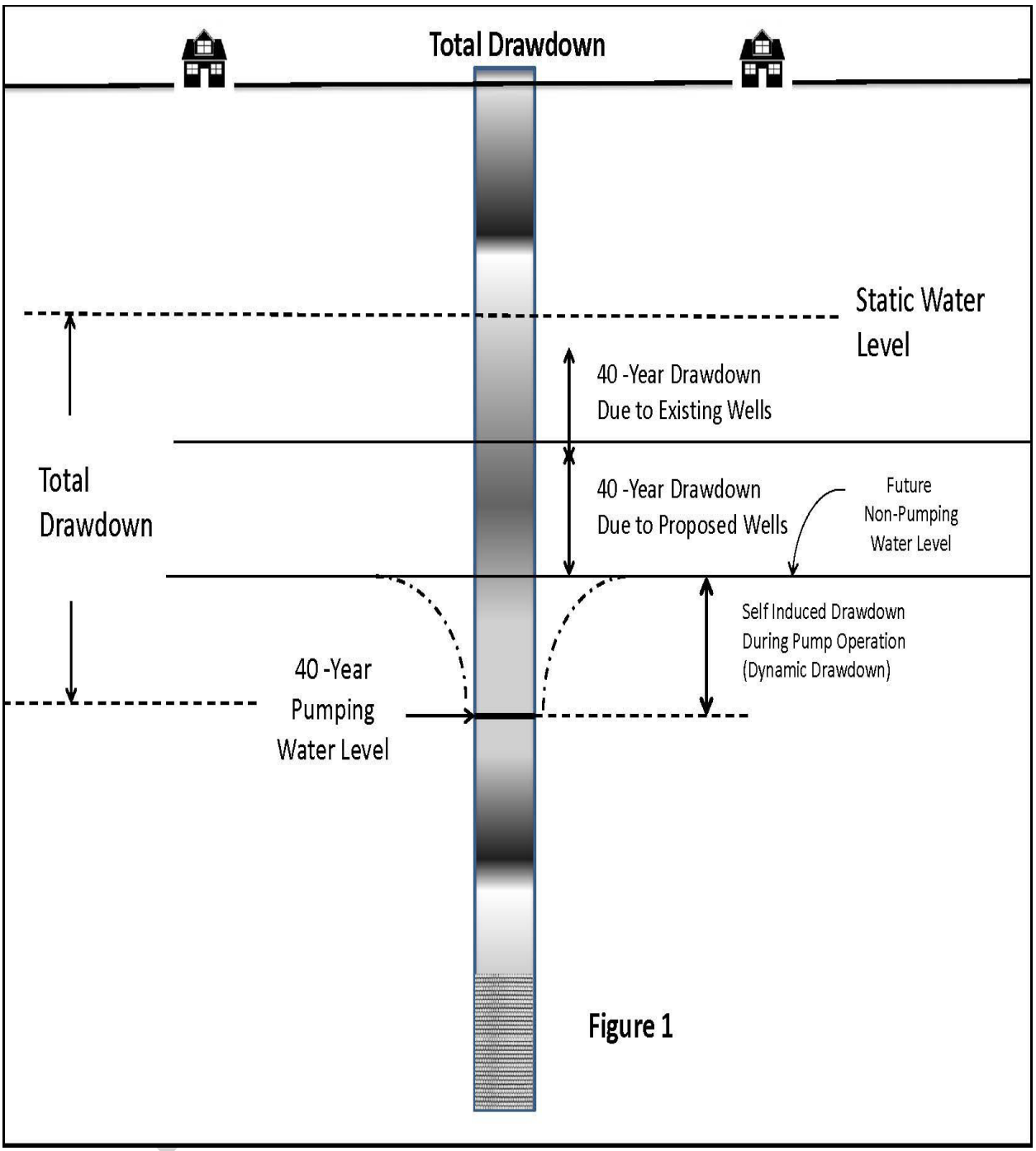

Saturated Thickness of the Ogallala/High Plains Aquifer, 2015.
Source: KGS, http://www.kgs.ku.edu/Publications/pic18/index.html



2015 percent average saturated thickness projected to remain in 25 years, KGS.
Non-blue townships don’t meet the maximum allowable depletion rate of 40% in 25 years.




Arkansas River flow/loss chart. Source: KDA/DWR




From *Guidelines for the Assessment of Drawdown Estimates for Water Right Application Processing* (New Mexico Office of the State Engineer Hydrology Bureau Report 05-17, May 10, 2017, by Tom Morrison, et. al.).

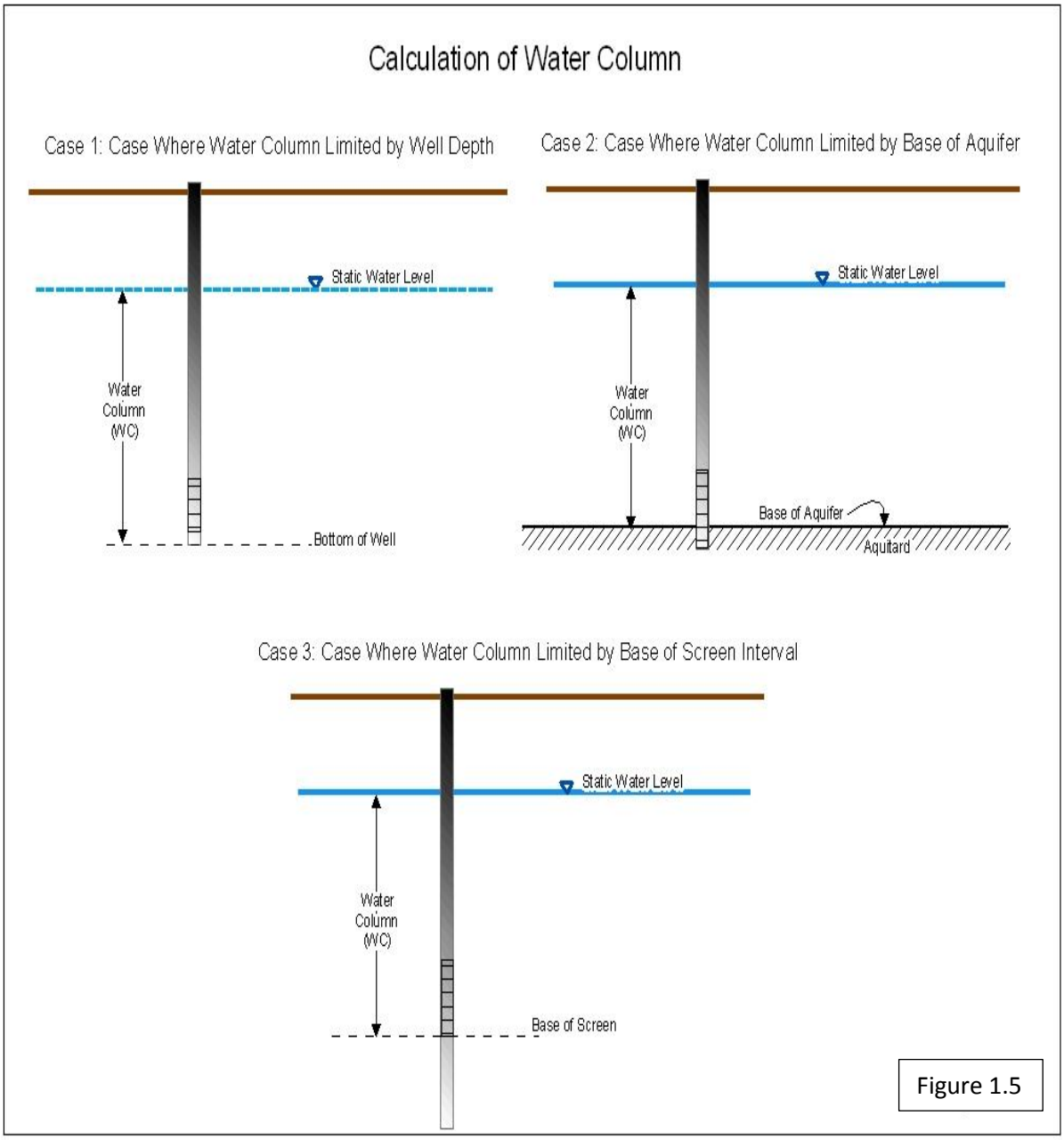



Figure 1.5

From: *ASSESSMENT OF DRAWDOWN ESTIMATES*, Training manual by Tom Morrison, 2017

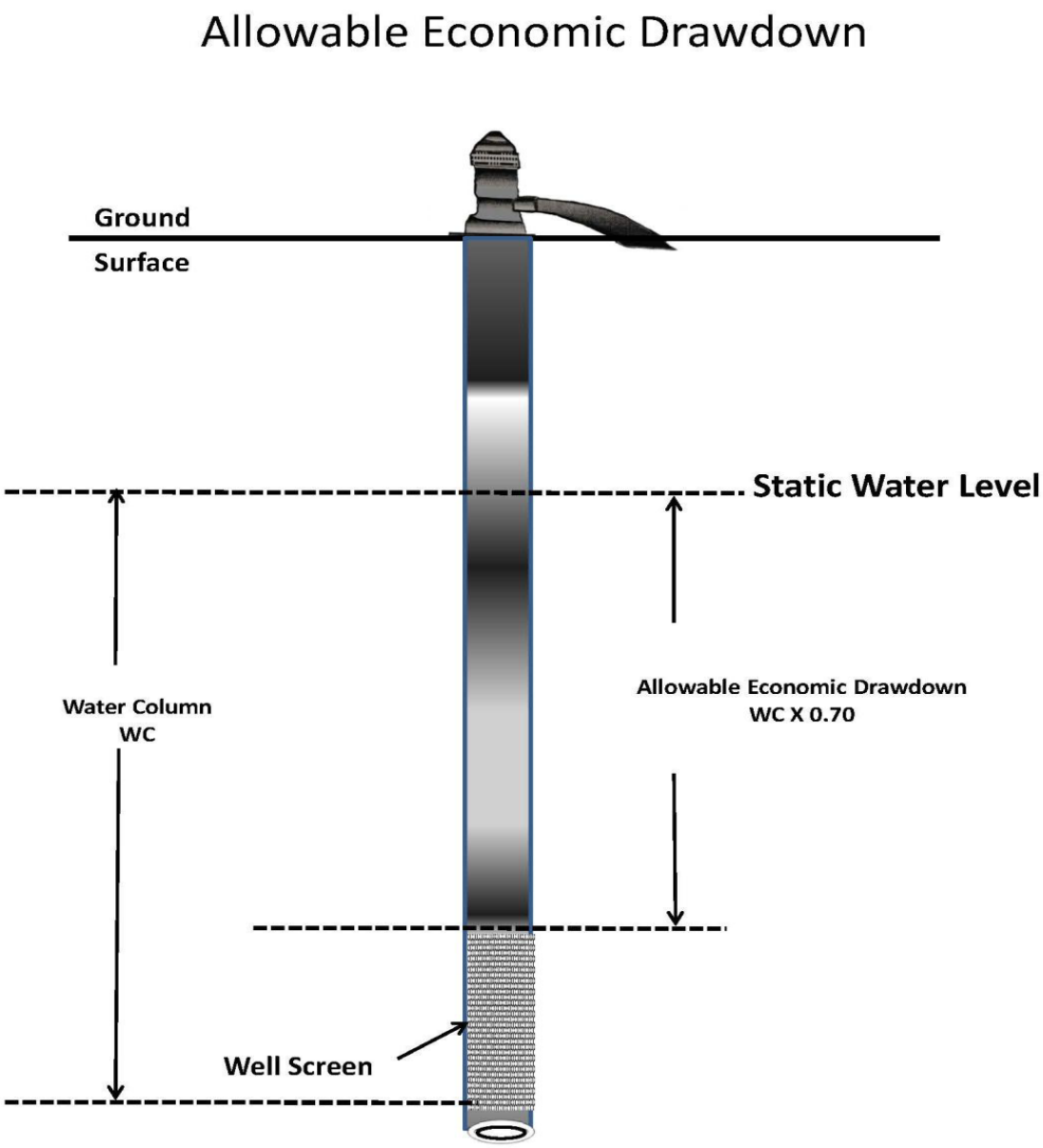
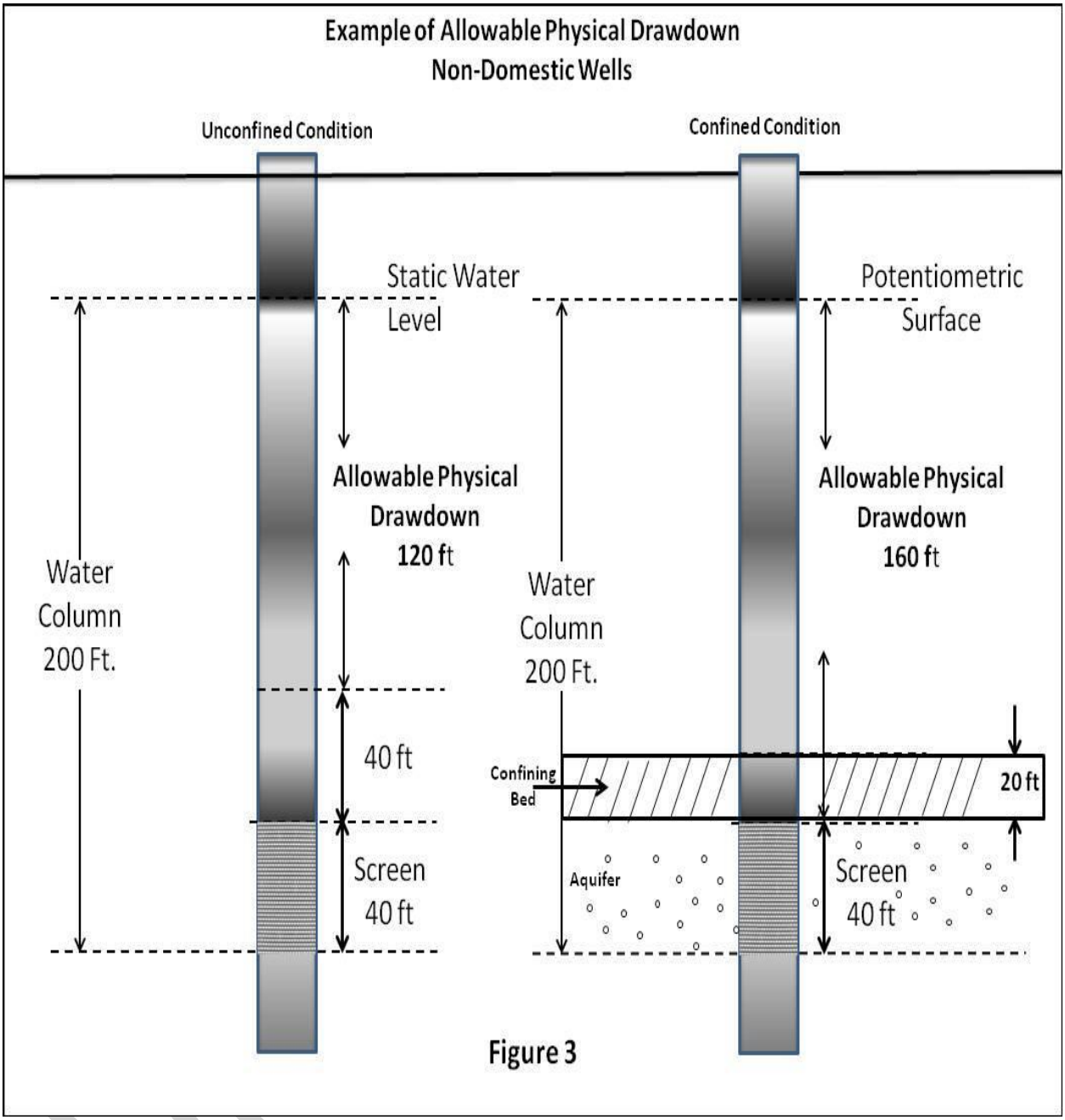



**Figure 2**

From *Guidelines for the Assessment of Drawdown Estimates for Water Right Application Processing* (New Mexico Office of the State Engineer Hydrology Bureau Report 05-17, May 10, 2017, by Tom Morrison, et. al.).




From *Guidelines for the Assessment of Drawdown Estimates for Water Right Application Processing* (New Mexico Office of the State Engineer Hydrology Bureau Report 05-17, May 10, 2017, by Tom Morrison, et. al.).

Dynamic Drawdown (Self-Induced Drawdown)

- The Theis equation estimates drawdown in aquifer but not inside of the well
- Dynamic drawdown represents drawdown inside of casing
- Dynamic drawdown represents fluctuating drawdown as pumps are cycled on and off

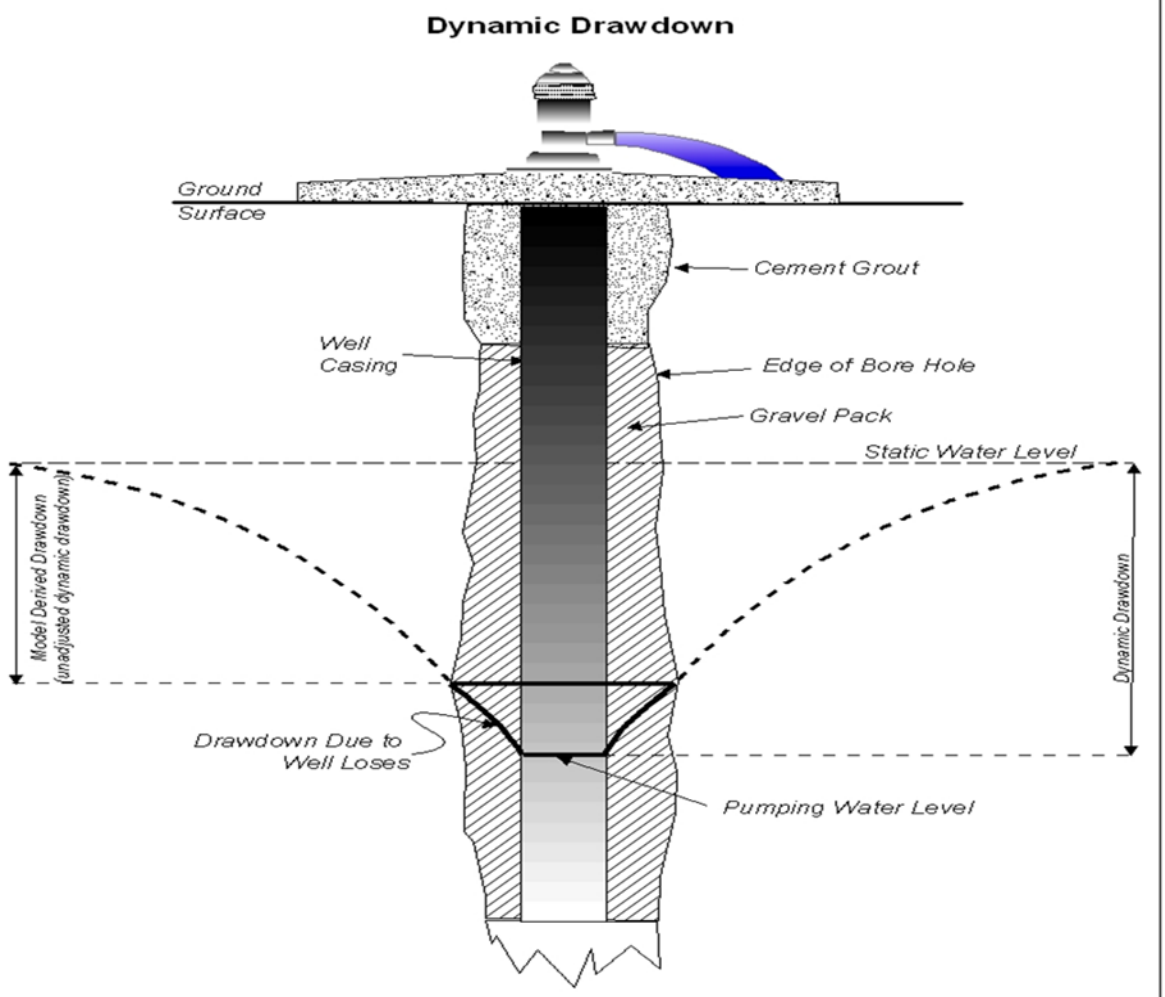



Figure 4

From: *ASSESSMENT OF DRAWDOWN ESTIMATES*, Training manual by Tom Morrison, 2017