RECLAMATION
Managing Water in the West

Upper Arkansas River Basin Public Water Supply Alternatives Viability Analysis

Water Supply Alternatives for Hamilton, Kearny, and Finney Counties, Kansas

Great Plains Region, Oklahoma-Texas Area Office
Kansas Water Office
Southwest Kansas Groundwater Management District #3

U.S. Department of the Interior
Bureau of Reclamation

June 2014

Mission Statements

The U.S. Department of the Interior protects America's natural resources and heritage, honors our cultures and tribal communities, and supplies the energy to power our future.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

TABLE OF CONTENTS

Figures

Tables

Appendices

Executive Summary

Several small communities in western Kansas along the Arkansas River Valley have reported difficulties providing municipal water demands due to their existing water supply quality and/or quantity. The existing water supplies in the area consist of bedrock aquifers and the Ogallala Aquifer. Many unknowns still exist with the bedrock aquifers and difficulties providing clean and reliable drinking water have been reported. The Ogallala aquifer has degraded water quality due to the influence of the Arkansas River.

The water quality issues that the study area is experiencing are sophisticated with several U. S. Environmental Protection Agency (EPA) primary and secondary maximum contaminant level violations.

The Bureau of Reclamation's Oklahoma-Texas Area Office in cooperation with the Kansas Water Office, and Southwest Kansas Groundwater Management District #3, and with assistance from Wichita State University Environmental Finance Center and Kansas Department of Health and Environment prepared this Viability Analysis (Analysis) of municipal water supply alternatives for the study area. The Analysis documents the water quality and quantity concerns for the small communities in Hamilton, Kearny, and Finney Counties that are west of Garden City, as shown in Figure ES-1. The purpose of this Analysis is to make a cursory evaluation of the potential costs, benefits, and impacts of proposed alternatives for each of the communities in the study area and make a comparison of these alternatives relative to one another. It also includes projected future demands, potential sources of water, water treatment alternatives, and an evaluation of potential alternatives.

Kansas Water Office developed the estimated 2050 water demand projections for the communities in the study area. Kansas Water Office utilized a conservative method, assuming a one percent increase in population growth. These projections indicate varying rates of modest increases though out the study area. Syracuse and Holcomb were identified to have insufficient water rights to meet their projected 2050 demands.

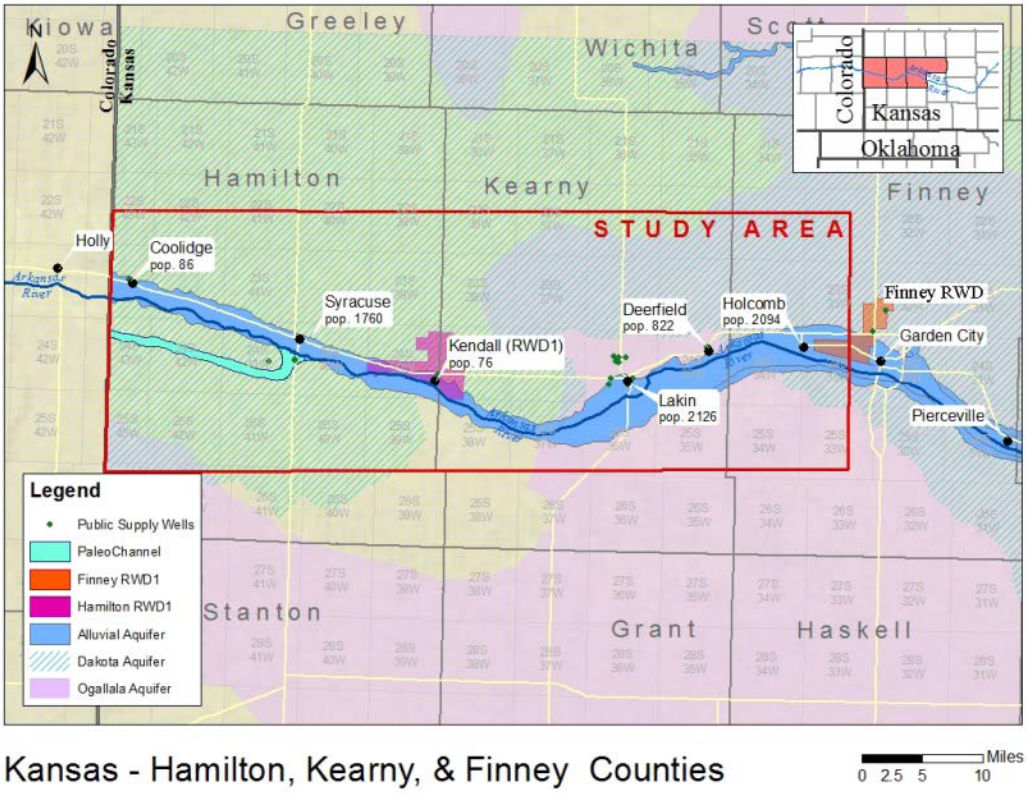


Figure ES-1. Cities and groundwater resources in the Study Area.

With communities facing water quantity and quality issues, the State of Kansas views the development of regional public water supply systems as a key state strategy for ensuring that small systems attain and maintain technical, financial and managerial capacity. The Kansas Legislature has enacted various pieces of legislation to encourage local government units to cooperate for their mutual benefit. This opportunity was explored through this analysis by evaluating how communities could share infrastructure and/or operation and maintenance (O&M) resources in the study area.

The list below describes the water supply alternatives evaluated as part of this Analysis.

Arkansas River/Alluvium: The Arkansas River/Alluvium is experiencing water quality issues and is closed to further appropriations and was not considered further.

Ogallala Aquifer: Most of the wells in northeastern Hamilton, Kearny, and Finney Counties obtain water from the Ogallala formation. The Ogallala is primarily recharged from precipitation. Where the Ogallala underlies and is hydraulically connected to the alluvial aquifer, downward migration of alluvial groundwater provides additional recharge. Groundwater levels have declined in southwest Kansas due to decreased recharge from the Arkansas

River and pumping from the aquifer. Municipal groundwater supplies from the Ogallala have been impacted by salinity and nitrate contamination. In areas of Kearny and Finney Counties where irrigation canals are present, canal seepage can provide a substantial amount of additional recharge.

Dakota Aquifer: The Dakota aquifer lies beneath the High Plains aquifer throughout the study area. Water from the Dakota may exceed the recommended concentration of total-dissolved solids, chloride, sulfate, fluoride, nitrates, iron, manganese, and selenium. The water quality of the Dakota is also characterized by high gross alpha particles, iron and combined radium 226 and 228.

Paleo Aquifer: The Paleo aquifer in western Hamilton County is an aquifer located in the paleo era Arkansas River channel. Monitoring wells are located in the alluvium and the Paleo Aquifer south of the Arkansas River and at Colorado-Kansas State line to record elevation and specific conductance. This information indicates that this source is or at least partially separated from the Arkansas River alluvium. The information on these wells are at: Monitoring well in the Alluvium at Colorado-Kansas Stateline, 0.5 miles south of the Arkansas River and, Monitoring well in the Paleo Aquifer at the Colorado-Kansas Stateline, 2.0 miles south of the Arkansas River.

Purchased Supplies: Other alternatives which were considered included the purchase of treated water from two public water providers within the study area (City of Lakin and Wheatland Water) that may have excess treatment capacity and water rights.

Alternatives were formulated based on their ability to meet the planning objectives of providing water, meeting public drinking standards and the estimated 2050 water demand of the communities.
The major considerations or concepts explored in the development of the alternatives were:

- Individual advanced water treatment for each community.
- Importation of high quality water that requires minimal water treatment. The two options for importation are the Paleo Aquifer and Ogallala Aquifer from a location not influenced by the Arkansas River.
- Development of a Regional Authority to construct, operate, and maintain the individual treatment systems of the locally impaired sources. For the purpose of this report, it was assumed that a 40% reduction in the operation and maintenance (O&M) of the facilities could be realized from the Regional Authority.
- Development of a Regional Authority to construct, operate, and maintain the infrastructure required for the importation of fresh water.

- Purchase and conveyance of treated water from other public water providers.

Alternatives were evaluated and ranked with regard to specific screening criteria related to *Effectiveness, Efficiency, Acceptability, and Completeness.* The purpose of this viability analysis is to (1) formulate and evaluate, using *preliminary-level* design and cost estimates, a range of potentially viable alternatives to meet identified planning objectives, and (2) determine which alternative(s), if any, are viable and could be further studied.[1]

Alternatives involving regionalization, both with a sharing of O&M and regional infrastructure ranked well for Hamilton County. The sizes of the communities are small, which indicate a sharing of resources and the cost of developing or maintaining existing water supplies is the most viable option. A more detailed assessment is recommended to define a Regional Authority and if it could benefit Hamilton County. The purchase of treated water from existing water purveyors scored high in Kearny and Finney Counties.

A cursory look at the capability of the entities to pay for the alternatives was undertaken. EPA affordability criterion for drinking water systems was utilized for this Analysis. The EPA established criteria is 2.5 percent of household income benchmark for affordability for drinking water supplies and is based on acceptability of fee increases by lending institutions and the cost of other utilities. The estimated annual payment capability of each entity was compared to the combined annualized capital costs (assumes three years of interest during construction) and annual O&M costs of the alternatives.

The results of the preliminary comparison of affordability suggest that Coolidge and Kendall would have difficulty paying for any of the recommended alternatives without significant financial assistance. The results also show that Deerfield, although below the financial capability threshold for each alternative, is within the limits of uncertainty for affordability of all of their alternatives. The remainder of the entities were under the threshold.

Public meetings were held in Garden City, Lakin, and Syracuse, Kansas on February 25th, and 26th, 2014. The meetings consisted of an overview of the water quality concerns and a discussion of the alternatives as listed in this report. All alternatives were well received, but public input was inadequate to rank the public acceptability of various alternatives.
Additional discussions of regionalization and purchase of water should occur and these are considered critical in determining which alternatives are acceptable and be considered for further study.

---

[1] Reclamations cost estimating definitions and procedures are outlined in Directives and Standards FAC 09-01, *Cost Estimating*, *Reclamation Directive on Cost estimating*.

Several unknowns were identified through the public meetings. The depth, extent, and characterization of the Paleo aquifer are unknown. Identifying these unknowns would be the next step before utilizing this source as an alternative. Unknowns were also identified on the quality and sustainability of the Dakota Aquifer. Coolidge and Hamilton County Rural Water District No. 1 have experienced “spikes” in poor water quality from their wells in the Dakota Aquifer.

The next steps in the process would be to continue gather information and public input. Some of the additional steps would be:

- Gather information on the Paleo Aquifer to determine the long-term sustainability. The extent of this aquifer in Colorado is currently unknown.
- Conduct pumping studies on the Dakota aquifer sources for Hamilton RWD1 and Coolidge, as well as Holly CO.
- Seek public input from the local communities to determine the viability of the alternatives. This input will need to be factored into the analysis.
- Several alternatives included combining infrastructure and the sale of treated water. It is critical the communities in the study area discuss and work together to ensure a long-term supply for the study area.
- Further exploration of the constraints to the development of a Regional Water Authority.
- Degradation of the Ogallala Aquifer water quality from the influence of the Arkansas River and been identified. The extent of this degradation should be identified before proceeding to identify the area of the aquifer at risk.

Page intentionally left blank)

Introduction

Background

Hamilton, Kearny and Finney Counties are located in the Arkansas River Basin in southwest Kansas. The proposed study area (Figure 1) includes portions of these Counties. Cities and communities located within the project area include Coolidge, Syracuse, Kendall, Lakin, Deerfield and Holcomb. Hamilton County Rural Water District No. 1 (Hamilton RWD1) serves the unincorporated community of Kendall and the surrounding area. Finney County Rural Water District No. 1 (Finney RWD1) services the unincorporated area between Garden City and Holcomb. Table 1 provides the 2010 U.S. Census data for each county and community in the study area.

Table 1. Population of Counties and Communities within Study Area

County	**Population**
Hamilton	2,265
Kearny	4,169
Finney	37,013
Community	**Population**
Coolidge	95
Syracuse	1,812
Kendall	85
Lakin	2,216
Deerfield	700
Holcomb	2,094

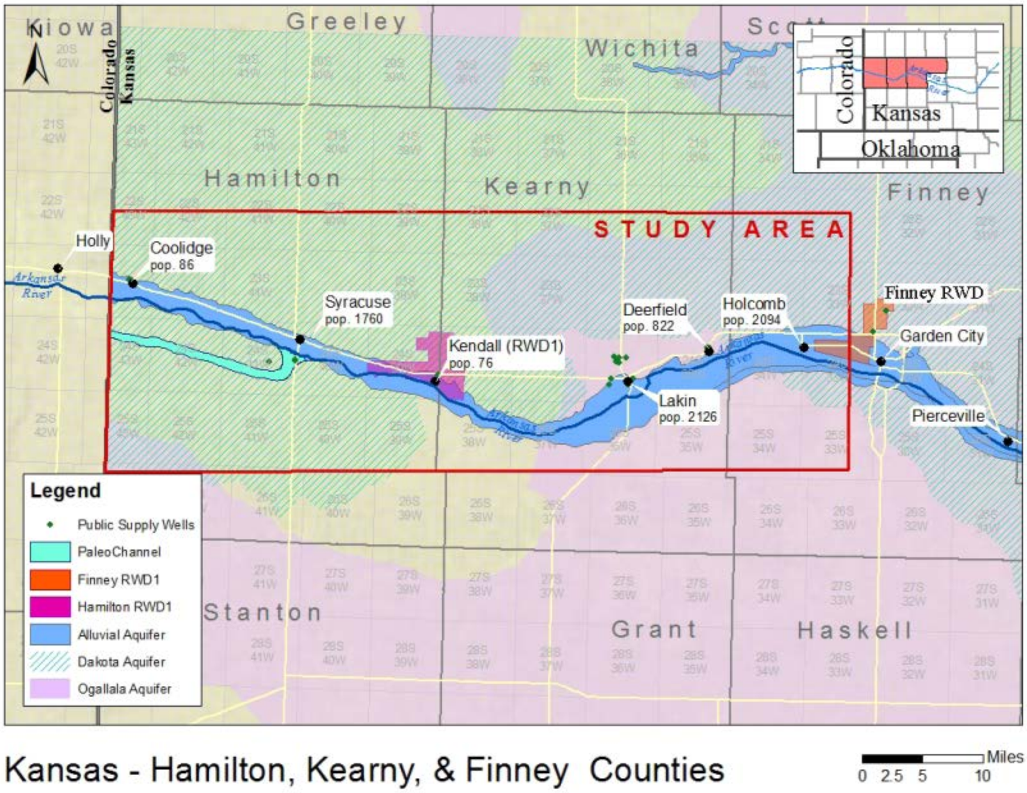


Figure 2. Cities and groundwater resources in the Study Area.

The water supply in the Study Area consists primarily of the Arkansas River and alluvium, the Ogallala and Dakota aquifer, and a small local aquifer in Hamilton County (Paleo aquifer).

The Arkansas River begins near Leadville, Colorado and flows through the southern Front Range of the Rocky Mountains and across southeast Colorado into southwest Kansas. The southern Front Range has a high water demand and utilizes the Arkansas River to meet this demand. The quality of the water in the river system continually degrades as it approaches Kansas. Figure 2 is a picture of the river taken near Coolidge.

The High Plains aquifer is a regional aquifer system composed of several smaller units that are geologically similar and hydrologically connected. The most important component of the High Plains aquifer is the Ogallala aquifer (Ogallala) located generally in the western third of Kansas. The Ogallala largely consists of silt and clay beds interlayered with sand and gravel, which is mostly unconsolidated material.

Beneath the High Plains aquifer is a much older, consolidated bedrock, usually limestone, sandstone, or shale. Some of these layers form the Dakota Aquifer. Layers of permeable sandstone in the Dakota Formation are connected to the High Plains aquifer in parts of southwestern or south-central Kansas. The Dakota aquifer consists of sandstone bodies in the Cheyenne Sandstone, Kiowa

Formation, and Dakota Formation in Kansas. The sandstone bodies are encapsulated in shales that are a part of these geologic units. The combined thickness of these geologic units ranges up to more than 700 feet in parts of west-central Kansas. In western and parts of central Kansas, the Dakota aquifer system is separated into upper and lower aquifers by an aquitard within the Kiowa Formation. The upper Dakota aquifer consists of the sandstones in the Dakota Formation and the lower Dakota aquifer consists of sandstones in the lower part of the Kiowa Formation and Cheyenne Sandstone[2].

Figure 3. Arkansas River near Coolidge (Kansas Biological Survey).

The groundwater levels have declined along the Arkansas River corridor in the study area, in response to pumping from the alluvial and High Plains aquifers primarily for agricultural use. In portions of the study area, the water level declines have produced a downward hydraulic gradient that results in flow from the alluvium to the underlying Ogallala aquifer[3]. The water quality in the study area has degraded due to this inflow of lower quality water and as this water continues to migrate, it is affecting previous fresh water sources. The Dakota Aquifer is also experiencing quality issues due to naturally occurring rock formations.

The water quality issues that the study area is experiencing are sophisticated with several U. S. Environmental Protection Agency (EPA) primary and secondary maximum contaminant level (MCL) violations. Increased water treatment costs due to locally poor groundwater and surface water quality and changing requirements of the Safe Drinking Water Act, have renewed local interest in alternative means of obtaining safe and clean water supplies for most of the Arkansas River Basin of Colorado and Kansas.

---

[2] Kansas Department of Agriculture Upper Arkansas River Subbasin Hydrogeology

[3] Whittemore, Donald Kansas Geological Survey

Southwest Kansas Groundwater Management District No. 3 (GMD3) was organized under the 1972 Groundwater Management District Act to conserve groundwater resources, prevent economic deterioration, and provide for the stabilization of agriculture by establishing the right of local users to determine their own destiny with respect to the use of groundwater. GMD3, Kansas Water Office (KWO), Wichita State University- Environmental Finance Center, (WSU); with the Bureau of Reclamation wish to identify alternative means of supplying potable water to the local communities in the area.

Study Authority

This report was conducted under the authority of the Federal Reclamation Act of June 17, 1902 (32 Stat. 388, 43 U.S.C. 391), as amended.

Purpose

KWO and GMD3 requested Reclamation to conduct an evaluation of public water supply options for the communities in the study area. The communities include Coolidge, Syracuse, Kendall and Deerfield, as well as Hamilton RWD1, all of which have experienced water supply quantity and quality issues of varying degrees.

KWO, GMD3, WSU and Reclamation collaborated through a series on conference calls during the preparation of this report.

Scope

The scope of this investigation covered a broad range of issues:

- Develop future demands for the study area.
- Identify potential sources of treatable water within the study area.
- Identify efficient treatment alternatives for the potential water sources.
- Formulate and evaluate alternatives from various sources within the study area.
- Develop preliminary-level designs and cost estimates for the various alternatives.
- Explore the institutional issues with the development of a regional water supply.
- Compare the advantages and disadvantages of advanced water treatment of local sources versus the importation of higher quality water.
- Determine which alternatives are viable.

Public Involvement

GMD3 met with representatives from the cities of Deerfield, Lakin, and Syracuse to discuss current water issues and the steps necessary to address those issues. GMD3 also met on July 16, 2012 in a regularly scheduled joint planning meeting of commissioners and staff from Cities of Holcomb and Garden City and Hamilton and Finney Counties to address an agenda item of water supply and water treatment needs.

Public meeting were held in Garden City, Lakin, and Syracuse on February 25th, and 26th 2014. The meetings consisted of an overview of the water quality concerns and a discussion of the alternatives as listed in this report. Specific concerns or items of interest brought forth in the public meetings will be referenced in the conclusions of each community's alternatives. The meeting notes are included in the appendices.

Problems and Needs

Water Quality

Public water supply systems in the study area are experiencing water quality issues. Water in the Arkansas alluvium, Ogallala, and Dakota aquifer are experiencing quality problems that are due to naturally occurring contaminants and the impaired quality of the Arkansas River.

A 2009 KWO ***Upper Arkansas Basin High Priority Issue*** discusses the water quality issues affecting the surface and groundwater within the study area.

"The Arkansas River in western Kansas is among the most saline in the country. The contamination is caused by high levels of salinity in the river as it enters Kansas from eastern Colorado (Figure 3 &4).In 2000; Kansas began to address the salinity issue by developing a Total Maximum Daily Load (TMDL) on the upper Arkansas River for sulfate. The Colorado Water Quality Control Division (Division) was consulted in the development of the TMDL. The sulfate TMDL is now consistent between Kansas and Colorado.

In 2007, the KDHE completed a TMDL to address selenium impairments along the Arkansas River from the Colorado Stateline to Pierceville. Selenium concentrations are high during summer (April to September) when deliveries to Kansas irrigation ditches are made by Colorado pursuant to the Arkansas River Compact. Moreover, concentrations during the irrigation off-season (October to March) remain elevated with the onset of drier conditions. The greatest concentrations of selenium are in the immediate vicinity of the river where large-

scale irrigation diversion of ground water begins east of the Bear Creek fault in Kearny County. In short, irrigation return flow deliveries from Colorado are poorer water quality than main stem deliveries, and the best water quality is from releases from John Martin Reservoir that never is diverted for Colorado farmland irrigation. The diminishment of streamflow east of Garden City confines the intrusion of saline water to the immediate alluvium of the river above this point.

Data from the U.S. Geological Survey and the Kansas Geological Survey (KGS) show uranium concentrations in the river during saline low flows generally exceeding the Environmental Protection Agency (EPA) drinking water standards. The dissolved concentrations of uranium are well correlated with sodium, sulfate, and chloride concentrations.

In general, selenium and uranium concentrations increase with increasing salinity of the surface and ground waters. Just as the primary source of the sulfate in the waters is natural (leaching of rocks and soils), the primary source of the uranium is natural. However, the high concentrations of both sulfate and uranium in the Arkansas River surface water and ground water affected by the river are not natural but the result of the evapotranspiration consumption of water in Colorado, leaving the residual salts dissolved in a much smaller volume of water.

The saline water from the Arkansas River seeps into the subsurface alluvial aquifer and then the Ogallala-High Plains aquifer in Kansas, thereby contaminating the ground water with high sulfate and uranium concentrations (Figure 4). In some cases, additional uranium may be derived from the sediments in which ground waters reside, and in other cases, some uranium may be removed by chemical conditions in ground water or by the sediments"[4].

[4] 2009 Kansas Water Plan

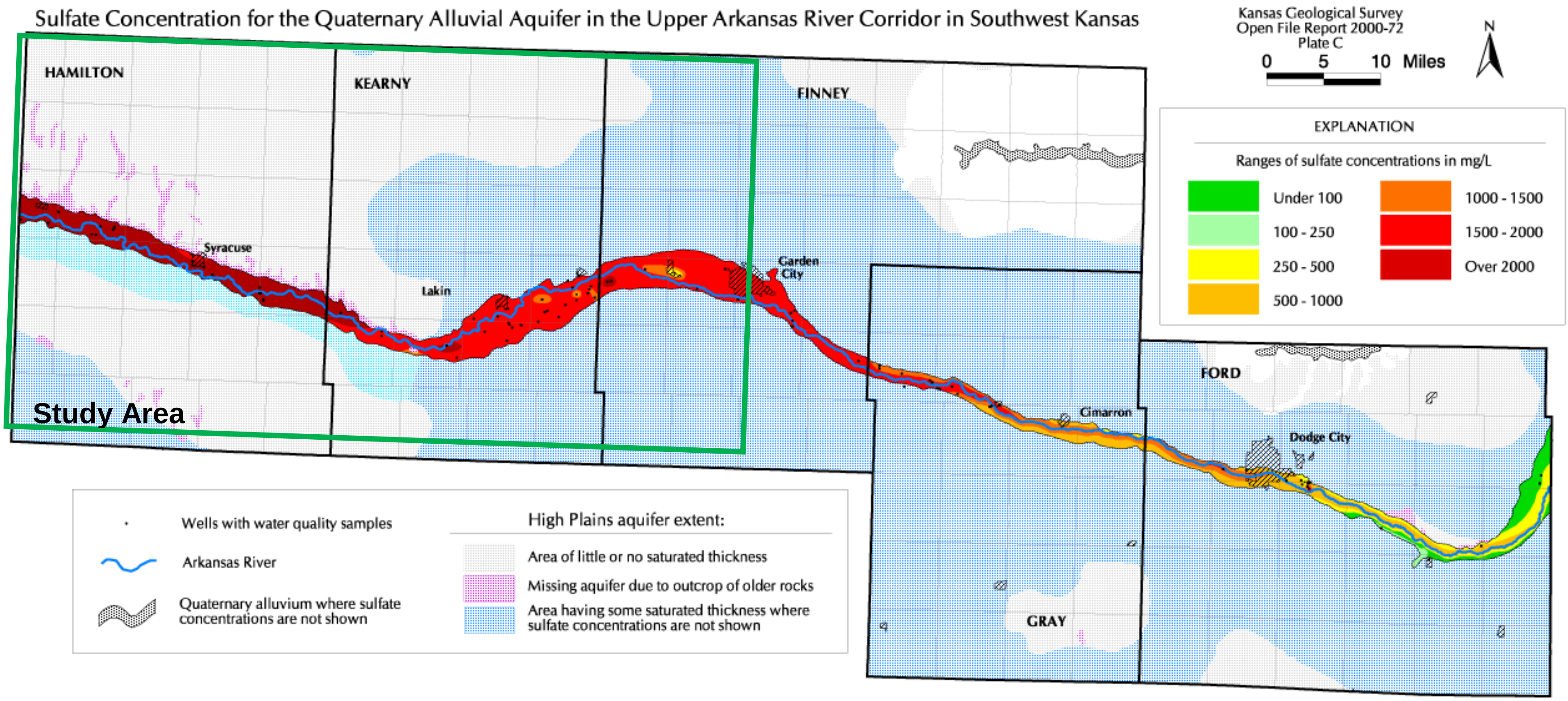


Figure 4. Sulfate Concentrations of the Arkansas Alluvial Aquifer.

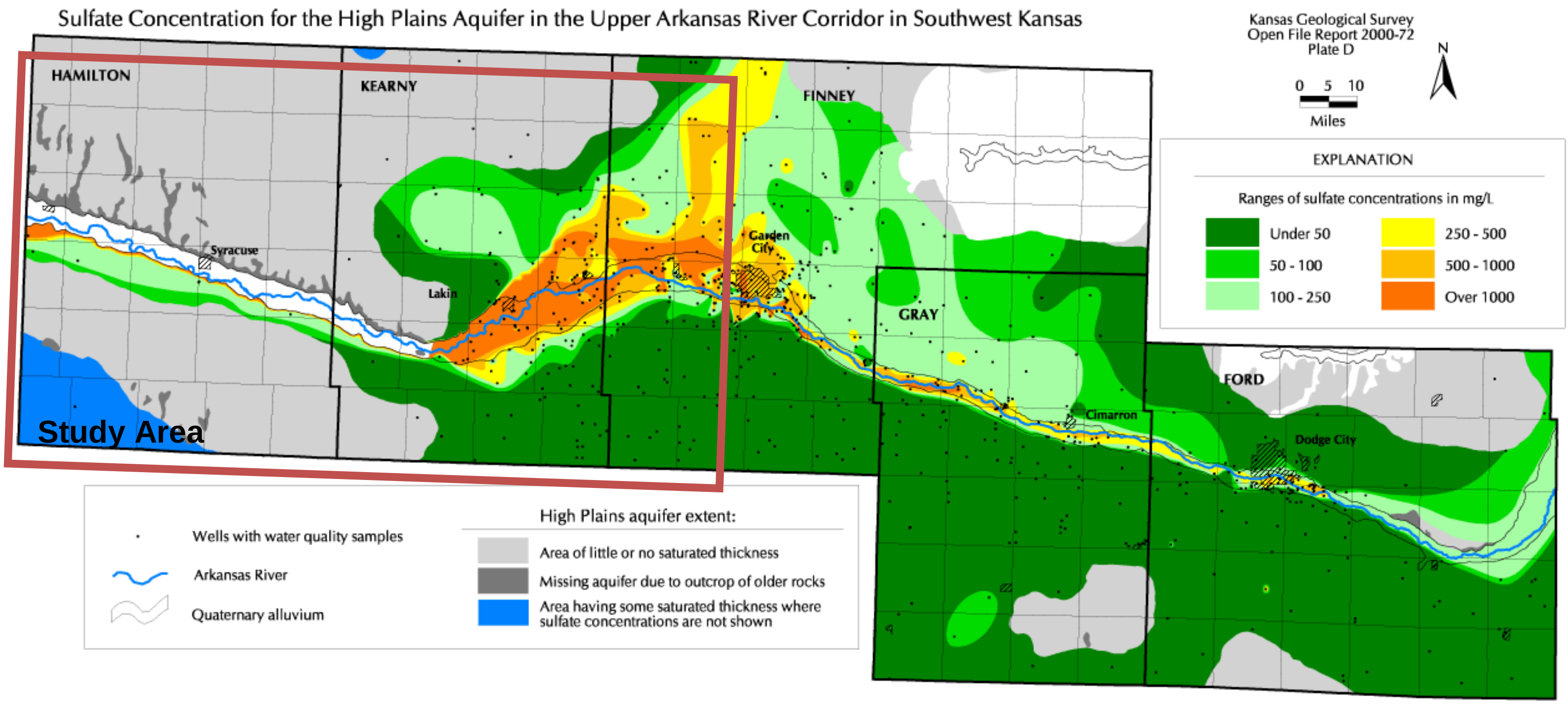


Figure 5. Sulfate Concentrations for the High Plains Aquifer.

KDHE monitors ambient water quality and has classified the Arkansas River at Coolidge as category 5 impaired water for water supply with low priority for total maximum daily load (TMDL) development due to gross alpha particles, uranium, and fluoride. The Arkansas River near Deerfield is classified as category 5 impaired water with low priority for development of a TMDL due to fluoride.

Table 2. Environmental Protection Agency Integrated Reporting Categories for 303(d) submissions

Category/ Subcategory	Description
Category 1	All designated uses are supported, no use is threatened.
Category 2	Available data and/or information indicate that some, but not all, designated uses are supported.
Category 3	There is insufficient available data and/or information to make a use support determination.
Category 4	Available data and/or information indicate that at least one designated use is not being supported or is threatened, but a TMDL is not needed.
• Category 4a	A State developed TMDL has been approved by EPA or a TMDL has been established by EPA for any segment-pollutant combination.
• Category 4b	Other required control measures that are expected to result in the attainment of an applicable water quality standard within a reasonable period.
• Category 4c	The non-attainment of any applicable water quality standard for the segment is the result of pollution and is not caused by a pollutant.
Category 5	Available data and/or information indicate that at least one designated use is not being supported or is threatened, and ***a TMDL is needed***.

TMDLs have been developed for the Arkansas at Coolidge and Deerfield for boron, Coolidge and Deerfield for sulfate and from Coolidge to Garden City for selenium for water supply. High levels of selenium have been measured in the groundwater and supply wells, particularly those close to the river.

Communities in the study area are experiencing complex issues associated with water quality. The treatment processes vary for the various contaminants. These issues consist of inadequate resources for the construction of new treatment facilities and O&M of existing facilities as well as adequate disposal of effluent stream. The communities, as well as rural homes and businesses along the Arkansas River corridor between the Colorado-Kansas Stateline to Garden City are struggling to have access to quality water.

The U.S. Environmental Protection Agency (EPA) has developed national primary drinking water standards that identify a list of contaminants and their maximum contaminant levels (MCLs). EPA has also developed National Secondary Drinking Water Regulations (secondary standards), which are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (skin or tooth discoloration) or aesthetic effects (taste, odor, or color) in drinking water. EPA recommends secondary standards to water systems but does not require compliance.

Kansas Department of Health and Environment (KDHE) reports that Lakin has consistently violated the MCL for uranium. In 2009, Finney County RWD at Holcomb was in violation of the Radium MCL and in 2007 and 2008 for Uranium as well. Coolidge has also been in violation of the radium MCL within the past five years.

The Kansas Geological Survey (KGS) worked with GMD3 staff in 2009 and 2010 to take water samples from the Arkansas River, including some reconnaissance samples from domestic, stock, and irrigation wells in the area aquifers. Data from this work indicated that the Arkansas River is a source of groundwater contamination and that many wells on the north side of the river do not meet drinking water standards for uranium and/or other contaminants[5]. Samples were tested for pH, nitrate-nitrogen, uranium, fluoride, sulfate, and chloride. Specific conductance was used to estimate total dissolved solids. The range of values tested, as well as the primary and secondary contaminant levels set by the EPA are shown in Table 3.

Table 3. Arkansas River sample results compared to the MCLs & MLCG (Whittemore and Ahring 2010)

Analyte	MCL	Secondary Standard MCLG[1]	Tested Contaminant Range
Nitrate-Nitrogen	10 mg/L	10 mg/L	<0.1 – 11.9 mg/L
Uranium	30 µg/L	30 µg/L	1.5 – 90.9 µg/L
Fluoride	4 mg/L	2 mg/L	0.21 – 1.04 mg/L
Sulfate	N/A	250 mg/L	28.6 – 2801 mg/L
Chloride	N/A	250 mg/L	3.6 – 642 mg/L
Lab pH	N/A	6.5-8.5	6.89 – 7.65
Estimated TDS[2]	N/A	500 mg/L	241 – 5270 mg/L

[1] Maximum Contaminant Level Goals (MCLG)

[2] Total Dissolved Solids (TDS)

Tables 4-9 show samples exceeding of primary and secondary MCL for each community. This reported contaminant level is the maximum measured value. The maximum values <u>are</u> utilized in determining compliance but they may not be the only values utilized. For example nitrate is an acute contaminant, therefore a single result above the MCL of 10 mg/L results in a violation. For all other primary contaminants, an exceedance of an MCL results in quarterly monitoring being required and the MCL violation is determined based on the running annual average. Exceedance of a secondary contaminant MCL does not require additional monitoring and will not result in a violation.

This is the value that water supply systems are required to include in their annual consumer confidence reports, but it is not strictly utilized to determine if a city is in violation of an MCL. Water supply systems that have measured contaminant levels close to the MCL are required to take frequent measurements, and the average measured value is utilized to determine MCL violations. The city of Holcomb has not had an MCL violation since 2007, when they were in violation of the coliform limit.

Every city within the project area has multiple analytes with contaminant levels above the MCLG or SMCL. These are goals, rather than limits. A contaminant being in excess of these goals does not pose a significant health risk to the public, but it may affect taste, smell, and/or

[5] Whittemore D., Petroske, Magnuson, Ahring, & Norquest, 2010 and Whittemore & Ahring, 2010

color, which reduces public acceptability. EPA drinking water violations, as well as analysis results that do not meet the EPA's maximum contaminant level goals (MCLG) over the past 5 years for Coolidge, Syracuse, Hamilton RWD1, Lakin, Deerfield, and Holcomb respectively are listed in tables 4-9.

Table 4. Analytes measured in excess of MCLs & MCLG - Coolidge from 2006–2011

Analyte	Year	MCL	Secondary Standard (MCLG)	Tested Contaminant Level
Bromodichloromethane	2010	N/A	0.0	0.5 µg/L
Bromoform	2007	N/A	0.0	0.5 µg/L
Bromoform	2010	N/A	0.0	2.3 µg/L
Coliform	2008	Presence not detected in more than one sample	N/A	Presence detected in more than one sample (neg. for E Coli)
Coliform	2010	Presence not detected in more than one sample	N/A	Presence detected in more than one sample (negative for E. Coli)
Iron	2007	N/A	0.3 mg/L	0.44 mg/L

Table 5. Analytes measured in excess of MCLs &MCLG - Syracuse from 2006-2011

Analyte	Year	MCL	Secondary Standard or MCLG	Tested Contaminant Level (µg/L)
Bromoform	2007	N/A	0.0	1.2
Bromoform	2010	N/A	0.0	3.6

Table 6. Analytes measured in excess of MCLs & MCLG – Hamilton RWD1 from 2006-2011

Analyte	Year	MCL	Secondary Standard or MCLG	Tested Contaminant Level
Bromodichloromethane	2007	N/A	0.0	0.6 µg/L
Bromoform	2007	N/A	0.0	0.57 µg/L
Iron	2007	N/A	0.3 mg/L	0.47 mg/L
Iron	2010	N/A	0.3 mg/L	0.69 mg/L
Manganese	2010	N/A	50 µg/L	80 µg/L

Table 7. Analytes measured in excess of MCLs and MCLG - Lakin from 2006–2011

Analyte	**Year**	**MCL (**µg/L)	**Secondary Standard or MCLG(**µg/L)	**Tested Contaminant Level(**µg/L)
Bromodichloromethane	2008	N/A	0.0	0.79
Bromoform	2008	N/A	0.0	1.3
Uranium	2006	30	30	31 – 38
Uranium	2007	30	30	35 – 64
Uranium	2008	30	30	35 – 59
Uranium	2009	30	30	43
Uranium	2010	30	30	31 – 40

Table 8. Analytes measured in excess of MCLs & MCLG- Deerfield from 2006-2011

Analyte	**Year**	**MCL**	**Secondary Standard (MCLG)**	**Tested Contaminant Level**
Bromodichloromethane	2007	N/A	0.0	0.6 µg/L
Bromoform	2007	N/A	0.0	1.8 µg/L
Bromoform	2007	N/A	0.0	3.3 µg/L
Sulfate	2006	N/A	250 mg/L	340 mg/L
Sulfate	2007	N/A	250 mg/L	360 – 390 mg/L
Sulfate	2010	N/A	250 mg/L	420 – 480 mg/L
Total Dissolved Solids	2006	N/A	500 mg/L	740 mg/L
Total Dissolved Solids	2007	N/A	500 mg/L	740 – 840 mg/L
Total Dissolved Solids	2010	N/A	500 mg/L	860 – 940 mg/L

Table 9. Analytes measured in excess of MCLs &MCLG – Holcomb 2007-2012

Analyte	Year	MCL	Secondary Standard (MCLG)	Tested Contaminant Level
Coliform	2007	Presence not detected in more than one sample	N/A	Presence detected in more than one sample
Total Haloacetic Acids	2007	60 ppb	0 ppb	8 ppb
TTHM	2007	80 ppb	0 ppb	7 ppb
Conductivity	2007	N/A	1500 UMHO/CM	1600 UMHO/CM
Hardness	2007	N/A	400 mg/L	740 mg/L
Sulfate	2007	N/A	250 mg/L	700 mg/L
Arsenic	2007	10 ppb	0 ppb	3.6 ppb
Total Dissolved Solids	2007	N/A	500 mg/L	1200 mg/L
Combined Radium	2008	5 pCl/L	0 pCl/L	1 pCi/L
Combined Uranium	2008	30 µg/L	0 µg/L	26 µg/L
Gross Alpha, excl. Radon & Uranium	2008	15 pCl/L	0 pCl/L	4.2 pCi/L
Arsenic	2010	10 ppb	0 ppb	2.6 ppb
TTHM	2010	80 ppb	0 ppb	5 ppb
Conductivity	2010	N/A	1500 UMHO/CM	1800 UMHO/CM
Corrosivity	2010	N/A	0 Lang	0.52 Lang
Hardness	2010	N/A	400 mg/L	800 mg/L
Iron	2010	N/A	0.3 mg/L	0.4 mg/L
Sodium	2010	N/A	100 mg/L	120 mg/L
Sulfate	2010	N/A	250 mg/L	740 mg/L
Total Dissolved Solids	2010	N/A	500 mg/L	1300 mg/L
Combined Radium	2011	5 pCl/L	0 pCl/L	1.3 pCi/L
Combined Uranium	2011	30 µg/L	0 µg/L	29 µg/L
Gross Alpha, excl. Radon & Uranium	2011	15 pCl/L	0 pCl/L	20 pCi/L
Combined Uranium	2012	30 µg/L	0 µg/L	31 µg/L
Gross Alpha, excl. Radon & Uranium	2012	15 pCl/L	0 pCl/L	17 pCl/L

Water Supply Treatment Issues

The communities in the study area use a variety of treatment methods for the Ogallala and Dakota aquifers. Each of the communities use treatment methods that were approved based on their water quality, but as previously discussed, the water quality of both sources is changing. The communities of Syracuse, Hamilton RWD1, Deerfield, and Holcomb treat their water supplies only by chlorination. Syracuse does not have water quality issues using this method, but Hamilton RWD1, Deerfield, and Holcomb are at risk of not meeting drinking water standards using chlorination alone. Alternative water treatment methods for Hamilton RWD1, Deerfield, and Holcomb will be examined in this assessment. Finney RWD1 is utilizing treated water from Wheatland Electric Cooperative (Wheatland) and does not have water quality issues.

The communities of Coolidge and Lakin have decided to use advanced water treatment methods to meet drinking water quality standards. Coolidge has constructed an ion exchange facility to treat the Dakota Aquifer, and Lakin is constructing a nanofiltration (NF) facility to treat the water from the Ogallala Aquifer. Coolidge has however reported difficulty consistently operating their ion exchange facility; additional water sources and water treatment methods are considered for Coolidge in this assessment. Treatment methods and associated constituent removal are defined in the Opportunities section.

Projected Demands

The KWO developed the methodology to project population and water use trends within the study area. Decadal population data for 1990, 2000 and 2010 is available for these cities and counties through the U.S. Census Bureau. Census data for these communities indicated varying rates of modest declines or increases. The projections were compared with two previous sets of population data: KWO 1999 projections and Wichita State University (WSU) projections completed in 2012. All projections indicate a varying rate of modest increases or declines. For future demand, the 2010 census data was projected to 2050, both with a constant population and with a 1% annual growth. These projections fall within the KWO and WSU projection range and were used for the low and high population projection range. Figure 5 illustrates population level and projection data through 2050 for Hamilton, Kearny, and Finney County.

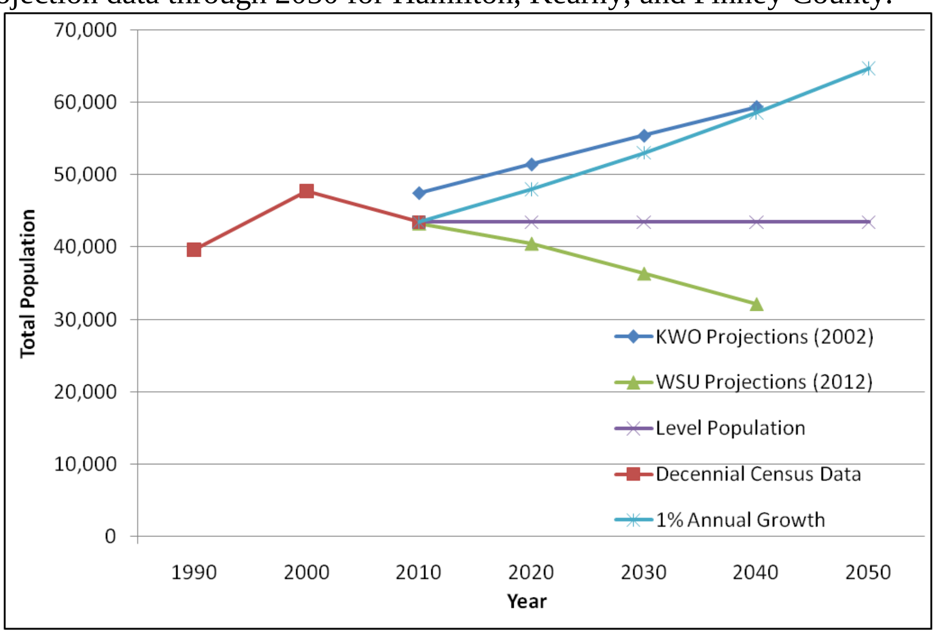


Figure 6. Hamilton, Kearny, and Finney Counties Population Data and Projections.

Projected water use demand for the study area is based on estimated percentage of county populations within the study area. Ninety percent (90%) of the population of Hamilton and Kearny counties and twenty five percent (25%) of Finney County are located in the study area.

The municipal water use in gallons per capita per day (GPCD) was obtained from the 2010 Kansas Municipal Water Use report. Two methods of water demand projections in 2050 were utilized:

1. The five year average usage in GPCD for the cities and entities within the study area; and
2. The utilization of the five-year regional average use in GPCD.

Kansas' average annual precipitation increases from west to east and is divided into eight regions for determining GPCD averages. Hamilton County falls in Region 1. Kearny and Finney counties lie in Region 2. Table 10 provides the GPCD average for the study area and Region 1 and Region 2.

Table 10. 2005-2010 average GPCD

Municipal water use (Average GPCD)								
Coolidge	Syracuse	Lakin	Deerfield	Holcomb	Hamilton RWD1	Finney RWD1	Region 1	Region 2
270	357	243	149	144	105	81	266	236

Table 11 below provides projected water use demands for each public water supply in the study area assuming 1% annual growth and method two demand projections. The 1% growth is utilized as a conservative approach to the projection. All Kansas water rights are by prior appropriation and each permit holder has an authorized quantity. The Table also lists the authorized quantities, and existing surplus/deficit for each.

Table 11. Study Area Water Use Projections and Authorized Quantities

Community		2010	2020	2030	2040	2050	Authorized Quantities
		Acre-feet per year					
Coolidge	DEMANDS	29	29	30	30	31	37
	Surplus / Deficit	8	8	7	6	5	
Syracuse	DEMANDS	724	779	820	860	901	856
	Surplus/Deficit	132	77	37	4	45	
Hamilton RWD1	DEMANDS	9	10	11	12	13	20
	Surplus/Deficit	11	10	9	8	7	
Lakin	DEMANDS	603	642	664	687	709	1,013
	Surplus/Deficit	410	371	349	326	304	
Deerfield	DEMANDS	117	142	153	164	176	148
	Surplus/Deficit	31	6	5	16	27	
Holcomb	DEMANDS	337	405	459	514	569	350
	Surplus/Deficit	13	55	109	164	219	
Finney.RWD1	DEMANDS	255	282	312	344	380	1,062
	Surplus/Deficit	806	780	750	717	681	
Hamilton Co.	DEMANDS	722	797	880	973	1,075	913
	Surplus/Deficit	191	116	32	60	162	
Kearny Co.	DEMANDS	946	1,046	1,155	1,276	1,409	1,203
	Surplus/Deficit	257	157	48	73	2	
Finney Co.	DEMANDS	2431	2,686	2,967	3,277	3,620	463
	Surplus/Deficit	1,968	2,222	2,503	2,814	3,157	
Total	DEMANDS	6,174	6,816	7,450	8,137	8,883	6,064
	Surplus/Deficit	109	752	1,386	2,073	2,819	

Water Conservation

Water conservation was not considered in the development of the future demand calculations. Conservation efforts, such as variable rate structure, would reduce water demands, but the expected effect would be negligible. Quantifying future water demand while considering conservation efforts is a delicate balance, because a portion of the GPCD for the study area is agricultural in nature and the efficacy of future conservation efforts cannot be guaranteed. Additionally, the sizing and cost of equipment is not greatly affected and in the viability analysis stage, it is better to err on the side of greater capacity to ensure future demands can be met, regardless of the conservation efforts that may or may not be undertaken later.

Socioeconomic Conditions

The project area has a low unemployment rate, but family poverty rates in both Hamilton and Kearny Counties are higher than both state and national levels. The individual poverty rate in Kearny County is higher than state and national levels, and the individual poverty rate in Hamilton County is higher than the state level. The median household income in both Kearny and Hamilton Counties is much lower than the median household income for both the State of Kansas and the United States. The median home values for Hamilton and Kearny Counties are much lower than the median values for the State of Kansas, and the values for both counties are less than half of the median value of homes in the United States. Table 12 provides the demographic data for Hamilton County, Kearny County, the State of Kansas, and the United States.

The percentage of the study area population with income below the poverty level as provided by the U.S. Census Bureau fall within 14.3% to 19.3% (Source: U.S. Census Bureau, Small Area Income and Poverty Estimates (SAIPE) Program, Dec. 2010).

Table 12. Study Area Demographics

Location	Population	Unemployment Rate	Family Poverty Rate	Individual Poverty Rate	Median Household Income	Median Home Value (Owner Occupied)
Hamilton County	2,625	1.7%	11.7%	12.7%	$34,478	$71,600
Kearny County	4,169	1.7%	15.6%	16.3%	$40,965	$81,700
Finney County	36,776	4.3%	10.5%	15.3%	$51,179	$105,300
State of Kansas	2,818,747	5.5%	8.3%	12.2%	$48,394	$118,500
United States	308,745,538	7.2%	9.9%	13.5%	$51,425	$185,400

Opportunities

Development of Regional Water Supplies in Kansas

Kansas encourages the development of regional public water supply systems (Regional Authorities). Regionalization is a key state strategy for ensuring that small systems attain and maintain technical, financial and managerial capacity. The Kansas Legislature has enacted various pieces of legislation to encourage local government units to cooperate for their mutual benefit. Some legislation has been directed at helping public water supply systems improve efficiency through voluntary interlocal cooperation.

Public Wholesale Water Supply District Act[6]

The Public Wholesale Water Supply District Act enables public water supply systems to cooperate through the creation of a separate legal entity for providing wholesale water to the participating entities. Eligible participants include any county, city or other municipal corporation, quasi-municipal corporation or political subdivision of the state.

Public water supply systems wishing to form a wholesale water supply district must enter into agreements by ordinance, resolution or laws of the governing bodies of the participating public

[6] K.S.A. 19-3545 et seq

water suppliers. The agreements must specify the purpose and duration of the agreement; the manner of financing the district and of establishing and maintaining a budget; the precise organization, composition and nature of the district created and the manner of acquiring, holding, and disposing of real and personal property of the district.

The district has the legal authority to obtain loans and grants; issue bonds; acquire land by gift, purchase, exchange, or eminent domain; and to purchase or lease, construct, install, and operate such facilities as necessary to carry out the purposes of the organization.

There is a governing body made up of at least one representative appointed by each participating public agency. The governing body appoints a general manager who is responsible for the management and operation of the district under the general supervision of the governing body.

Twenty-six public wholesale water supply districts have been organized in Kansas to date; fourteen are either actively serving water or have received funding and are under development.

Interlocal Cooperation Act[7]
The Interlocal Cooperation Act provides a mechanism for local governmental units to cooperate with each other in a manner that best suits the geographic, economic, population, and other needs influencing the communities. Eligible participants include any county, city or other municipal corporation, privately owned water system, quasi-municipal corporation or other political subdivision of the state.

Public water suppliers wishing to create an interlocal cooperative enter into agreements by ordinance, resolution or laws of their governing bodies. The agreement specifies the purpose and duration of the agreement, the manner of financing and the administration of the cooperative undertaking. The agreement may create a separate legal entity or may have one of the participating entities by the administrator. If a separate entity is formed, the entity has the power to issue bonds, notes or other indebtedness and to hold property.

Examples of water supply systems formed under this act are Marais des Cygnes Public Utility Authority, Chisholm Creek Utility Authority and Hillsdale Area Water Cooperative.

Public Improvement District Act
Under this act, the governing bodies of any three or more counties may enter into an agreement for interlocal cooperation under the Interlocal Cooperation Act (except counties in a Metropolitan statistical area, MSA) to create a public improvement district for the purpose of constructing, operating and maintaining public infrastructure improvements. A public improvement district may levy a tax upon all taxable real and tangible personal property or to impose a sales tax of not to exceed 50% or both sales and property tax of a period not to exceed 10 years and must be approved by voters in each county. The district is authorized to issue and sell general obligation bonds.

[7] K.S.A. 12-2901 et seq

Special Benefit District[8]
Benefit Districts are a financing and development tool whereby cities can issue general obligation bonds for construction of public improvements and assess the cost to properties that benefit. The bonds are then retired through payment of special assessments by these benefiting properties.

If the benefit district is outside of a city but within three miles of such city, the board of county commissioners where the city is located must approve the creation of the district. If the boundaries of the district cross county lines and the district created would be located within the fringe area of a city, the board of county commissioners of each county where such city is located shall be required to approve the creation of the district by a 3/4 majority vote.

Horsethief Special Benefit District[9]
Specific legislation established board, terms and authority for this district to impose sales tax, issue bonds and impose fees for the purpose of managing recreational facilities within its boundaries.

Community Improvement Districts[10] **(CID)**
The creation of a CID allows property owners and communities to assess or tax themselves for improvements and services which benefit the community. The CID will establish a reliable mechanism whereby numerous and diverse private interests can act in unison. The CID could be governed by a Board comprising of owners, businesses and voters appointed by the City Council or by election, or by a not-for-profit agency if the District is funded solely through assessments. Within its boundary, the CID could provide assistance to or construct, install, repair, maintain, and equip a broad range of public improvements and facilities, as well as undertaking security and promotional activities.

Institutional Issues

Serving Water Out of State
State provisions exist for water suppliers to provide water out of state and for out of state entities to participate in regional water supply districts.

A Public Wholesale Water Supply District may include political subdivisions of this state or any state. A rural water district can form with entities outside the state. A district may sell water to persons engaged in hauling water and to any municipal, quasi-municipal, or nonprofit corporation organized for any purpose consistent with that for which the district was organized, including out of state entities.

[8] K.S.A 19-270
[9] K.S.A. 82a-2201
[10] K.S.A. 12-6a26 et seq

Water can be diverted or transported out of state under a permit to appropriate water for beneficial use or under an existing use. However, in order to divert or transport water produced from a point or points of diversion located in Kansas for use in another state[11] a permit approved by the chief engineer is required. The diversion must comply with the Kansas water appropriation act, the water transfer act and any other applicable laws pertaining to such diversion, transportation and use of water. The proposed diversion and transportation of water will not allow water apportioned to the state of Kansas by an interstate water compact to be used in another state.

Water Transfer Act[12]

Kansas allows the transfer of water for use at a different location. A transfer means the transportation of 2,000 AF or more per year for use at a point 35 miles or more away. The act is administered by a Water Transfer Panel made up of the chief engineer, the secretary of the Kansas Department of Health and Environment and the Director of the Kansas Water Office - 3 state agency heads. The chief engineer is the chair of the panel.

Water Supply Sources

Water supply options for Hamilton, Kearny, and Finney Counties consist of four sources; the local Arkansas River/ Arkansas River Alluvium, the confined Dakota aquifer, the unconfined Ogallala aquifer, and a local aquifer described as a Paleo aquifer on the south side of the Arkansas River in Hamilton County.

Arkansas River / Arkansas River Alluvium

The Arkansas River corridor consists of coarse-grained highly porous sediments, which make up the alluvial aquifer. The alluvium is composed of sand, gravel and lesser amounts of silt and clay.

Groundwater levels have declined along the Upper Arkansas River corridor in southwest Kansas in response to consumptive pumping from the alluvial and High Plains aquifers. Water-level declines in the alluvial aquifer cause Arkansas River water to seep into the aquifer rather than flowing downstream. Water-level declines along the river valley have produced a downward hydraulic gradient that results in groundwater flow from the alluvial aquifer to the underlying High Plains aquifer. Regional water-level declines have produced a groundwater ridge along the river corridor such that groundwater flow no longer moves west to east; rather, it moves away from the river valley to the north and south.

The water quality in the Arkansas River and the alluvium is poor. Sulfates, uranium, and selenium exceed water quality standards. Water level decline has caused the Kansas to designate the area as an Intensive Groundwater Use Control Area (IGUCA) and closing it to further groundwater and surface water appropriation, except for rates less than 50 gallons per minute and not to exceed 25 acre feet per year.

[11] K.S.A. 82a-726

[12] K.S.A. 82a-1501 et seq

Ogallala Aquifer

Most of the Hamilton-Kearny-Finney area is underlain by the Ogallala formation. In much of this area, however, these deposits are covered by a thin mantle of loess and dune sand.

The thickness of the Ogallala formation is quite variable. It is absent or thin in southern and northwestern Hamilton County. In the Syracuse upland, the Ogallala formation ranges in thickness from a few feet in western Hamilton County to about 75 feet in southeastern Hamilton County.

Most of the wells in northeastern Hamilton County and in northern Kearny County obtain water from the Ogallala formation. In other parts of the Hamilton-Kearny area, the Ogallala yields little water to wells. In the Syracuse upland, these beds lie above the water table so that wells must be drilled to the Dakota formation in order to obtain water. Well yields in the Ogallala range from a few gallons per minute for many domestic and stock wells to more than 1,000 gallons per minute from some irrigation wells in the Kearny County[13].

The Ogallala is primarily recharged from precipitation. Where the Ogallala underlies and is hydraulically connected to the alluvial aquifer, downward migration of alluvial groundwater provides additional recharge. In areas of Kearny and Finney Counties where irrigation canals are present, canal seepage provides an additional amount of recharge. In addition, applied irrigation water on cultivated fields can infiltrate below the soil zone and act as a source of recharge.

Groundwater levels have declined in southwest Kansas due to decreased recharge from the Arkansas River and pumping from the aquifer. Municipal groundwater supplies that are or may be impacted by salinity and nitrate contamination include those for Syracuse, Lakin, Deerfield, Holcomb, Garden City, Cimarron, and Dodge City. Figure 6 illustrates the distribution of the aquifers' usable lifetime.

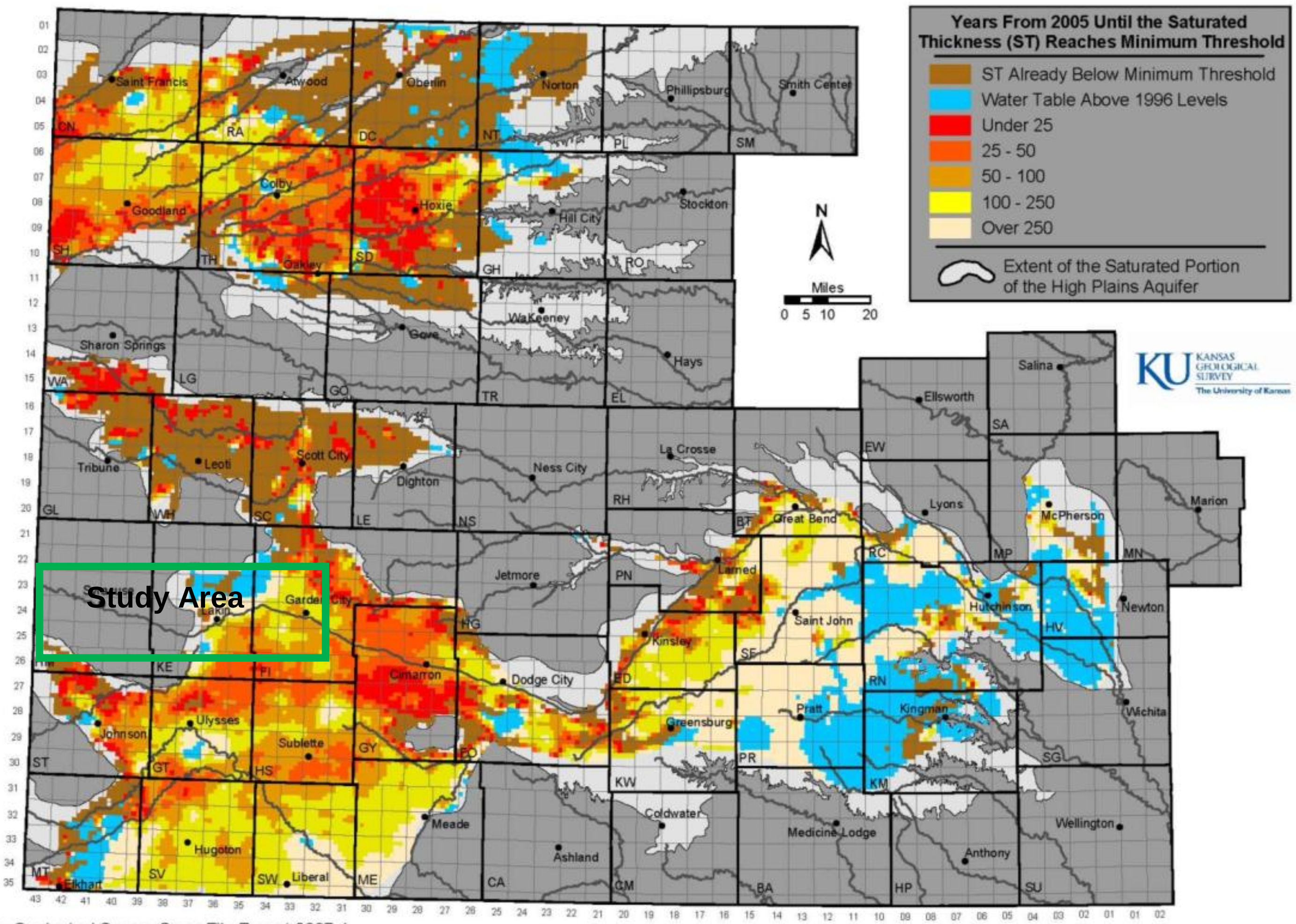
Groundwater flow direction in the Ogallala is generally from northwest to southeast. Local deviations in flow direction are common where substantial declines or cones of depression are present. These are a result of the effects of groundwater pumping in the area. Generally, groundwater trends in the Ogallala within the Upper Arkansas subbasin have been on a steady decline since the 1960's[14].

---

[13] KGS-Hamilton and Kearny Counties-Geologic Formations

[14] Kansas Department of Agriculture Upper Arkansas River Subbasin Hydrogeology

Estimated Usable Lifetime for the High Plains Aquifer in Kansas
(Based on ground water trends from 1996 to 2006 and the minimum saturated thickness required to support well yields at 400 gpm under a scenario of 90 days of pumping with wells on 1/4 section)



Kansas Geological Survey Open-File Report 2007-1

Figure 6. High Plains Aquifer-Estimated Usable Life. Study area contained in the green square

Dakota Aquifer

The Dakota lies beneath the High Plains aquifer throughout the study area. The bedrock is composed of Cretaceous rocks with alternating layers of sandstones and shales. The Dakota is the principal aquifer in use only in areas where the High Plains aquifer is thin or absent. This includes northeastern Finney, Hodgeman, easternmost Ford, and parts of Hamilton, Greeley, and Wichita Counties[15]. Groundwater flow in the Dakota aquifer is from recharge areas in southwestern Kansas and southeastern Colorado northeastward towards discharge areas in central Kansas and Nebraska.

An assessment of the quality of water in the Dakota based on drinking-water standards was made utilizing the KGS WATer CHEMistry database (KWATCHEM). Waters from over 60% of the wells examined exceeded the recommended concentration of total-dissolved solids, while 28-29% of the wells exceeded recommended values for chloride and sulfate. Fluoride concentrations were above the MCL at 35%, and nitrate contents above the MCL at 7% of the well sites. High fluoride waters are common in areas of the Dakota where the water type is sodium-bicarbonate. Nearly half of the well sites had iron and manganese contents above the recommended levels. None of the samples in the database exceeded the standard for toxic heavy metals or arsenic, but four sites had higher selenium values than the standard. The amount of data for toxic heavy and semi-metals, as well as radioactivity, is limited. The water quality of the Dakota aquifer is characterized by high gross alpha particles, iron and combined radium 226 and 228.

Paleo Channel

Paleo Channels are deposits of unconsolidated sediments deposited in river or stream channels creating buried water channel aquifers[16].

An alluvial aquifer located in the Arkansas River Basin separated from the Arkansas Alluvium has been noted in western Hamilton County[17]. This alluvial aquifer is identified as the Paleo aquifer (Paleo) for the purpose of this report. This groundwater occurs in the Pleistocene deposits and fine-grained Holocene deposits. Monitoring wells have been established at the 0.5 and 2.5 south of the Arkansas River at Colorado-Kansas State line, with the 0.5 south well in the alluvium and the 2.5 south well in the Paleo Aquifer. Water quality information gathered indicate that this source is or at least partially separated from the Arkansas River alluvium. The information on these wells can be found at:

---

[15] Kansas Department of Agriculture Upper Arkansas River Subbasin Hydrogeology

[16] Encyclopedia of Snow, Ice, and Glaciers, Singh, Singh, and Haritashya, 2011.

[17] Water Resources of Hamilton County, Southwestern Kansas, Hydrologic Investigations Atlas HA-516 sheet 2 of 2, D.H. Lobmeyer and C.G. Sauer, 1974

Monitoring well in the alluvium at the Colorado-Kansas Stateline, 0.5 miles south of the Arkansas River and, Monitoring well in Paleo Aquifer at the Colorado-Kansas Stateline, 2.0 south of the Arkansas River .

Recharge of the Paleo in the sand-hills area south of the Arkansas River occurs largely from precipitation. Because of the high porosity of the dune sand and the presence of many undrained basins that serve as catchment areas for the rainfall, much water percolates downward to the zone of saturation. Very little water is lost to runoff, most of the precipitation in this area is held in the basins until it percolates downward and/or evaporates. The Arkansas valley probably derives part of its groundwater by lateral movement from adjacent areas. The huge area of sand hills that extend from Prowers County, Colorado, to Ford County, Kansas, is a principal recharge area for the groundwater reservoir in much of southwestern Kansas.[18]

There is little information on the Paleo. Several agricultural wells are located over this buried channel. Syracuse also has four wells located in this formation. The well logs indicate a very productive formation capable of producing over 1000 gpm and approximately 100' in depth. The Syracuse wells' only treatment is chlorination.

The extent, sustainability and risk of contamination of this source are unknown. The Paleo is the source of quality water for the City of Syracuse and farming operations, as well as a resource for Hamilton County. Additional information on the Paleo is needed before it can be utilized as a long term water source.

Figure 6 shows the approximate location of the Paleo Channel with several wells[19] in the area south of the Arkansas. The well logs are included in **Appendix D.**

[18] Geology and Groundwater Resources of Hamilton and Kearny Counties, 1943, Kansas, Kansas Geological Survey

[19] KGS Water Well Completion Records Database

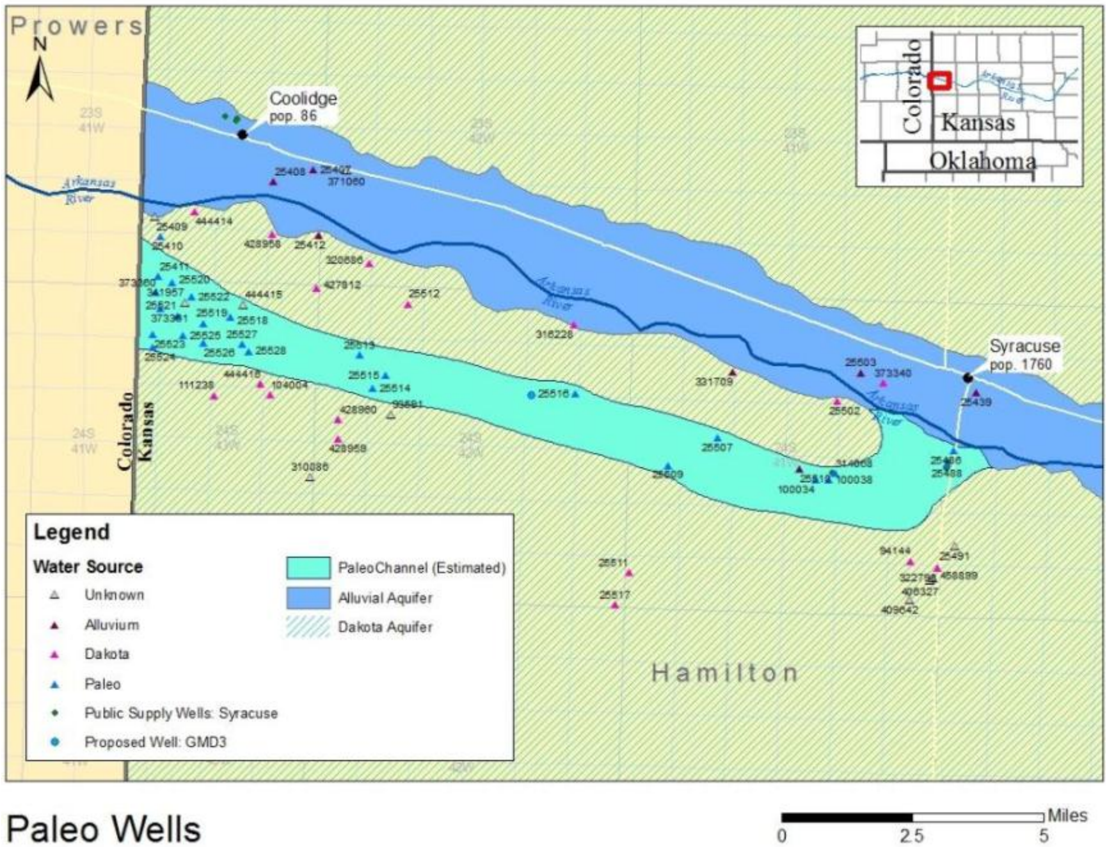


Figure 7. Paleo Channel Aquifer Estimated Location.

Wholesale Water Providers

Preliminary discussions with City of Lakin and Wheatland water indicated that both entities had available water rights and were open to becoming providers of treated water to communities within the area.

Lakin

Lakin obtains its water from eight wells drilled into the Ogallala. The city is currently using only two of their wells because the others all violate the EPA's MCL for uranium. Other quality issues are additional radionuclides, iron, and manganese.

Lakin is currently working on the design of a nanofiltration treatment facility that will have the capacity to treat 1.5 million gallons per day (mgd) and could be expanded to 2.25 mgd. Lakin's 2050 demand is 709 ac-ft per year with an authorized water right of 1,013 ac-ft per year, leaving them with excess water. Lakin has completed the deep disposal well necessary for NF treatment and has begun construction on the treatment facility.

Lakin has secured an alternate water source for the irrigation of their municipal golf course, which currently accounts for about 16% of all of their water use. When this alternate source is in place, Lakin hopes to have an adequate supply and treatment capacity to sell treated water to other entities.

Lakin's water rates are tiered and are as follows: $40.16 for the first 5,000 gallons; $3.76 per thousand gallons for 5001 – 10,000 gallons, $5.01 per thousand gallons for 10,001 – 18,000 gallons; $5.62 per thousand gallons for 18,001 – 40,000 gallons; $6.24 per thousand gallons for more than 40,000 gallons.

Wheatland Electric Cooperative

Wheatland, located in western Kansas, was established in 1948 as a distribution and power cooperative to provide a needed electric service for the member consumers. Along with power, Wheatland has developed water resources and is a regional provider of water. Wheatland has water rights to both contaminated and fresh Ogallala sources.

Wheatland's reverse osmosis plant, located near Garden City, Kansas, has a capacity of 6 mgd and could be expanded to 15 mgd. It is the sole supplier to Finney RWD1, supplies 2 mgd to Garden City, and supplies 1 mgd to others.

Disposal is via a class 1 injection well into the Arbuckle formation. Wheatland operates 14 wells south of Holcomb, 2 wells south of the Arkansas River, and 3 wells near Garden City that feed into the RO plant. They currently have 15,000 ac-ft of unused water rights. Wheatland provides water to a Tyson processing plant and reclaimed water from Garden City to the Sunflower Company cooling tower water. Wheatland's existing infrastructure is 2-miles from Holcomb and approximately 6-miles from Deerfield.

Water Treatment

The drinking water treatment standards for public water providers in Kansas are included in Kansas Administrative Regulations 28-15. The treatment technologies below can be designed to meet these standards within their known capabilities.

Ion Exchange

Ion Exchange (IX) is a chemical process where certain unwanted ions of a given electrical charge are absorbed on resin to be removed from the solution, and replaced by wanted ions of a like charge. IX is an EPA Best Available Technology Economically Achievable (BAT) for the following contaminants: barium, beryllium, chromium, copper, cyanide, lead, nitrate and nitrite, thallium, radionuclides, and uranium[20]. IX is used extensively in both water and wastewater treatment. Some of the common applications are water softening, demineralization, desalting, ammonia removal, treatment of heavy metal wastewaters, and treatment of some radioactive wastes.

Pretreatment prior to IX may be required to reduce excessive amounts of TSS, which could plug the resin bed, and typically includes media or carbon filtration. The IX resin requires regular regeneration, the frequency of which depends on raw water characteristics and the unwanted ion concentration. Since the removal of all of the hardness is undesirable for a domestic water supply a portion of the flow may bypass the exchangers to give a blended water of the desired hardness. Preparation of the NaCl (or KCl) regenerating solution is required. If utilized, pretreatment filter replacement and backwashing will be required. Table 13 describes some of the benefits and limitations associated with IX treatment for public drinking systems.

Table 13. Comparison benefits and limitations associated with IX treatment for drinking systems (Reclamation, 2010).

Benefits:	Limitations:
Acid addition, degasification, and repressurization is not required.	Pretreatment lime softening may be required.
Ease of operation; highly reliable.	Requires salt storage; regular regeneration.
Lower initial cost; resins will not wear out with regular regeneration.	Concentrate disposal.
Effective; widely used.	Usually not feasible with high levels of TDS[1].
Suitable for small and large installations.	Resins are sensitive to the presence of competing ions.
Variety of specific resins are available for removing specific contaminants.	No Reduction in the total dissolved solid TDS[1] concentration of treated water.
	Does not remove suspended solids.

[1] Total Dissolved Solids (TDS)

Membrane filtration

Membrane filtration is a pressure- or vacuum-driven separation process in which particulate matter larger than 1 micrometer is rejected by an engineered barrier, primarily through a size-exclusion mechanism and which has a measurable removal efficiency of a target organism that can be verified through the application of a direct integrity test.[21] This definition includes the following membrane processes commonly used in drinking water treatment:

- Microfiltration (MF)

[20] Water Treatment Plant Design, 3rd edition, American Water Works Association, 1998

[21] Membrane Filtration Guidance Manual, EPA, 2005.

- Ultrafiltration (UF)
- Nanofiltration (NF)
- Reverse Osmosis (RO)

A visual representation of various membranes pore size removal capabilities are shown in Figure 7. MF and UF are used for the removal of suspended solids, *Giardia*, and *Cryptosporidium* and the reduction of turbidity. MF and UF do not have the capability of treatment necessary for the water quality of the Dakota or Ogallala Aquifer and will not be consider an alternative treatment method.

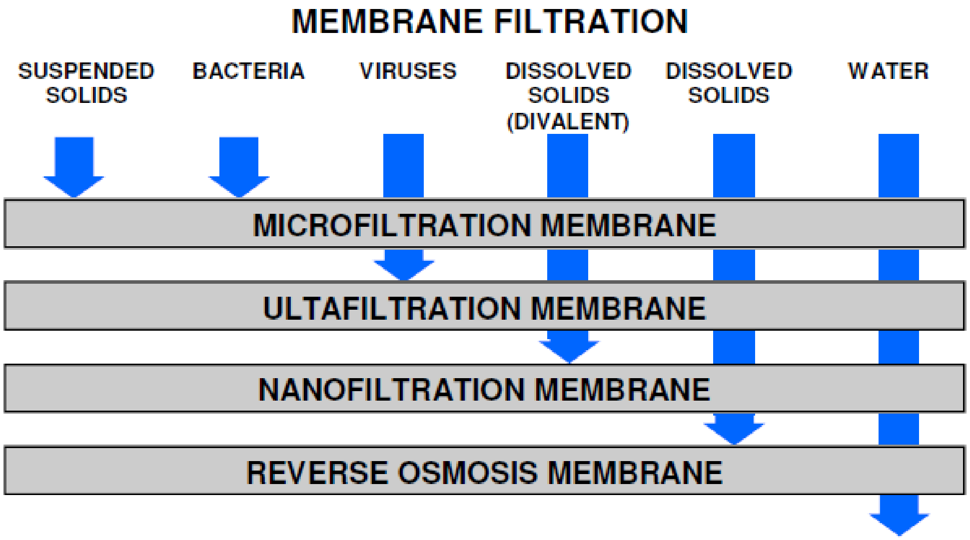


Figure 8. Membrane filtration capability illustrated to show the typical passing resistance through various membrane technologies[22].

Nanofiltration

NF is a physical and chemical filtration membrane process capable of filtering water quality contaminants down to 0.001 micrometers in size.[23] NF has a lower rejection rate for monovalent ions than multivalent ions and can operate at significantly lower operating pressures than reverse osmosis membranes.

Some of the benefits and limitations associated with NF membrane treatment for public drinking systems are shown in Table 14. A NF membrane system includes a sequence of treatments (train) designed to meet treatment needs of a particular water quality and typically requires:

- Chemical addition for pretreatment and pH adjustment,
- Cartridge filter for the removal of large particles that may foul the membranes, and

[22] Water Treatment Plant Design, 3rd edition. Denver, Colorado. American Water Works Association. 1998.

[23] Water Treatment Primer for Communities in Need, Desalination Series Report No. 68. Bureau of Reclamation. 2010. Denver, Colorado.

- Disposal system for concentrate management.

Table 14. Benefits and limitations associated with NF membrane treatment for drinking water systems (U.S. EPA, 2006).[24]

Benefits:	Limitations:
Absolute pathogen removal.	Capital costs for all membrane technologies are relatively high.
Effective removal of colloidal material, organics, and disinfection byproducts.	Concentrate disposal costs add additional capital and operations and maintenance expenses.
Ease of adding additional modular components allows for future increases in treatment capacity with reduced capital costs.	Operations and maintenance costs for NF membranes are high because operation requires skilled and intensive labor to perform activities such as chemical cleaning and pretreatment for turbidity and suspended solids.
NF membranes can have up to a 90 percent recovery rate, therefore decreasing concentrate disposal.	

Reverse Osmosis

RO utilizes an applied pressure to overcome osmotic pressure and force the permeate across a membrane and the reject with the dissolved salts (ions), particles, colloids, organics, bacteria remain. RO could provide an effective means of treatment for the Dakota and Ogallala Aquifer. Since both NF and RO are similar technologies and are valid advanced water treatment alternatives NF was selected for alternative comparison since it has a lower cost.

Table 15 provides a listing of contaminants and removal by the two selected treatment technologies, IX and NF.

[24] Technology and Cost Document for the Final Ground Water Rule. United States Environmental Protection Agency. 2006. Washington, D.C.

Table 15. Treatment Technologies and contaminants removed.

Contaminants	Dakota Aquifer	Ogallala Aquifer	Treatment Technologies contaminant removal	
			Ion Exchange	Nanofiltration
Chloride				
Fluoride				
Gross Alpha Emitters				
Beta particles				
Radium (226,228)				
Uranium radiation				
Iron				
Manganese				
Selenium				
Sulfates				
Total dissolved Solids				
Uranium				

Alternatives

Formulation

Alternatives were formulated based on their ability to meet the planning objectives of providing water, meeting public drinking standards and meeting the estimated 2050 water demand of the communities.

The major considerations or concepts explored in the development of the alternatives were:

- Advanced water treatment for each community individually
- Two options exist for the importation of fresh water supplies. The communities could purchase a right in the Paleo, or obtain water from an Ogallala location not influenced by the Arkansas River.
- Development of a Regional Authority to construct, operate and maintain the individual treatment systems of the locally impaired sources. Little information was available in the reduction of cost and for the purpose of this report; it was assumed that a 40% reduction in O&M of the facilities could be realized from the Regional Authority.
- Development of a Regional Authority to construct, operate and maintain the infrastructure required for the importation of fresh water.

- Purchase and conveyance of treated water from other public water providers.

These concepts were developed for each entity that was identified as having a need for advanced treatment or importation of water in order to meet the public drinking standards and/or 2050 water demand.

Infrastructure

The required infrastructure was developed utilizing the estimated 2050 demand in ac-ft per year for each of the entities. The maximum daily demand was utilized to size the infrastructure for the conveyance and treatment systems. The maximum daily demand was calculated by multiplying the average daily demand by a peaking factor of 2.25 and is expressed in terms of gallons per minute (gpm). Table 16 provides a summary of the calculated infrastructure demands for each community. Note that Lakin is not included because current infrastructure is projected to meet future demands. In addition, Syracuse is the only community listed on the table with an existing drinking supply that is expected usable without further treatment. Therefore, only 45 ac-ft of water is necessary in addition to current infrastructure.

Table 16. Demand for Infrastructure Development

Entity	2050 annual demand (ac-ft)	Average daily demand (gpm)	Maximum Daily Demand (gpm)
Coolidge	31	19	43
Syracuse*	177 (45)	109 (35)	245 (56)
Hamilton RWD1	13	8	18
Deerfield	176	109	246
Holcomb	569	353	794

*Water right shortfall for the 2050 demand from Syracuse

Assessment Criteria Guidelines

Alternatives were assessed based on criteria set forth in the Principles and Guidelines (P&Gs) for Water and Related Land Resources Implementation Studies (Water Resources Council 1983). The P&Gs were developed to ensure proper and consistent planning by Federal agencies in the formulation and evaluation of water-related resources studies, including appraisal and feasibility investigations. The four criteria are as follows:

- **Effectiveness:** The extent to which an alternative reliably meets the planning objective by alleviating a specified problem and achieving goals.
- **Efficiency:** The extent to which an alternative is cost effective.
- **Acceptability:** The workability and viability of an alternative with respect to how compatible it is with authorities, regulations, policies, and environmental law.

- **Completeness:** The extent to which an alternative accounts for all necessary investments or other actions to ensure realization of goals.

Although the P&Gs list the above criteria as requirements to consider in the evaluation of alternatives, the P&Gs do not specify the manner by which these criteria are analyzed, so discretion is allowed due to wide variation among project types. For this investigation, criteria were analyzed based on a variety of key factors considered important to each criterion. For instance, the Effectiveness criterion was analyzed based on factors related to the reliability of water deliveries, as well the challenges associated with construction and servicing the project. Next, points were allocated based on whether a criterion and/or factor scored a “high”, “moderate”, or “low”. The point allocation system is described later in this section; below is a detailed description of each criterion and its associated ranking factors.

The discussion of the individual assessment criteria for each alternative is located in **Appendix A.**

No Action Alternatives

Reclamation evaluated the **No Action Alternative** for each of the communities. The No Action Alternative includes steps that would likely occur within the study area during the planning horizon to address the identified problems, needs, or opportunities if the proposed project is not constructed. The analysis must include the estimated cost of those steps and projected results, including risks and uncertainties. The No Action Alternatives are identified in the following description of alternatives.

Alternatives Considered but Eliminated

Arkansas River and Alluvium

The water quality in the Arkansas River and Alluvium is considered extremely poor with high concentrations of salinity, total dissolved solids, selenium, sulfur and uranium. The communities in the Study Area do not currently utilize this as a drinking water source. This source is closed to new appropriations by the State of Kansas and therefore was eliminated as a source alternative.

Coolidge Alternatives Formulation and Evaluation

Coolidge has a population of 95 with 47 service connections[25] and obtains its water from two wells drilled into the Dakota. The demand will increase from 29 ac-ft per year in 2010 to 31 ac-ft per year in 2050. The 2050 maximum daily demand was calculated at 43 gpm. Coolidge has adequate water rights for the 2050 demand. The wells are capable of producing 150 gpm each and the average production from the system is capable of 29,600 gallons per day.

Coolidge has utilized an IX facility to treat water since 2005 due to issues with high iron content. Prior to the installation of this facility, the city had issues meeting the EPA regulations for combined radium and gross alpha particles. IX softens the water and reduces the levels of gross alpha particles and radium. Since 2008, Coolidge has been able to meet the regulations on Radium and Gross Alpha Particles. The IX facility currently has the capacity to treat water at a rate of 165 gallons per minute. Only minor upgrades are required to the facility for future increase in demand.

Coolidge reportedly has difficultly in performing O&M due to lack of resources[26]. The backwash from the IX facility is currently disposed of in evaporative lagoons and that may not meet current Kansas standards, for impermeable lining. If Coolidge continues to utilize IX for treatment, it is likely that lining of the backwash evaporative lagoons will be required.

Description of Alternatives

Six alternatives were developed for Coolidge. Figure 8 provides a map showing the alignment of all the pipeline alternatives for Coolidge. Figures 9 and 10 provide more detail for the individual alternatives.

[25] Kansas Safe Drinking Water Watch maintained by Kansas Department of Health and Environment.

[26] Conversation with Mark Rude, GMD3 Executive Director

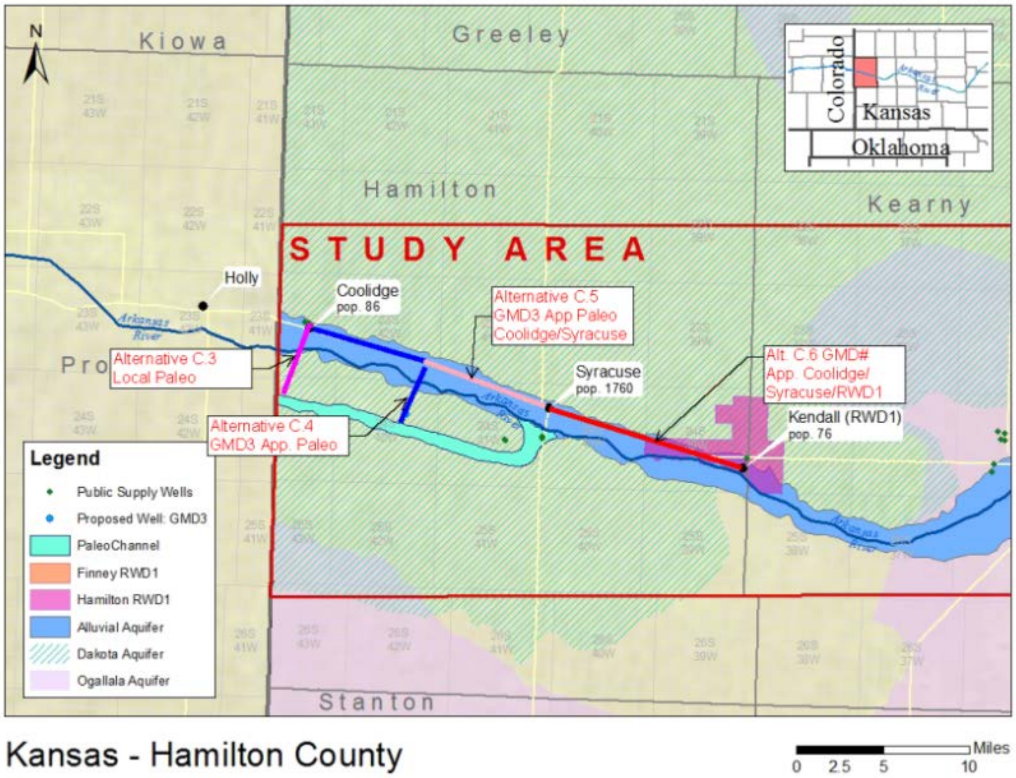


Figure 9. Map of proposed pipelines for Coolidge Alternative C.3, C.4, C.5 and C.6

Alternative C.1: Regional/Partnership Shared O&M of Advanced Water Treatment

Summary: Alternative C.1 consists of the development of a Regional Authority to construct, operate and maintain the water treatment systems for the various cities. Coolidge would continue to utilize water treated by IX from the Dakota. Due to the reported difficulties in retaining the technical expertise to maintain and operate an advanced treatment plant, Coolidge would work with other communities in the region (potentially Syracuse, Hamilton RWD1, Deerfield, and Holcomb*)* to develop a Regional Authority to operate and maintain the existing or upgraded treatment facilities. Through this Regional Authority, Coolidge would provide an adequate level of treatment, operation and maintenance of the existing raw water supply wells and transmission lines to the treatment facilities. It assumes that each individual community would maintain separate facilities (no sharing of infrastructure). The Regional Authority could also be involved in billing and collections, or simply charge each entity their pro-rata share.

Infrastructure: The actual capacity of the existing ion exchange treatment plant is 165 gpm, and is adequate to meet the 2050 demand with only minor upgrades. The construction of an evaporative lagoon with an impermeable liner to dispose of the backwash is required.

Alternative C.2: Dakota Aquifer - Advanced Treatment (Also considered the No Action Alternative)

Summary: Coolidge would upgrade the existing treatment plant and disposal facility to meet current regulations and the 2050 demand.

Infrastructure: The actual capacity of the existing IX treatment plant is 165 gpm and only minor upgrades are required to meet the 2050 demand. The construction of an evaporative lagoon with impermeable lining is likely required for the disposal of the backwash.

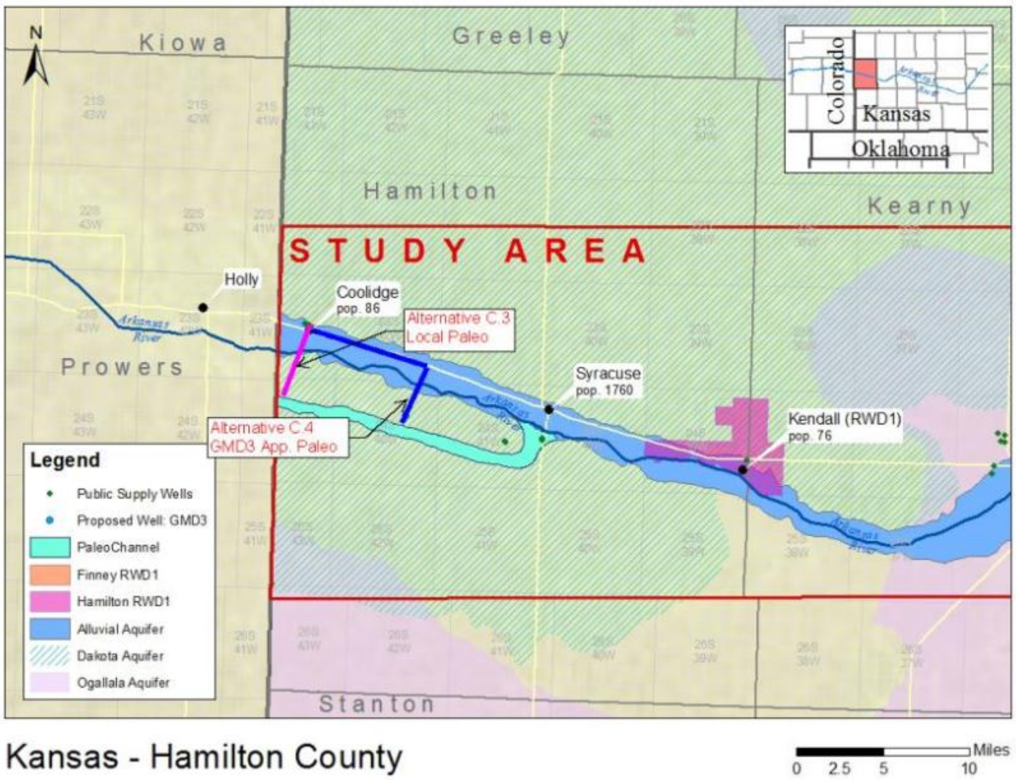


Figure 10. Coolidge Alternatives C.3 and C.4

Alternative C.3: Purchase Existing Rights in Paleo

Summary: Coolidge would purchase an existing agricultural right in close proximity and convert this right to a municipal right.

Infrastructure: The construction of a new municipal supply well approximately 100' in depth is required. The project would require the installation of a pump and pipeline construction of a 6" pipeline approximately 4.1 miles in length, both capable of 45 gpm, with a river crossing and a railroad crossing. Road B crosses the Arkansas River in the same general location as the proposed pipeline. It is possible for the pipeline to utilize the existing bridge for the river crossing. The elevation of the proposed well and Coolidge are approximately equal and it was assumed that the well pump could generate sufficient head for transport to Coolidge.

Alternative C.4: Individual GMD3 Application in Paleo

Description: Coolidge would utilize the GMD3 or other application and develop the necessary infrastructure to convey the water. The preferred option would be to construct the pipeline along Hwy 50 to access residence and business in this corridor. The water would require treatment (chlorination) at the well site.

Infrastructure: The construction of a new municipal supply well approximately 100' in depth utilizing GMD3 application is necessary. The installation of a pump and a pipeline construction of approximately 8.5 miles will be required. The well and pipeline is required to produce and convey a minimum of 45 gpm. A 6" line would be required to deliver the peak daily demand. A river crossing and railroad crossing is required. Chlorination would occur at the well site. The difference in elevation from the approximate well location and Coolidge is 20 feet. The pump at the well site will generate sufficient head to transport the water to Coolidge.

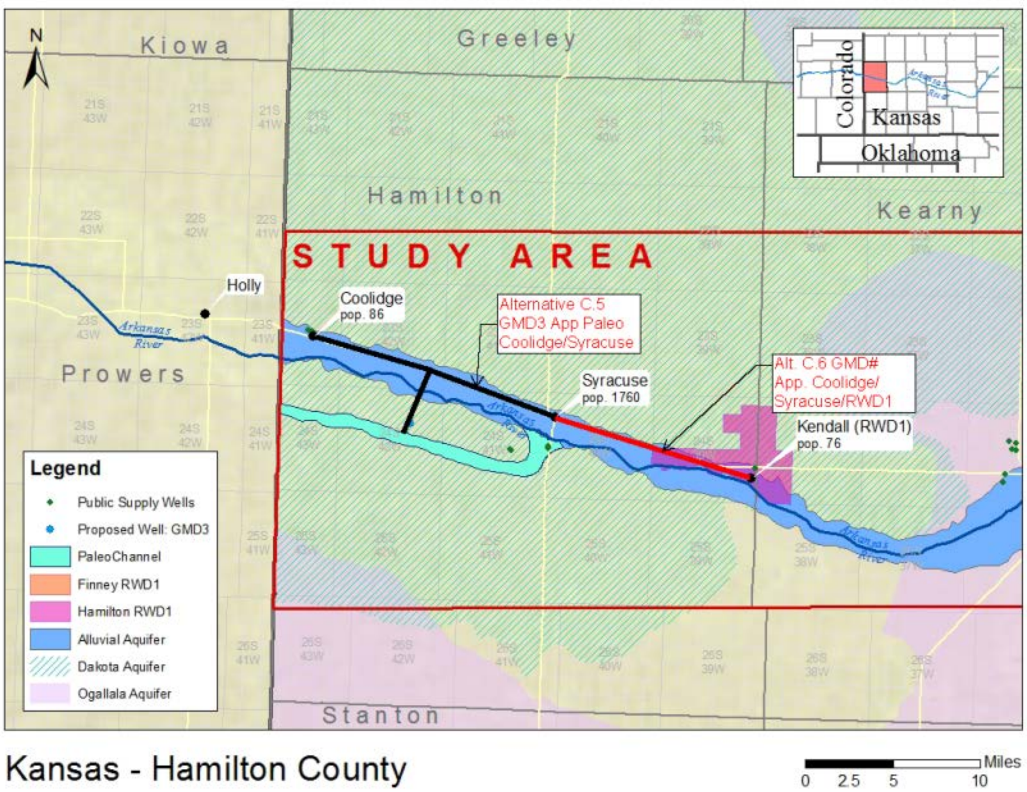


Figure 11. Coolidge Alternatives C.5 and C.6

Alternative C.5: GMD3 Application in Paleo with Syracuse (See Alt. S.4)

Summary: Coolidge and Syracuse would develop a Regional Authority to utilize the GMD3 or other water right application. The construction and O&M of a new municipal supply well and the conveyance pipeline would be shared. GMD3's application for 320 ac-ft per year could easily meet the 2050 estimated demand of Coolidge and the future demands increases of Syracuse. Additional customers located along the Arkansas River corridor from Coolidge to Syracuse would be accommodated with this system.

Infrastructure: Conveyance of the peak daily demand of Coolidge and the increase from the current to the 2050 peak daily demand of Syracuse will be required. The well and conveyance pipeline will be capable of conveying the peak daily demand of 288 gpm. A municipal water supply well approximately 100' deep and installation of a pump capable of pumping 290 gpm is required. Chlorination will occur at the well site. A 10" pipeline of 4 miles in length with an Arkansas River and a railroad crossing would be required to convey the water to Hwy 50. A bifurcation structure at the Hwy 50 location would be constructed and individual pipelines will convey the pipelines to the respective cities. The additional pipeline to Coolidge would be a 6" pipeline approximately 4.6 miles in length. An 8" pipeline 10.5 miles in length would convey the water to Syracuse. The pump at the well site will provide sufficient head to deliver the water to Coolidge and Syracuse.

Alternative C.6: GMD3 Application Paleo with Syracuse and Hamilton RWD1) (See Alternatives S.6 and RWD1.5)

Summary: Coolidge, Syracuse and Hamilton RWD1 will utilize GMD3 or other water right application of 320 ac-ft per year. The construction of a new municipal supply well and conveyance pipeline would be constructed, operated, and maintained by a Regional Authority. Additional customers located along the Arkansas River corridor from Coolidge to Kendall could be accommodated with this system.

Infrastructure: The well and conveyance pipeline should be capable of conveying the maximum daily demand of 306 gpm. A municipal water supply well approximately 100' deep and installation of a pump is required. Chlorination will occur at the well site. A 10" pipeline approximately 4 miles in length with an Arkansas River and a railroad crossing would convey the water to Hwy 50. A bifurcation structure located at the Hwy 50 location will service individual pipelines to convey water to the respective cities. The additional pipeline to Coolidge would be a 6" pipeline approximately 4.6 miles in length. An 8" pipeline approximately 10.5 miles in length would convey the water to Syracuse and Hamilton RWD1. An additional 11.6 mile, 4" pipeline would convey the water to the Hamilton RWD1. The pump at the well site will generate sufficient head to deliver the water to Coolidge, Syracuse and Hamilton RWD1.

Table 17 provides a summary of the various alternatives developed in this assessment for Coolidge.

Table 17 Coolidge Alternatives

Alt #	Description of Water Source	Proposed Treatment	Preliminary Cost Estimate[3]	Preliminary Annual O&M Cost[3] (Cost/AFY)
C.1	Shared Regional O&M of advanced water treatment	Various	$700,000	$363
C.2	Advanced Water Treatment of Dakota Aquifer	Ion Exchange	$700,000	$606
C.3	Purchase Rights in Locally in the Paleo	Chlorination	$2,700,000	$396
C.4	GMD3 Application in Paleo	Chlorination	$4,200,000	$760
C.5 (S.4)[1]	GMD3 Application in Paleo with Syracuse	Chlorination	$2,900,000	$225
C.6 (S.5 & RWD1.5)[2]	GMD3 Application in Paleo with Syracuse and RWD1	Chlorination	$2,200,000	$181

[1] Alternative C.5 is the same regional option as Alternative S.4.
[2] Alternative C.6 is the same regional option as Alternative S.5 and Alternative K.5.
[3] Preliminary Cost Estimate and Annual O&M costs presented provide only Coolidge's assumed proportion share for all regional alternatives.

Alternative Comparison

The results of the evaluations for each of Coolidge's six alternatives across the four criteria are shown in Table 18 and Figure 11. The maximum number of points assigned to each of the criteria and points received by each alternative for each criterion are included. The points were developed during the collaborative calls with KWO, GMD3 and WSU. Alt. C.1 scored the highest due to the utilization of, and the development of a Regional Authority to maintain the existing infrastructure. Alt. C.2 is described as the most likely to occur if no further action is taken. Under this alternative, Coolidge continues to struggle in maintaining and operating the existing system due to the population base of Coolidge. Alt. C.3 and C.4 scored the lowest, scoring only 39 to 51 total points, due to the cost of new infrastructure, which lowered the efficiency criteria. They were also not well represented in the completeness criteria. Alt. C.5 and C.6 require a large amount of infrastructure, but the scoring benefited from shared expenses through the development of a Regional Authority.

Table 18. Coolidge Alternatives matrix ranking sheet.

Screening Criteria:	Alternative C.1	Alternative C.2	Alternative C.3	Alternative C.4	Alternative C.5 (See S.4)	Alt. C.6 (See S.6 & RWD1.5)
	Shared Regional O&M	Dakota Aquifer Advanced Treatment	Agricultural Rights in Paleo Aquifer	Individual GMD3 Application Paleo Aquifer	GMD3 Application Paleo Coolidge/Syracuse	GMD3 Application Paleo Coolidge/Syracuse/Hamilton RWD1
Effectiveness (Total Pts)	18	13	14	13	14	14
(0-8 pts)	8	8	7	7	7	7
Quality and Quantity Notes:	Existing water rights provide sufficient quantity; IX treatment plant provides sufficient quality	Existing water rights provide sufficient quantity; IX treatment plant provides sufficient quality	Purchase existing rights provide sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)
(0-4 pts)	4	4	2	1	1	1
Constructability Notes:	Waste stream disposal requires standard modifications	Waste stream disposal requires standard modifications	Paleo well and pipeline (4-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required
(0-6 pts)	6	1	5	5	6	6
Operation and Serviceability Notes:	Regional operators and leverage resources provide experienced O&M	Documented O&M strains the existing resources	Operational challenges are moderate	Operational challenges are moderate	Operational challenges are minimal due to leveraged resources	Operational challenges are minimal due to leveraged resources
Efficiency	16	11	12	0	14	17
(0-8pts)	8	8	4	0	3	5
Construction Cost	$700,000	$700,000	$2,600,000	$4,200,000	$2,900,000	$2,200,000
(0-12 pts)	8	3	8	0	11	12
Annualized O&M Cost/AF	$ 363	$ 606	$355	$760	$225	$181
Acceptability	13	14	15	15	14	14
(0-5 pts)	4	5	5	5	4	4
Authorities, regulations, and policies Notes:	Regional Authority or agreement requires moderate challenges; waste stream disposal provides no conflict with regulations and policies	Existing authority remains in place; waste stream disposal provides no conflict with regulations and policies	Existing authority remains in place; Paleo well and pipeline provide no conflict with regulations and policies	Existing authority remains in place; Paleo well and pipeline provide no conflict with regulations and policies	An agreement with Syracuse would provide authority; Paleo well and pipeline provide no conflict with regulations and policies	An agreement with Syracuse and Kendall would provide authority; Paleo well and pipeline provide no conflict with regulations and policies
(N/A)	N/A	N/A	N/A	N/A	N/A	N/A
Insufficient information to determine public acceptance	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking
(0-5 pts)	4	4	5	5	5	5
Environmental considerations Notes:	Waste stream disposal require the construction of an additional lagoon on disturbed (or undisturbed) land	Waste stream disposal require the construction of an additional lagoon on disturbed (or undisturbed) land	Waste stream disposal is not required; pipeline requires short term land disturbance	Waste stream disposal is not required; Paleo well and pipeline requires short term land disturbance	Waste stream disposal is not required; Paleo well and pipeline requires short term land disturbance	Waste stream disposal is not required; Paleo well and pipeline requires short term land disturbance
(0-5 pts)	5	5	5	5	5	5
Public health and safety	No issues were found	No issues were found	No issues were found	No issues were found	No issues were found	No issues were found
Completeness	12	13	9	11	12	12
(0-5 pts)	4	5	2	3	4	4
Coordination and available water rights Notes:	Development of a Regional Authority or agreement; existing water rights provide future demand	Existing water rights provide future demand	Agricultural water rights required	GMD3 water rights application required	GMD3 water rights application required; development of agreement with Syracuse (benefit from the economies of scale)	GMD3 water rights application required; development of agreement with Syracuse and Kendall (benefit from the economies of scale)
(0-5 pts)	4	4	3	4	4	4
Engineering Uncertainties and risks Notes:	Existing infrastructure provides few risks; waste stream analysis provides moderate uncertainty	Existing infrastructure provides few risks; waste stream analysis provides moderate uncertainty	Paleo aquifer potential quality and quantity and pipeline alignment (private property challenges) provide moderate risks and uncertainties	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties
(0-5 pts)	4	4	4	4	4	4
Permits, ROW, and easements Notes:	Waste stream disposal requires land (purchased land)	Waste stream disposal requires land (purchased land)	Paleo well requires permits and easement note; pipeline (4 miles) requires a railroad permit and river crossing ROW access	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access
TOTAL	**59**	**51**	**50**	**39**	**54**	**57**

Figure 12. Comparison of Alternatives for Coolidge

Conclusions

A public meeting presenting these alternatives was conducted in Syracuse, Kansas and Holly, Colorado on February 26 and 27th, respectively. The public opinion gathered was insufficient to rank public opinion on the alternatives, however all alternatives were well received.

The alternatives utilizing a Regional Authority scored relatively well in this analysis. The sizes of the communities are small, which indicate a sharing of resources and the cost of developing or maintaining existing water supplies is the most viable option. Coolidge has begun IX treatment of the Dakota water. Utilizing the existing infrastructure while developing a Regional Authority to operate and maintain the treatment facilities scored the highest of the alternatives.

Certain advantages of the regional infrastructure concept (C.5 and C.6) were not captured in this analysis. The construction of a Regional Authority infrastructure encompassing Hamilton County by utilizing the existing GMD3 water application would be able to provide water to approximately 90% of the population of Hamilton County. Providing potable water to the rural population as well as industries located along the river corridor is important to the future growth in Hamilton County.

The potential for a Regional Authority between communities should be explored before Coolidge moves forward with an independent development of water supply.

Syracuse Alternatives Formulation and Evaluation

Syracuse has a population of 1,812 with 954 service connections. Syracuse currently has four wells located within the Paleo channel south of the Arkansas. One well is located just south of the city. The other three wells are located approximately two miles south and three miles west of Syracuse. The water only requires chlorination for treatment, but the wells near the river sometimes degrade in quality during the summer when the water table around the city wells is low. This is believed to be because when the water table is lowered, water from the Arkansas alluvium contaminates the clean water in the Paleo locally.

The 2050 estimated demand for Syracuse is 901 ac-ft per year, an increase of 177 ac-ft per year from the 2010 demand. Syracuse will have a supply deficit of 45 ac-ft per year. Syracuse currently charges $14.00 for the first 5,000 gallons, and $1.30 per additional thousand gallons.

For the purpose of developing alternatives it was assumed that Syracuse would need to acquire an additional right of 45 ac-ft and infrastructure to convey the increase peak demand of 245 gpm.

Description of Alternatives

Figure 12 below provides a map showing all of the alignments for Syracuse alternatives. Figures 13 through 15 shows more detail of individual alternatives.

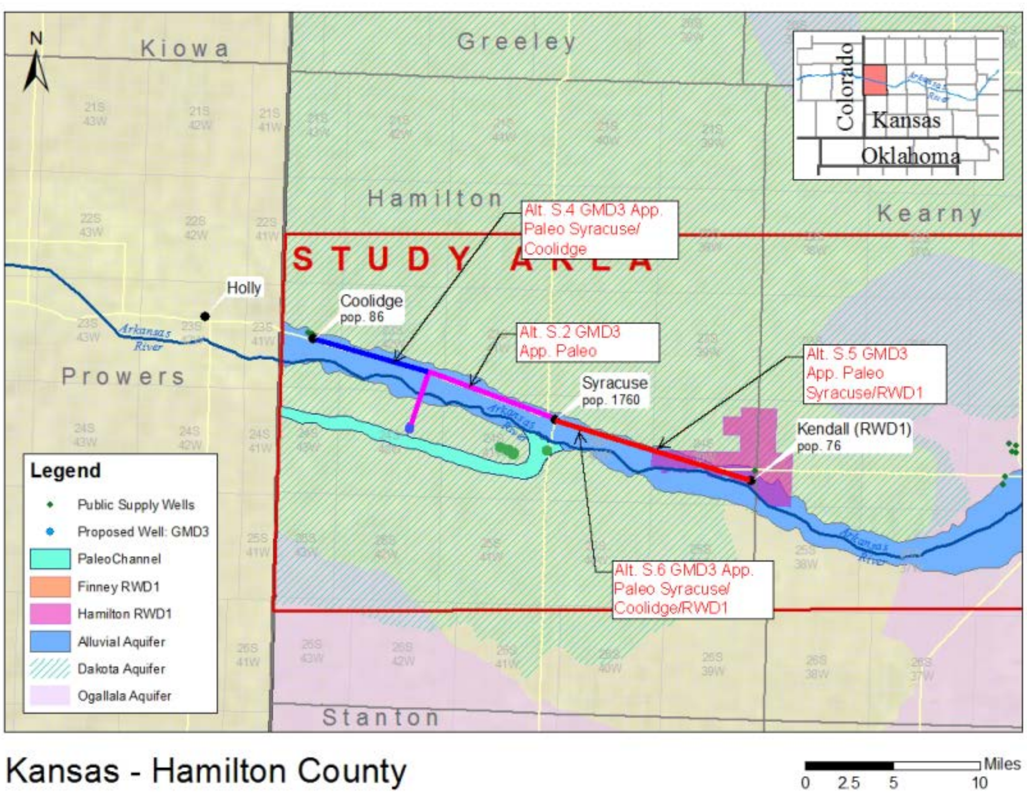


Figure 13. Map of proposed pipelines for Syracuse Alternative S.2-6.

Alternative S.1: Administrative Rule Change for Paleo (Also considered the No Action Alternative)

Summary: Syracuse will seek administrative changes that would allow the increased pumping of existing wells. The current wells may not meet the safe yield or spacing requirements for the increased pumping. A hydrologic study would be required to determine if required yield could be met without a negative impact. Any increase in withdrawal would require approval by the Chief Engineer.

It is currently unknown if the existing facilities could pump and convey the additional water demand; therefore for this alternative new infrastructure was constructed.

Infrastructure: A municipal water supply well approximately 100’ deep and installation of a pump capable of pumping 250 gpm is required. This may require a new well or the reworking of an additional well. Chlorination would occur at the well site. The construction of an 8” pipeline 4 miles in length will be required.

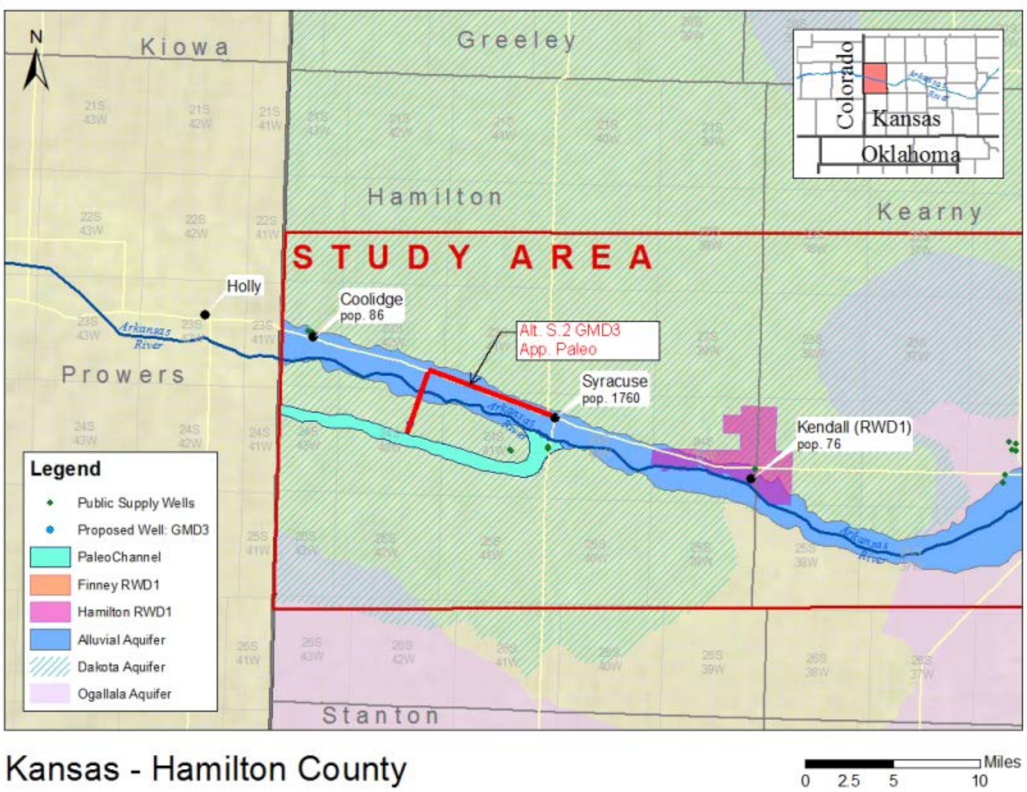


Figure 14. Syracuse Alternative S.2

Alternative S.2: Individual GMD3 Application in Paleo

Summary: Syracuse would assume the GMD3 or other water right application, which is for 320 acre-feet annually. It is unlikely that water can be legally appropriated to Syracuse from a location in the Paleo Aquifer between their wells and the GMD3 application without an administrative rule change.

Infrastructure: The infrastructure will convey the increase from the existing to the 2050 peak daily demand. The well and conveyance pipeline should be capable of conveying 250 gpm. A municipal water supply well approximately 100' deep and installation of a pump capable of pumping 250 gpm is required. Chlorination would occur at the well site. An 8" pipeline of 4-miles with an Arkansas River and a railroad crossing would convey the water to Hwy 50. An 8" pipeline 10.5 miles long would convey the water to Syracuse. The pump at the well site will provide sufficient head to deliver the water to Syracuse.

Alternative S.3: Dakota Advanced Water Treatment

Summary: Syracuse will develop a water right in the Dakota in close proximity to the city. It is unknown if the water from the Dakota will require treatment by IX, NF, or blending with Paleo water supplied by their existing wells. For this alternative, it was assumed that IX would be used for the removal of gross alpha particles and radium before blending for distribution.

Infrastructure: Infrastructure would include the construction of two wells meeting municipal standards into the Dakota, north of the city. The infrastructure would include pumps, a conveyance pipeline and IX treatment facility, as well as facilities to mix the water with the existing water. Productions of wells from the Dakota near Syracuse appear to be limited in production, varying from 25 to 50 gpm. The peak daily demand increase would require approximately 55 gpm. The length of the pipeline is estimated to be 5 miles, assuming that Syracuse will not be able to tie into the existing infrastructure.

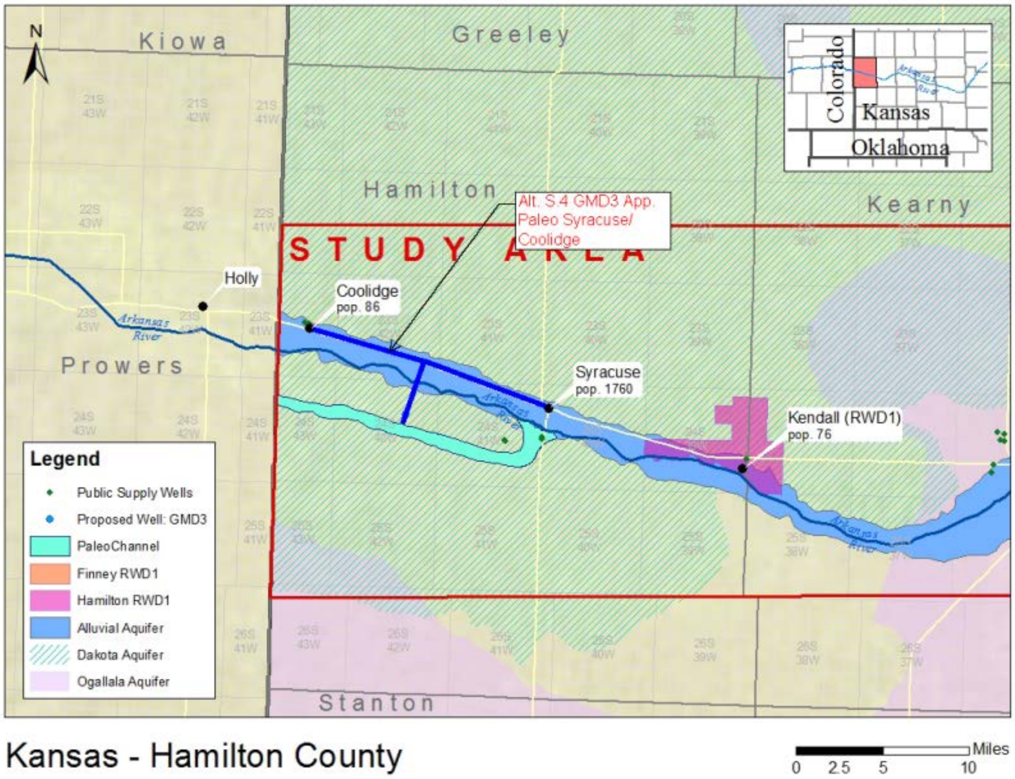


Figure 15. Syracuse Alternative S.4

Alternative S.4: GMD3 Application in Paleo with Coolidge (See Alt. C.5)

Summary: Coolidge and Syracuse would utilize GMD3 or other water right application. Construction of a new municipal supply well and the conveyance pipeline would be shared through a Regional Authority. Additional customers located along the Arkansas River corridor from Coolidge to Syracuse could be accommodated with this system.

Infrastructure: The infrastructure is required to convey the peak daily demand of Coolidge and the increase from the existing peak to the 2050 peak daily demand of Syracuse. Therefore, the well and conveyance pipeline should be capable of conveying 286 gpm. A municipal water supply well approximately 100 feet deep and installation of a pump capable of pumping 286 gpm is required. Chlorination would occur at the well site. A 10” pipeline 4 miles in length with an Arkansas River and a railroad crossing would convey the water to Hwy 50. A bifurcation structure is required at the Hwy 50 location and individual pipelines would convey the water to the respective cities. The additional pipeline to Coolidge would be a 6” pipeline approximately 4.6 miles in length and an 8” pipeline 10.5 miles in length would convey the water to Syracuse. The pump at the well site will provide sufficient head to deliver the water to Coolidge and Syracuse.

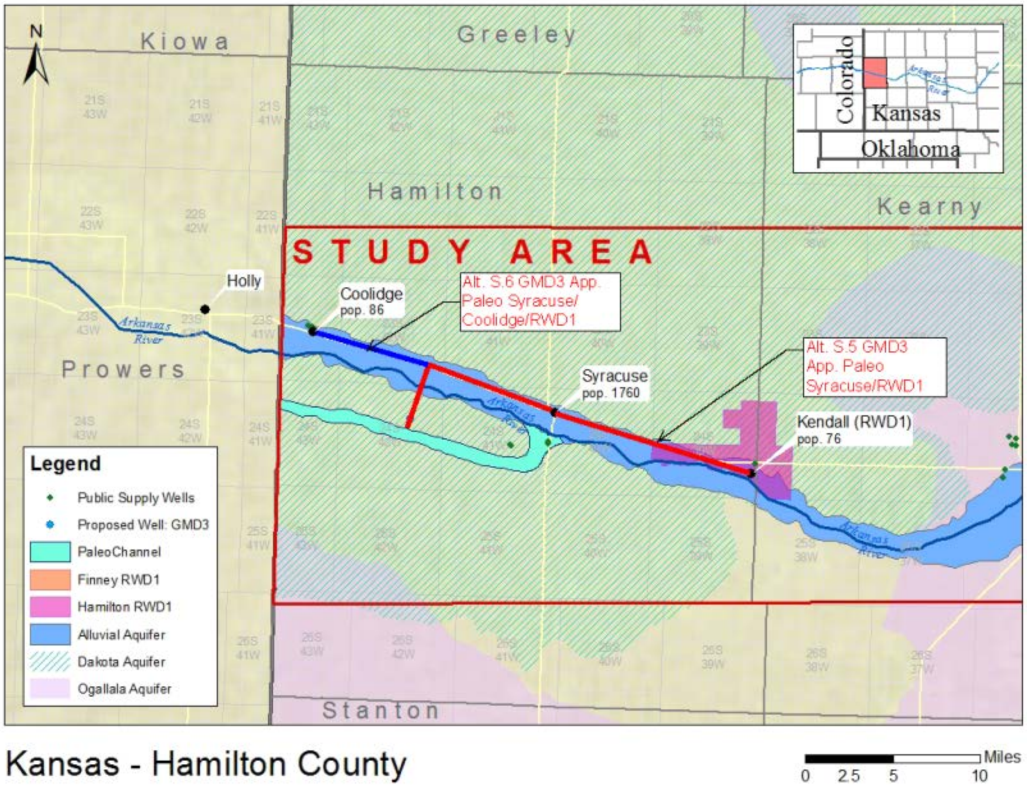


Figure 16. Syracuse Alternative S.5 and S.6

Alternative S.5: GMD3 Application in Paleo with Hamilton RWD1 (See Alt. RWD1.4)

Summary: Syracuse and Hamilton RWD1 would utilize the GMD3 or other water right application. The construction of a new municipal supply well and the conveyance pipeline would be shared through a Regional Authority. Additional customers located along the Arkansas River corridor from Syracuse to Kendall would be accommodated with this system.

Infrastructure: The infrastructure will provide the difference between the existing peak daily and the 2050 peak daily demand of Syracuse and the peak daily demand of Hamilton RWD1. The well and conveyance pipeline will be sized to convey 263 gpm. A municipal water supply well approximately 100-feet deep and installation of a pump cable of pumping 263 gpm is required. Chlorination will occur at the well site. A 10" pipeline of 4 miles with an Arkansas River and a railroad crossing would convey the water to Hwy 50.

An 8" pipeline 10.5 mile in length would convey the water to Syracuse and Hamilton RWD1. An additional 11.6 mile, 4" pipeline would convey the water to Hamilton RWD1. The pump at the well site will provide sufficient head to deliver the water to Syracuse and Hamilton RWD1.

Alternative S.6: GMD3 Application in Paleo with Coolidge and Hamilton RWD1 (See Alt. S.6 and RWD1.5)

Summary: Coolidge, Syracuse, and Hamilton RWD1 would utilize the GMD3 or other water right application. The construction of a new municipal supply well and a portion of the conveyance pipeline would be shared through a Regional Authority. Additional customers located along the Arkansas River corridor from Coolidge to Kendall would be accommodated with this system.

Infrastructure: The infrastructure will provide the difference between the existing peak daily demand and the 2050 peak daily demand of Syracuse and the peak daily demand of Coolidge and Hamilton RWD1. Therefore the well and conveyance pipeline should be capable of conveying 308 gpm. A municipal water supply well approximately 100 feet deep and installation of a pump capable of pumping 308 gpm is required. Chlorination will occur at the well site. A 10" pipeline of 4 miles with an Arkansas River and a railroad crossing would convey the water to Hwy 50. The pipeline and the well would be a shared pipeline between Coolidge, Syracuse, and Hamilton RWD1.

A bifurcation structure located at a Hwy 50 location and individual pipelines would convey the waters to the respective cities along Hwy 50. The additional pipeline to Coolidge would be a 6" pipeline approximately 4.6 miles in length. An 8" pipeline 10.5 miles in length would convey the water to Syracuse and Hamilton RWD1. An additional 11.6 mile, 4 inch pipeline would convey the water to Hamilton RWD1. The pump at the well site will produce sufficient head to deliver the water to Coolidge, Syracuse, and Hamilton RWD1.

A summary of the various alternatives for Syracuse developed in this assessment are listed in Table 19.

Table 19. Alternatives for Syracuse.

Alt #	Description of Water Source	Proposed Treatment	Preliminary Cost Estimate[4]	Preliminary O&M Cost[4] (Cost/AFY)
S.1	Administrative Rule Change for Paleo	Chlorination	$3,300,000	$417
S.2	GMD3 Application in Paleo	Chlorination	$7,700,000	$897
S.3	Advanced Water Treatment of Dakota	Ion Exchange	$4,9100,000	$1,072
S.4 (C.5)[1]	GMD3 Application in Paleo with Coolidge	Chlorination	$6,000,000	$785
S.5 (RWD1.4)[2]	GMD3 Application in Paleo with Hamilton RWD1	Chlorination	$4,300,000	$627
S.6 (C.6 & RWD1.5)[3]	GMD3 Application in Paleo with Coolidge and Hamilton RWD1	Chlorination	$3,700,000	$608

[1] Alternative S.4 is the same regional option as Alternative C.5.
[2] Alternative S.5 is the same regional option as Alternative K.4.
[3] Alternative S.6 is the same regional option as Alternative C.6 and Alternative K.5.
[4] Preliminary Cost Estimate and Annual O&M costs presented provide only Syracuse's assumed proportion share for all regional alternatives.

Alternatives Comparison

The results of the evaluation for each of the Syracuse's six alternatives across the four criteria are shown in Table 20 and Figure 16. The results are depicted as points scored for each of the alternatives for Syracuse across the four criteria. Alternatives S.1 is the most likely to occur if no further action is taken. Under this alternative Syracuse would seek administrative rule changes for Kansas Water Rights. Alternative S.1 ranked high due to the lowest capital cost, but scored low in completeness due to the unknowns in seeking the Rule changes. Alternatives S.2 and S.3 scored the lowest, because cost of new infrastructure lowered the efficiency criteria and scored low in the completeness criteria. Alternative S.4, S.5 and S.6 also require a large amount of infrastructure, but indicate the benefits of shared expenses through the development of a Regional System.

Table 20. Syracuse Alternaitve matrix ranking sheet.

Screening Criteria:	Alternative S.1	Alternative S.2	Alternative S.3	Alternative S.4 (See C.5)	Alternative S.5 (See RWD1.4)	Alt. S.6 (See C.6 & RWD1.5)
	Administrative Rule Changes in Kansas Water Rights	Individual GMD3 Application Paleo	Dakota Aquifer Advanced Water Treatment	GMD3 Application Paleo Syracuse/Coolidge	GMD3 Application Paleo Syracuse/ Hamilton RWD1	GMD3 Application Paleo Coolidge/Syracuse/Hamilton RWD1
Effectiveness (Total Pts)	17	14	11	14	14	14
(0-8 pts)	7	7	7	7	7	7
Quality and Quantity Notes:	Modified water rights provide sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	Would require the construction of wells and Ion exchange treatment facility	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)
(0-4 pts)	4	1	1	1	1	1
Constructability Notes:	Existing wells and pipelines provide adequate flow.	Similar but more difficult crossings (possibly boring for river) as Alt. 3, longer pipeline	Construction of wells, pipeline, ion exchange and evaporative lagoon	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required
(0-6 pts)	6	6	3	6	6	6
Operation and Serviceability Notes:	Existing O&M provides no challenges	Existing O&M provides no challenges	Operational challenges	Operational challenges are minimal due to leveraged resources	Operational challenges are minimal due to leveraged resources	Operational challenges are minimal due to leveraged resources
Efficiency	20	2	5	12	11	18
(0-8pts)	8	0	5	3	5	7
Construction Cost	$ 3,360,000	$7,700,000	$3,800,000	$6,000,000	$5,160,000	$3,710,000
(0-12 pts)	12	2	0	9	6	11
Annualized O&M per AF	$ 417	$897	$1,072	$785	$627	$608
Acceptability	12	15	11	14	14	14
(0-5 pts)	2	5	4	4	4	4
Authorities, regulations, and policies Notes:	Request to Chief Engineer for a special management area provides some precedent for moderate difficulties (or intensive groundwater use control area); Paleo well and pipeline provide no conflict with regulations and policies	Existing authority remains in place; Paleo well and pipeline provide no conflict with regulations and policies	Existing authority remains in place; existing technologies provide minimal regulations and policy difficulties	An agreement with Coolidge would provide authority; Paleo well and pipeline provide no conflict with regulations and policies	An agreement with Kendall would provide authority; Paleo well and pipeline provide no conflict with regulations and policies	An agreement with Coolidge and Kendall would provide authority; Paleo well and pipeline provide no conflict with regulations and policies
N/A	N/A	N/A	N/A	N/A	N/A	N/A
Insufficient information to determine public acceptance	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking
(0-5 pts)	5	5	4	5	5	5
Environmental considerations Notes:	No issues were found	Paleo well and pipeline requires short term land disturbance	Water treatment plant provides small footprint and minimal environmental disturbance; waste stream disposal requires construction disturbed (or undisturbed) land	Paleo well and pipeline requires short term land disturbance	Paleo well and pipeline requires short term land disturbance	Paleo well and pipeline requires short term land disturbance
(0-5 pts)	5	5	3	5	5	5
Public health and safety Notes:	No issues were found	No issues were found	Waste disposal lagoon location would likely to be in the flood plain or would disturb the flood plain due to levees	No issues were found	No issues were found	No issues were found
Completeness	9	11	8	12	12	12
(0-5 pts)	3	3	2	4	4	4
Coordination and available water rights Notes:	Request to Chief Engineer for a special management area provides some precedent for moderate difficulties (or intensive groundwater use control area)	GMD3 water rights application required	Required to obtain rights in the Dakota	GMD3 water rights application required; development of agreement with Coolidge (benefit from the economies of scale)	GMD3 water rights application required; development of agreement with Kendall (benefit from the economies of scale)	GMD3 water rights application required; development of agreement with Coolidge and Kendall (benefit from the economies of scale)
(0-5 pts)	1	4	3	4	4	4
Engineering Uncertainties and risks Notes:	Hydrologic study required to determine if required yield could be met without a negative impact; existing pipeline size provides adequate future demands	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties	Design and specifications associated with water treatment plant design and waste stream disposal requires standard risks and uncertainties	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties
(0-5 pts)	5	4	3	4	4	4
Permits, ROW, and easements notes:	Existing infrastructure requires no permits, ROW, and easements notes	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access	Water treatment plant design and waste stream disposal requires permits and easements	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access
TOTAL	**58**	**42**	**35**	**52**	**51**	**58**

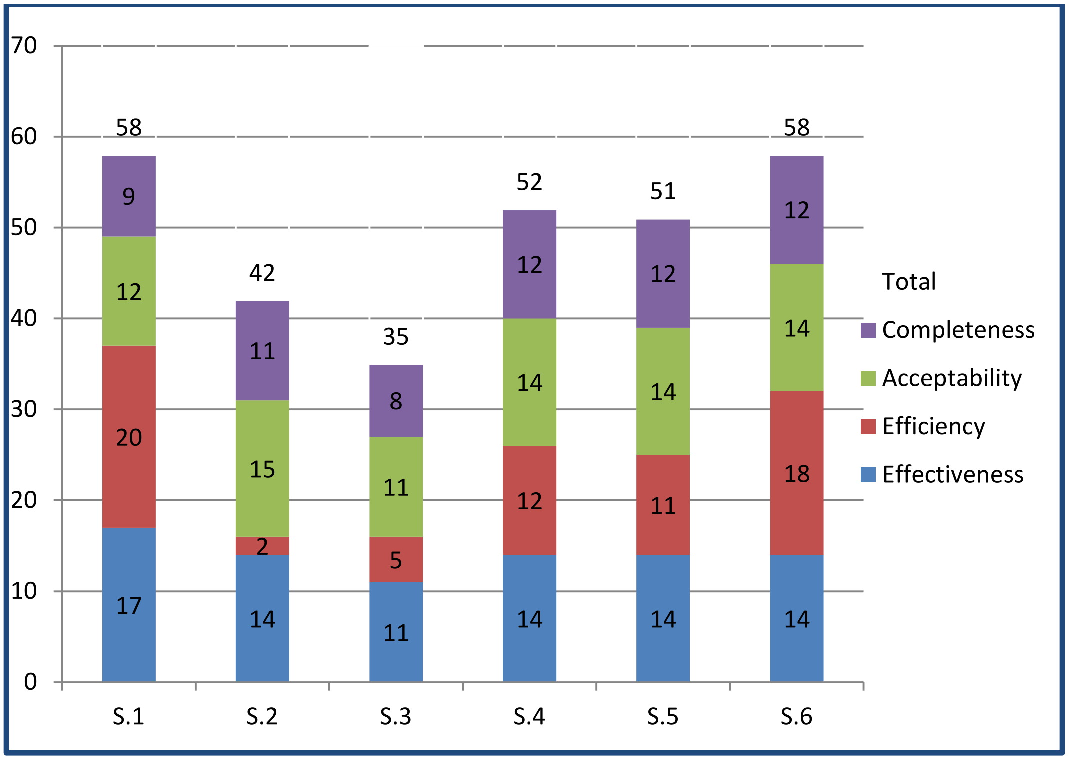


Figure 17. Comparison of Alternatives for Syracuse

Conclusions

A public meeting presenting these alternatives was conducted in Syracuse, Kansas and Holly, Colorado on February 26th. The Syracuse meeting was attended by representatives from Hamilton County, the city of Syracuse, and town of Kendall (Hamilton RWD1). The status of Syracuse's wells were discussed and their relation to the Paleo aquifer. The discussion included if accessing the Paleo aquifer near Syracuse or Coolidge could benefit all of Hamilton County by providing fresh water for the county needs and if water rights application from Syracuse to address study need was necessary before further state issued appropriations occur. The benefit of protecting and securing that source as soon as possible was described. All alternatives were well received; however, the information gathered was insufficient to rank public opinion on the alternatives.

The City of Syracuse has since submitted a letter to the State Engineer, requesting that future appropriations from the source be suspended until a study is completed on the sustainable yield.

The alternatives utilizing a Regional Authority including the communities of Kendall and Coolidge scored very well in this analysis. The sizes of the communities are small, which indicate a sharing of resources and the cost of developing or maintaining existing water supplies is the most viable option.

The outcome of seeking an administrative rule change is unknown and a significant amount of engineering work will likely be required. Additional discussions need to occur before deciding to proceed with or disregard this option.

Certain advantages of the regional infrastructure were not captured in this analysis. The construction of a regional infrastructure encompassing Hamilton County by utilizing the existing GMD3 water application would be able to provide water to approximately 90% of the population of Hamilton County. Providing potable water to the rural population as well as industries located along the river corridor is important to the future growth in Hamilton County.

The potential for Regional Authority between communities should be explored before Syracuse moves forward with the development of an individual water supply.

Hamilton County Rural Water District No. 1's (Hamilton RWD1) Alternatives Formulation and Evaluation

Hamilton RWD1 obtains its water from two wells drilled into the Dakota. These wells were completed in 1983 and are 382' in depth, with a design capacity of 40 gpm each. Water quality problems include high iron content and is treated by chlorination and iron sequestration. Hamilton RWD1 has adequate water rights for the 2050 demand. The 2050 estimated demand is 13 ac-ft per year

Needs: The water quality in the Dakota is degrading, and Hamilton RWD1 may need to upgrade their existing treatment system or import higher quality water. If advanced treatment were utilized, a lined evaporative lagoon would be required. Hamilton RWD1 could also consider utilizing Lakin's disposal well to dispose of the waste stream.

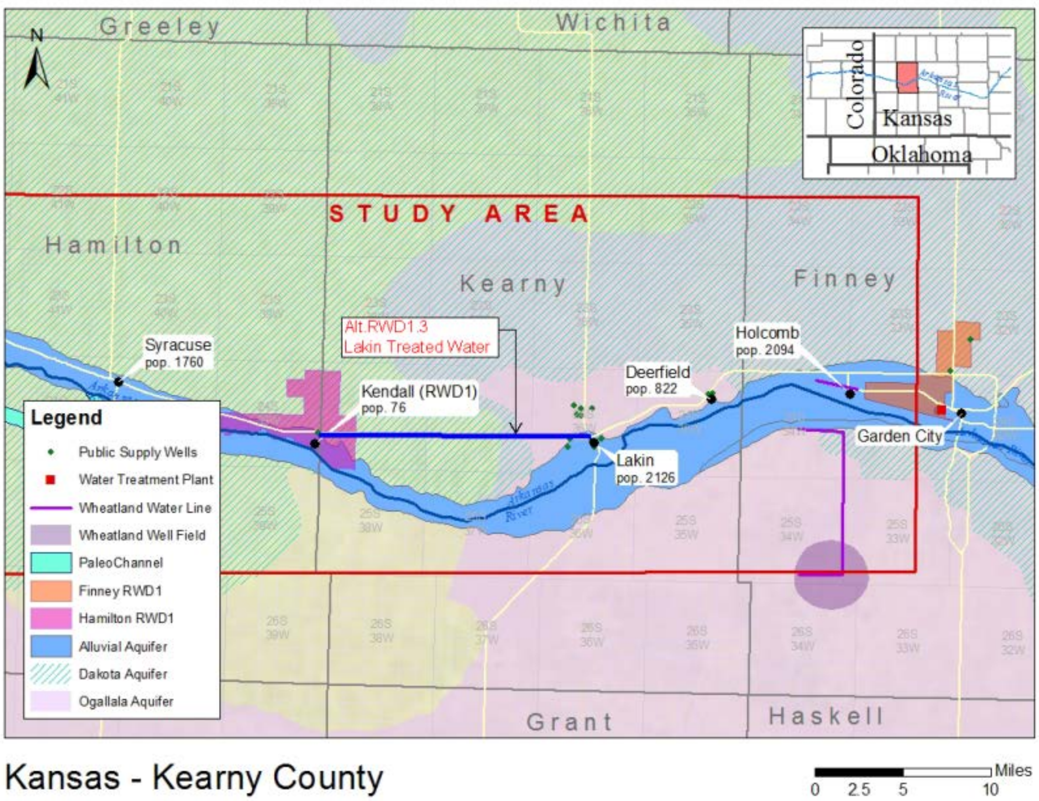


Figure 18. Hamilton RWD1 Alternative RWD1.3

Description of Alternatives

Figures 18 and 19 provide a map showing the alignment of alternatives RWD1.3, RWD1.4 and RWD1.5.

Alternative RWD1.1: Dakota Aquifer - Advanced Treatment –Shared Regional O&M

Summary: Hamilton RWD1 would participate in a Regional Authority to operate an IX treatment plant and the construction and operation of an evaporative lagoon to meet current regulations.

Infrastructure: The **c**onstruction of an IX treatment plant and an evaporative lagoon with an impermeable liner for the disposal of the backwash would be required.

Alternative RWD1.2: Dakota Advanced Water Treatment (Also considered the No Action Alternative)

Summary: Hamilton RWD1 would construct an IX treatment facility. The disposal of the waste stream would be required.

Infrastructure: The existing wells have adequate capacity. The installation of an IX treatment plant would be required. A lagoon will be constructed to dispose of the waste stream.

Alternative RWD1.3: Lakin Treated Water

Summary: Hamilton RWD1 would purchase treated water from Lakin to meet the 2050 demand. Lakin has constructed a nanofiltration plant and disposal well. After the construction of the NF treatment plant, Lakin may have adequate capacity to serve Hamilton RWD1.

Infrastructure: The construction of a 15.5 mile, 4" pipeline from the Lakin NF plant to Hamilton RWD1 capable of conveying 18 gpm will be required. The pipeline would follow Hwy 50 ROW. It is likely that a booster pump will be required. The elevation at Lakin is 3,020-ft and the elevation at Hamilton RWD1 is 3,220-ft, an elevation difference of 200-feet.

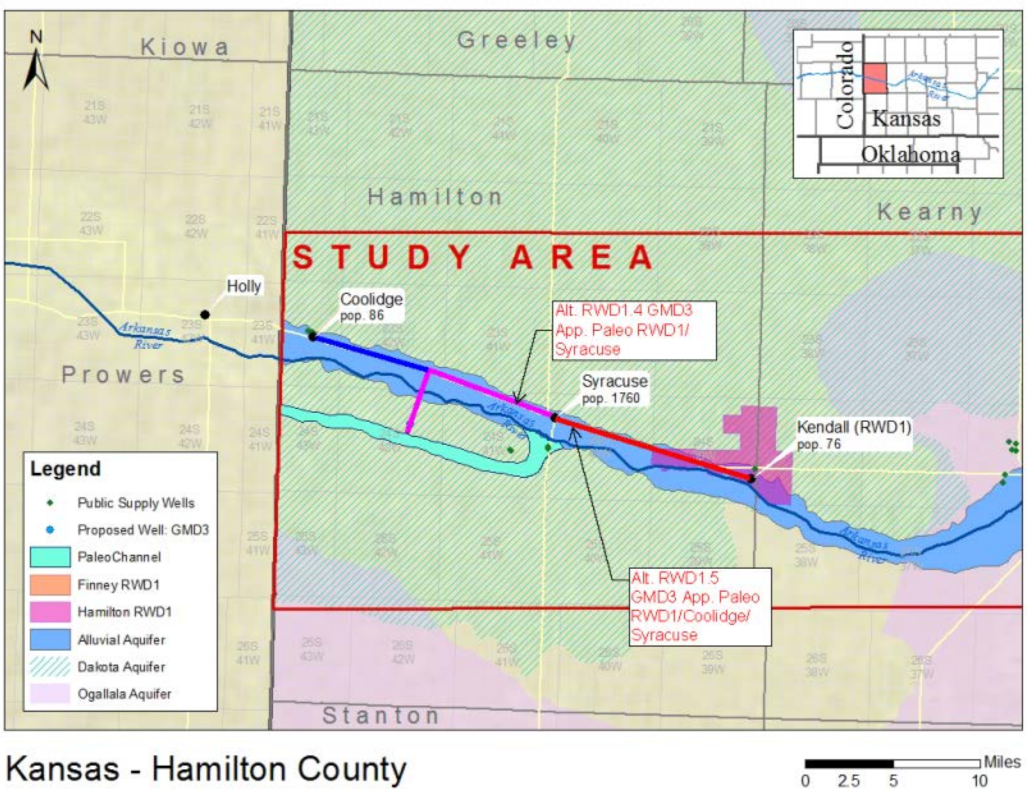


Figure 19. Hamilton RWD1 Alternatives RWD1.4 and RWD1.5

Alternative RWD1.4: GMD3 Application in Paleo with Syracuse (See Alt. S.5)

Summary: Syracuse and Hamilton RWD1 would utilize the GMD3 or other water right application. Construction of a new municipal supply well and the conveyance pipeline would be completed by a Regional Authority. Additional customers located along the Arkansas River corridor from Syracuse to Kendall would also be accommodated with this system.

Infrastructure: The infrastructure will provide the difference between the existing peak and the 2050 peak daily demand of Syracuse and the peak daily demand of Hamilton RWD1. A municipal water supply well approximately 100' deep and installation of a pump capable of pumping 263 gpm is required. Chlorination will occur at the well site. A 10" pipeline of 4 miles in length with Arkansas River and railroad crossings would convey the water to Hwy 50. An 8" pipeline 10.5 miles in length would convey the water to Syracuse and Hamilton RWD1. An additional 11.6 mile, 4" pipeline would convey the water to Hamilton RWD1. The pump at the well site will provide sufficient head to deliver the water to Syracuse, and Hamilton RWD1.

Alternative RWD1.5: GMD3 Application in Paleo with Coolidge and Syracuse (See Alt. C.6 and S.6)

Summary: Coolidge, Syracuse, and Hamilton RWD1 would utilize GMD3 or other water right application. Construction of a new municipal supply well and a portion of the conveyance pipeline would be shared through a Regional Authority. Additional customers located along the Arkansas River corridor from Coolidge to Kendall would also be accommodated with this system.

Infrastructure: This infrastructure will provide the difference between the existing peak daily demand and the 2050 peak daily demand of Syracuse and the peak daily demand of Coolidge and Hamilton RWD1. The well and conveyance pipeline should be capable of conveying 308 gpm. A municipal water supply well approximately 100 feet deep and installation of a pump capable of pumping 308 gpm is required. Treatment (chlorination) would occur at the well site. A 10" pipeline of 4 miles with an Arkansas River and a railroad crossing would convey the water to Hwy 50. The pipeline and the well would be a shared pipeline between Coolidge, Syracuse, and Hamilton RWD1.

A bifurcation structure will be constructed at the Hwy 50 location and individual pipelines along Hwy 50 would convey the water to the respective cities. The pipeline to Coolidge would be a 6" pipeline 4.6 miles in length. An 8" pipeline 10.5-miles in length would convey the water to Syracuse and Hamilton RWD1. An additional 11.6 mile, 4" pipeline would convey the water to the Hamilton RWD1. The pump at the well site will produce sufficient head to deliver the water to Coolidge, Syracuse, and Hamilton RWD1.

Table 21 provides a summary of the various alternatives developed in this assessment for Hamilton RWD1.

Table 21. Alternative for Hamilton RWD1.

Alt #	Description of Water Source	Proposed Treatment	Preliminary Cost Estimate[3]	Preliminary Annual O&M Cost[3] (Cost/AFY)
RWD1.1	Shared Regional O&M of Advanced Water Treatment	Various	$1,000,000	$662
RWD1.2	Dakota Advanced Water Treatment	Ion Exchange	$1,000,000	$1,103
RWD1.3	Lakin Treated Water	Chlorination	$4,100,000	$4,405
RWD1.4 (S.5)[1]	GMD3 Application in Paleo with Syracuse	Chlorination	$5,600,000	$690
RWD1.5 (C.6 & S.6)[2]	GMD3 Application in Paleo With Coolidge and Sryacuse	Chlorination	$5,300,000	$439

[1] Alternative K.4 is the same regional option as Alternative S.5.
[2] Alternative K.5 is the same regional option as Alternative C.6 and Alternative S.6.
[3] Preliminary Cost Estimate and Annual O&M costs presented provide only Kendall's assumed proportion share for all regional alternatives.

Comparison of Alternatives

Table 22 and Figure 19 provide a summary of results of the alternative evaluation. The evaluations are depicted as points scored for each of the six alternatives for Hamilton RWD1 across the four criteria. Alternative RWD1.2 is described as the most likely to occur if no further action is taken. This alternative would have Hamilton RWD1 developing an IX water treatment plant. Alternative RWD1.1 ranked high due to the lowest capital cost, but scored low in acceptability and completeness. Alternatives RWD1.3 scored the lowest due to the cost of infrastructure to import water from Lakin. This option scored high in the completeness option. Alternative RWD1.4 and RWD1.5 also require a large amount of infrastructure to import the Paleo water from Syracuse, but indicate the benefits of shared expenses through the development of a Regional Authority.

Table 22. Hamilton RWD1 (Kendall) matrix ranking sheet.

Screening Criteria:	Alternative RWD1.1	Alternative RWD1.2	Alternative RWD1.3	Alternative RWD1.4 (See S.5)	Alt. RWD1.5 (See C.6 & S.6)
	Shared Regional O&M	Dakota Aquifer Advanced Water Treatment	Treated Water from Lakin	GMD3 Application Paleo Hamilton RWD1/Syracuse	GMD3 Application Paleo Coolidge/Syracuse/Hamilton RWD1
Effectiveness (Total Pts)	16	10	17	14	14
(0-8 pts)	8	8	8	7	7
Quality and Quantity Notes:	Existing water rights provide sufficient quantity; water treatment plant provides sufficient quality	Existing water rights provide sufficient quantity; water treatment plant provides sufficient quality	Treated water from Lakin provides sufficient quality and quantity	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)	GMD3 application provides sufficient quantity; Paleo aquifer provides sufficient water quality (sustainability unknown)
(0-4 pts)	2	2	3	1	1
Constructability Notes:	Water treatment plant and waste stream disposal construction provides moderate challenges	Water treatment plant and waste stream disposal construction provides moderate challenges	Pipeline along highway ROW, no river or railroad crossings. Pump station and surge tank required.	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required	Paleo well and pipeline (8.5-miles) requires standard construction; railroad and river crossing provides moderate challenges; waste stream disposal is not required
(0-6 pts)	6	0	6	6	6
Operation and Serviceability Notes:	Regional operators and leverage resources provide experienced O&M	Water treatment plant and waste stream disposal requires high O&M challenges	Existing O&M provides no challenges	Operational challenges are minimal due to leveraged resources	Operational challenges are minimal due to leveraged resources
Efficiency	19	18	3	11	13
(0-8pts)	8	8	3	0	1
Construction Cost	$1,000,000	$1,000,000	$4,100,000	$5,600,000	$5,300,000
(0-12 pts)	11	9	0	11	12
Annualized O&M per AF	$662	$1,103	$4405	$690	$439
Acceptability	10	11	14	14	14
(0-5 pts)	3	4	4	4	4
Authorities, regulations, and policies Notes:	Regional Authority or agreement requires moderate challenges; existing authority remains in place; existing technologies provide minimal regulations and policy difficulties	Existing authority remains in place; existing technologies provide minimal regulations and policy difficulties	An agreement with Lakin would provide authority; transfer of water from Kearny County to Hamilton County requires the development of a Kearny County Authority and includes service along the line.	An agreement with Syracuse would provide authority; Paleo well and pipeline provide no conflict with regulations and policies	An agreement with Coolidge and Syracuse would provide authority; Paleo well and pipeline provide no conflict with regulations and policies
N/A	N/A	N/A	N/A	N/A	N/A
Insufficient information to determine public acceptance	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking
(0-5 pts)	4	4	5	5	5
Environmental considerations Notes:	Water treatment plant provides small footprint and minimal environmental disturbance; waste stream disposal requires construction disturbed (or undisturbed) land	Water treatment plant provides small footprint and minimal environmental disturbance; waste stream disposal requires construction disturbed (or undisturbed) land	No issues were found	Paleo well and pipeline requires short term land disturbance	Paleo well and pipeline requires short term land disturbance
(0-5 pts)	3	3	5	5	5
Public health and safety Notes:	Waste disposal lagoon location would likely to be in the flood plain or would disturb the flood plain due to levees	Waste disposal lagoon location would likely to be in the flood plain or would disturb the flood plain due to levees	No issues were found	No issues were found	No issues were found
Completeness	11	11	13	12	12
(0-5 pts)	4	4	4	4	4
Coordination and available water rights Notes:	Development of a Regional Authority or agreement; existing water rights provide future demand	Existing water rights provide future demand	Lakin's existing water rights provide future demand; moving water from Kearny to Hamilton would require the development of a Kearny Co. Authority and additional coordination (Would be seen as a benefit for Lakin and Kearny Co.)	GMD3 water rights application required; development of agreement with Syracuse (benefit from the economies of scale)	GMD3 water rights application required; development of agreement with Coolidge and Syracuse (benefit from the economies of scale)
(0-5 pts)	4	4	5	4	4
Engineering Uncertainties and risks Notes:	Design and specifications associated with water treatment plant design and waste stream disposal requires standard risks and uncertainties	Design and specifications associated with water treatment plant design and waste stream disposal requires standard risks and uncertainties	Treated water.	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties	Paleo aquifer potential quality and quantity and pipeline alignment (access road required) provide moderate risks and uncertainties
(0-5 pts)	3	3	4	4	4
Permits, ROW, and easements Notes:	Water treatment plant design and waste stream disposal requires permits and easements	Water treatment plant design and waste stream disposal requires permits and easements	Highway ROW	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access	Paleo well requires permits and easement note; pipeline (8.5 miles) requires a railroad permit and river crossing ROW access
TOTAL	**56**	**50**	**47**	**51**	**52**

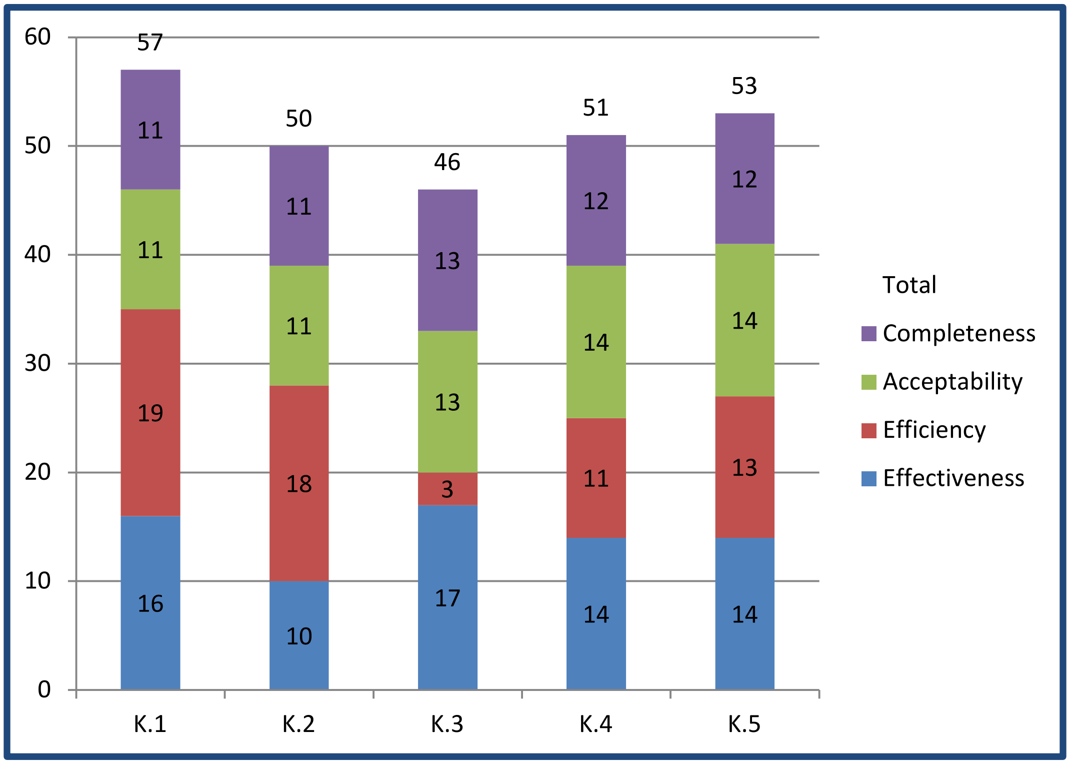


Figure 20. Comparison of Alternatives for Hamilton RWD1

Conclusions

A public meeting presenting these alternatives was conducted in Lakin and Syracuse, Kansas on February 25 and 26th, respectively. The public opinion gathered was insufficient to rank public opinion on the alternatives; however, the all alternatives were well received.

The City of Lakin originally anticipated selling water to other entities but the well production has less than anticipated.

The alternatives utilizing a Regional Authority scored well in this analysis. The sizes of the communities are small, which indicate a sharing of resources and the cost of developing or maintaining existing water supplies is the most viable option.

Certain advantages of the regional infrastructure concept (RWD1.4 and RWD1.5) were not captured in this analysis. The construction of a Regional Authority infrastructure encompassing Hamilton County by utilizing an application from the Paleo would be able to provide water to approximately 90% of the population of Hamilton County. Providing potable water to the rural population as well as industries located along the river corridor is important to the future growth in Hamilton County.

The potential for a Regional Authority between communities should be explored before Hamilton RWD1 moves forward with an independent development of water supply.

Deerfield Alternatives Formulation and Evaluation

The City of Deerfield population is 700 with 2,503 service connections. A City of Deerfield meeting occurred with City Manager Craig Turrentine on July 19, 2012 at City Hall. At this meeting, it was reported that the quality of the water is degrading and the city officials are concerned that it will be unable it to meet the standard for uranium in the future.

Deerfield has not developed an official plan of action, but they indicate that they will contact Wheatland, who supplies water to Finney RWD and several other large customers, and performs reverse osmosis treatment for the city of Garden City. Wheatland has a raw water pipeline located within a few miles of Deerfield, and is interested in selling treated water.

Deerfield water rates are tiered and are as follows: a flat fee of $24.30 is charged for the first 3,000 gallons; $1.64 per thousand gallons is charged from 3,001 – 15,000 gallons; $1.76 per thousand gallons is charged from 15,001 – 25,000 gallons; $1.94 per thousand gallons is charged from 25,001 – 50,000 gallons; $2.00 per thousand gallons is charged for more than 50,000 gallons.

Needs: Deerfield currently has three wells into the Ogallala near the Arkansas River with an approved capacity of 1,740 gpm. Deerfield's 2050 estimated demand is 176 ac-ft per year. The existing water supply and right is adequate for the 2050 demand. Deerfield currently obtains their water supply from a single well in the Ogallala, due to quality issue in the other wells. The water currently meets the EPA's MCL standards, but their water quality is deteriorating due to infiltration of poor quality Arkansas River water.

Description of Alternatives

Figure 20 provides a map that show the proposed alignments of Alternatives D.3 and D.4

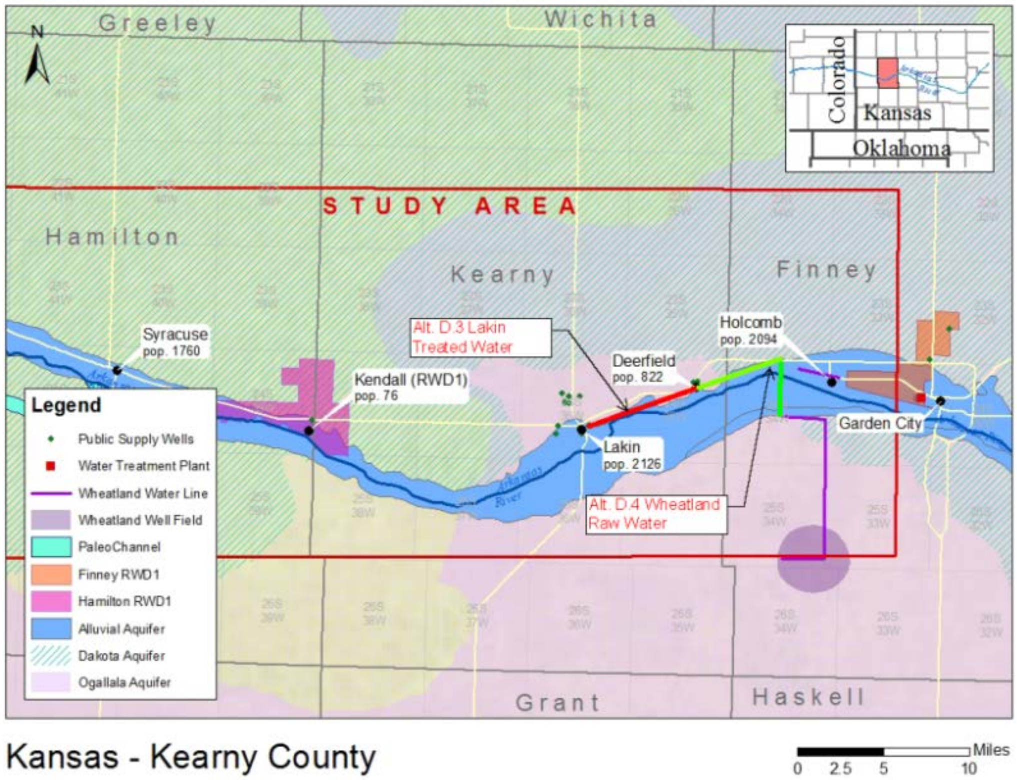


Figure 21. Map of proposed pipelines for Deerfield Alternative D.3 and D.4.

Alternative D.1: Regional/Partnership Shared O&M of Advanced Water Treatment

Summary: This alternative consists of the development of a Regional Authority to construct, operate, and maintain the water treatment systems for the various cities. Deerfield would utilize NF to treat water from its wells in the Ogallala and work with other communities in the region (Syracuse, Hamilton RWD 1, and Holcomb*)* to develop Regional Authority to operate and maintain the existing or upgraded treatment facilities to provide an adequate level of treatment and potentially operate and maintain the existing raw water supply (wells and transmission lines to the treatment facilities). It is assuming that each individual community would maintain separate facilities (no sharing of infrastructure). The Regional System could also be involved in billing and collections, or simply charge each entity their pro-rata share.

Infrastructures: The infrastructure would consist of a NF plant capable of providing the 2050 demand of 176 ac-ft per year and the presence of uranium in the waste stream will require Deerfield to dispose of the waste stream through deep well injection.

Alternative D.2: Ogallala Advanced Water Treatment (Also considered the No Action Alternative)

Summary: Deerfield would utilize existing water rights in Ogallala. The existing treatment facilities would be upgraded to address the increased water quality problems. IX with softening or NF for uranium, iron, or manganese is the most likely option. Using Lakin as an example for the area's treatment of the Ogallala Aquifer, NF was selected for this assessment. The disposal of the waste stream is likely to be met by deep well injection.

Infrastructure: A NF plant capable of providing the 2050 estimated demand of 176 ac-ft per year will be required. The presence of uranium in the waste stream will require Deerfield to dispose of the waste stream through deep well injection.

Alternative D.3: Lakin Treated Water

Summary: Deerfield will purchase treated water from Lakin. Lakin has constructed a NF plant and disposal well. Lakin may have excess capacity in its system to provide Deerfield with treated water.

Infrastructure: The infrastructure will consist of a 7.5 mile, 10" pipeline from Lakin to Deerfield. The pipeline is sized to deliver the maximum daily demand of 246 gpm and follow the Hwy 50 ROW. The elevation at Lakin is 3,020 feet and the elevation at Deerfield is 2,965 feet. A booster pump is not required.

Alternative D.4: Wheatland Water from fresh Ogallala Aquifer

Summary: Wheatland has available water rights and will construct a pipeline from an Ogallala fresh water source requiring only chlorination or treat with RO. Deerfield would develop an agreement to purchase treated water from Wheatland.

Components: The infrastructure will consist of a 7 mile, 10" pipeline extension from an existing Wheatland water transmission line to Deerfield. The pipeline would require an Arkansas River and Railroad crossing and convey the maximum daily demand of 246 gpm. A booster pump may be required to deliver the water to Deerfield. The approximate location of the Wheatland transmission line is 4.5 miles east and 2.5 miles south of Deerfield. The elevation in Deerfield is approximately 40-feet higher than at the Wheatland water main location.

A summary of the alternatives for Deerfield are listed in Table 23.

Table 23. Alternatives for Deerfield.

Alt #	Description of Water Source	Proposed Treatment	Preliminary Cost Estimate	Preliminary Annual O&M Cost (Cost/AFY)
D.1	Shared Regional O&M of advanced water treatment	Nanofiltration	$5,250,000	$235
D.2	Ogallala Aquifer Advanced Water Treatment	Nanofiltration	$5,250,000	$392
D.3	Lakin Treated Water	Chlorination	$3,500,000	$1,136
D.4	Wheatland Water from Fresh Ogallala Aquifer	Chlorination	$4,000,000	$611

Comparison of Alternatives

The evaluation for each of the Deerfield's four alternatives are shown in Table 24 and Figure 21. The results are depicted as points scored for each of the four alternatives for Deerfield across the four criteria. Alternative D.2 is described as the most likely to occur if no further action is taken. Under this alternative Deerfield would develop a nanofiltration treatment plant and a disposal well was necessary to dispose of the waste stream due to the presence of uranium. Alternatives D.1 and D.2 scored the lowest due to cost of the new infrastructure (includes a disposal well) in the efficiency criteria. Both alternatives also received low scores in the completeness criteria. Alternative D.3 and D.4 required a large amount of infrastructure, but benefited from the shared expenses through the development of a regional authority.

Table 24. Deerfield's alternative matrix ranking sheet.

Screening Criteria:	Alternative D.1	Alternative D.2	Alternative D.3	Alternative D.4
	Shared Regional O&M	Ogallala Aquifer Advanced Treatment	Treated Water from Lakin	Raw Water from Wheatland
Effectiveness (Total Pts)	15	12	18	14
(0-8 pts)	8	8	8	7
Quality and Quantity Notes:	Existing water rights provide sufficient quantity; water treatment plant provides sufficient quality	Existing water rights provide sufficient quantity; water treatment plant provides sufficient quality	Treated water from Lakin provides sufficient quality and quantity	Raw water from Wheatland provides sufficient quantity and quality (water quality sustainability is well known in Ogallala)
(0-4 pts)	1	1	4	2
Constructability Notes:	Water treatment plant and waste stream disposal through deep well injection construction provides high challenges	Water treatment plant and waste stream disposal through deep well injection construction provides high challenges	Pipeline along highway ROW, no river or railroad crossings; no pumping requires	Require construction of river and railroad crossing (Additional justification?)
(0-6 pts)	6	3	6	5
Operation and serviceability Notes:	Regional operators and leverage resources provide experienced O&M	Water treatment plant and waste stream disposal requires moderate O&M challenges	Existing O&M provides no challenges (no chlorination required)	Existing O&M provides no challenges
Efficiency	8	10	8	13
(0-8pts)	0	0	8	6
Construction Cost	$5,250,000	$5,250,000	$3,500,000	$4,000,000
(0-12 pts)	12	10	0	7
Annualized O&M Cost/AF	$ 397	$ 392	$ 1,136	$ 611
Acceptability	8	9	14	14
(0-5 pts)	3	4	4	4
Authorities, regulations, and policies Notes:	Regional Authority or agreement requires moderate challenges; waste stream disposal through deep well injection provides no conflict with regulations and policies; Uranium water quality and NRC license issue	Existing authority remains in place; waste stream disposal through deep well injection provides no conflict with regulations and policies; Uranium water quality and NRC license issue	An agreement with Lakin would provide authority	Agreement with Wheatland would provide authority
N/A	N/A	N/A	N/A	N/A
Insufficient information to determine public acceptance	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking
(0-5 pts)	3	3	5	5
Environmental considerations Notes:	Water treatment plant provides small footprint and minimal environmental disturbance; waste stream disposal through deep well injection requires moderate challenges	Water treatment plant provides small footprint and minimal environmental disturbance; waste stream disposal through deep well injection requires moderate challenges	No issues were found	No issues were found
(0-5 pts)	2	2	5	5
Public health and safety Notes:	Water treatment plant and waste stream disposal through deep well injections provide minimal health and safety concerns	Water treatment plant and waste stream disposal through deep well injections provide minimal health and safety concerns	No issues were found	No issues were found
Completeness	5	5	13	13
(0-5 pts)	3	3	4	5
Coordination and available water rights Notes:	Development of a Regional Authority or agreement; existing water rights provide future demand	Existing water rights provide future demand	Agreement with Lakin required (benefit from the economies of scale)	Agreement with Wheatland (benefit from the economies of scale)
(0-5 pts)	0	0	5	4
Engineering Uncertainties and risks Notes:	Design and specifications associated with water treatment plant design requires standard risks and uncertainties; waste stream disposal deep well injection requires high risks and uncertainties; Uranium water quality and NRC license issue	Design and specifications associated with water treatment plant design requires standard risks and uncertainties; waste stream disposal deep well injection requires high risks and uncertainties; Uranium water quality and NRC license issue	Pipeline alignment provide minimal risks and uncertainties	Ogallala aquifer quality and quantity and pipeline alignment provide minimal risks and uncertainties
(0-5 pts)	2	2	4	4
Permits, ROW, and easements Notes:	Water treatment plant design and waste stream disposal requires permits and easements	Water treatment plant design and waste stream disposal requires permits and easements	Construct along HWY 50 corridor requires ROW access; Ditch service area could be an additional benefit (uncertainty)	Pipeline requires a railroad and river crossing permits and ROW access
TOTAL	**40**	**36**	**53**	**54**

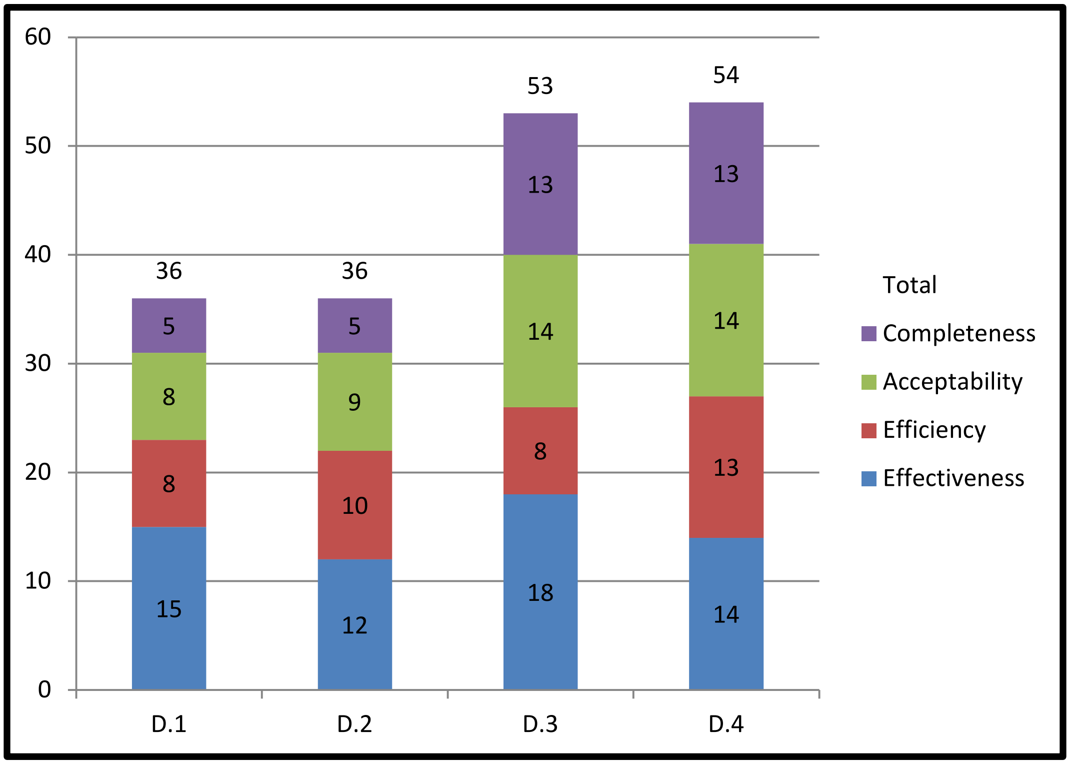


Figure 22. Comparison of Alternatives for Deerfield

Conclusions

A public meeting presenting these alternatives was conducted in Lakin, Kansas on February 25th. The public opinion gathered was insufficient to rank public opinion on the alternatives; however, the all alternatives were well received. Lakin originally anticipated selling water to other entities but the well production has less than anticipated and until these issues are resolved, they are unable to determine the quantity that they would be able to sell. Deerfield indicated that they have had early discussions with Wheatland Water concerning future supply and distribution options.

The alternatives utilizing the purchase of treated water scored very well in comparison to Deerfield constructing and operating its own facilities. The negotiated cost of the treated water will also have a large impact on the efficiency of Alternatives D.3 and D.4. The conveyance infrastructure could be constructed by either entity.

The costs for the purchased water will ultimately determine if these are the most viable of the options. Certain advantages of the purchase of treated water were not captured in this analysis. The construction of water line from Lakin or Wheatland would provide an opportunity to provide treated water to a larger segment of the population in Kearny County.

Holcomb Alternatives Formulation and Evaluation

The City of Holcomb population is 2,094 with 666 service connections. Holcomb charges $30/for first 2000 gallons and $3/for each additional 1000 gallons. Holcomb has five wells in the Ogallala; these wells have issues with hardness, uranium, iron, manganese, and/or iron bacteria. Specifically, Well #5 has problems with uranium, iron, manganese, and iron bacteria. Well #4 only has problems with hardness. Currently, Holcomb is only treating their wells with chlorination. Holcomb has also obtained the water rights to the west of city limits, but has not begun developing wells there.

Need: Holcomb is having difficulty meeting current drinking water quality standards. The 2050 estimated demand for Holcomb is expected to increase from 337 ac-ft per year in 2010 to 569 ac-ft per year. An additional water right or the purchase 219 ac-ft per year is required.

Description of Alternatives

Figure 22 provides a map that shows the proposed alignment of Alternatives H.3 and H.4.

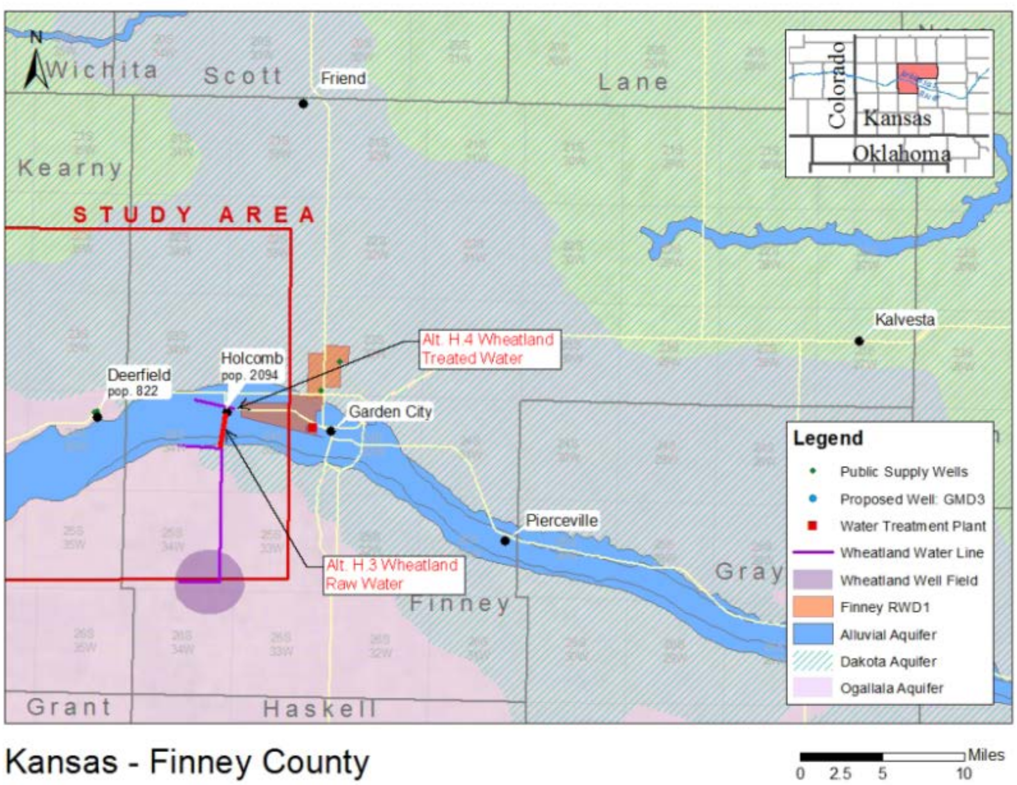


Figure 23. Map of proposed pipelines for Holcomb Alternative H.3 and H.4

Alternative H.1: Regional/Partnership Shared O&M of Advanced Water Treatment

Summary: This Alternative consists of the development of a Regional Authority to construct, operate, and maintain the water treatment systems for the various cities. Holcomb would utilize nanofiltration to treat water from its wells in the Ogallala Aquifer. Holcomb would work with other communities in the region (Syracuse, Hamilton RWD1, Deerfield and Holcomb*)* to develop a Regional Water Authority to operate and maintain the existing or upgraded treatment facilities to provide an adequate level of treatment and potentially operate and maintain the existing raw water supply (wells and transmission lines to the treatment facilities). It is assuming that each individual community would maintain separate facilities (no sharing of infrastructure). The regional entity could also be involved in billing and collections, or simply charge each entity their pro-rata share.

Infrastructure: Holcomb does not currently utilize advanced water treatment and would require the construction of a NF plant capable of providing the 2050 estimated demand of 569 ac-ft per year. The presence of uranium in the waste stream from the water treatment plant will require disposal by deep well injection.

Alternative H.2: Ogallala Aquifer Advanced Water Treatment (Also considered the No Action Alternative)

Summary: Holcomb will utilize their existing wells and the Ogallala along with the existing infrastructure to provide water. Treatment facilities would need to be upgraded to address the increased water quality problems. IX with softening or NF for uranium, iron, or manganese is the most likely option. Using Lakin as an example for the area's treatment of the Ogallala, NF was selected for this assessment. The disposal of the waste stream will require deep well injection.

Infrastructure: The construction of a NF treatment plant to meet the 2050 demand of 569 ac-ft per year, and the construction of a disposal well will be required.

Alternative H.3: Wheatland Treated Water (RO) from Ogallala Aquifer

Summary: Holcomb would purchase treated water from Wheatland. Wheatland will provide Ogallala water treated by an existing RO plant.

Infrastructure: Minor construction would be required to tie into Wheatland's existing infrastructure. Holcomb's existing infrastructure is located in close proximity to Wheatland's R.O. plant.

Wheatland's existing treated water supply quantity and available pressure at the connection location is unknown. Mixing may be required to mitigate any issues with placing water treated by RO into Holcomb's existing infrastructure.

Alternative H.4: Wheatland Treated Water from fresh Ogallala Aquifer Source

Summary: Holcomb would purchase water from Wheatland. Wheatland will have adequate volume and infrastructure to deliver Ogallala fresh water from a location south of the river.

Components: The construction of a 2.8 mile, 12” pipeline extension from an existing raw water transmission line to Holcomb capable of conveying 793 gpm is required. The pipeline would require an Arkansas River and Railroad crossing. The approximate location of the Wheatland water transmission line is 3 miles south of Holcomb. The assumed alignment of the pipeline would convey the water directly north across the Arkansas River. The current quality and quantity of the Wheatland fresh supply is unknown, as well as the available pressure at the connection location. Table 25 provides a summary of the alternatives developed for Holcomb.

Table 25. Alternatives for Holcomb.

Alt #	Description of Water Source	Proposed Treatment	Preliminary Cost Estimate	Preliminary Annual O&M Cost (Cost/AFY)
H.1	Shared Regional O&M	Nanofiltration	$6,500,000	$213
H.2	Ogallala Aquifer Advanced Water Treatment	Nanofiltration	$6,500,000	$355
H.3	Wheatland Raw Water from Fresh Ogallala Aquifer	Chlorination	$150,000	$1,141
H.4	Wheatland Treated Water (RO) from Ogallala Aquifer	Residual Chlorination	$3,200,000	$501

Alternative Comparison

The evaluation of Holcomb’s four alternatives are shown in Table 26 and Figure 23. The results are depicted as points scored for each of the four alternatives for Holcomb across the four criteria. Alternative H.2 is described as the most likely to occur if no further action is taken. Under this alternative Holcomb will construct a nanofiltration advanced treatment plant and a disposal well. A disposal well is required due to the presence of uranium in the waste stream. H.2 ranked low due to the capital cost and low score in completeness and acceptability. Alternatives H.3 and H.4 include the purchase of treated water and scored the highest.

Table 26. Holcomb matrix ranking sheet.

Screening Criteria:	Alternative H.1	Alternative H.2	Alternative H.3	Alternative H.4
	Shared Regional O&M	**Ogallala Aquifer Advanced Treatment**	**Treated water from Wheatland's RO Plant**	**Raw Water from Wheatland**
Effectiveness (Total Pts)	15	13	18	16
(0-8 pts)	8	8	8	7
Quality and Quantity Notes:	Existing water rights provide sufficient quantity; water treatment plant provides sufficient quality	Existing water rights provide sufficient quantity; water treatment plant provides sufficient quality	Quality and Quantity sufficient	Raw water from Wheatland provides sufficient quantity and quality (water quality sustainability is well known in Ogallala)
(0-4 pts)	1	1	4	3
Constructability Notes:	Water treatment plant and waste stream disposal through deep well injection construction provides high challenges	Water treatment plant and waste stream disposal through deep well injection construction provides high challenges (unique situation with Sunflower's ownership of their evaporative pond or blending levels for Uranium)	Minimal infrastructure modifications provide few construction limitation	Require construction of river and railroad crossing
(0-6 pts)	6	4	6	5
Operation and Serviceability Notes:	Regional operators and leverage resources provide experienced O&M	Water treatment plant and waste stream disposal requires moderate O&M challenges (better economic setting)	Existing O&M provides no challenges (no chlorination required)	Existing O&M provides no challenges
Efficiency	12	10	8	12
(0-8pts)	0	0	8	4
Construction Cost	$6,500,000	$6,500,000	$150,000	$3,200,000
(0-12 pts)	12	10	0	8
Annualized O&M Cos/ AF	$213	$355	$ 1100	$499
Acceptability	8	9	14	14
(0-5 pts)	3	4	4	4
Authorities, regulations, and policies Notes:	Regional Authority or agreement requires moderate challenges; waste stream disposal through deep well injection provides no conflict with regulations and policies; Uranium water quality and NRC license issue	Existing authority remains in place; waste stream disposal through deep well injection provides no conflict with regulations and policies; Uranium water quality and NRC license issue	Agreement with Wheatland would provide authority	Agreement with Wheatland would provide authority
N/A	N/A	N/A	N/A	N/A
Insufficient information to determine public acceptance	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking	Public acceptance is not to be considered in this ranking
(0-5 pts)	3	3	5	5
Environmental considerations Notes:	Water treatment plant provides small footprint and minimal environmental disturbance; waste stream disposal through deep well injection requires moderate challenges	Water treatment plant provides small footprint and minimal environmental disturbance; waste stream disposal through deep well injection requires moderate challenges	No issues were found	No issues were found
(0-5 pts)	2	2	5	5
Public health and safety Notes:	Water treatment plant and waste stream disposal through deep well injections provide minimal health and safety concerns	Water treatment plant and waste stream disposal through deep well injections provide minimal health and safety concerns	No issues were found	No issues were found
Completeness	9	10	15	13
(0-5 pts)	3	4	5	5
Coordination and available water rights Notes:	Development of a Regional Authority or agreement; existing water rights provide future demand	Existing water rights provide future demand	Agreement with Wheatland (benefit from the economies of scale)	Agreement with Wheatland (benefit from the economies of scale)
(0-5 pts)	3	3	5	4
Engineering Uncertainties and risks Notes:	Design and specifications associated with water treatment plant design requires standard risks and uncertainties; waste stream disposal deep well injection requires high risks and uncertainties; Uranium water quality and NRC license issue	Design and specifications associated with water treatment plant design requires standard risks and uncertainties; waste stream disposal deep well injection requires high risks and uncertainties; Uranium water quality and NRC license issue	Ogallala aquifer quality and quantity provide minimal risks and uncertainties	Ogallala aquifer quality and quantity and pipeline alignment provide minimal risks and uncertainties
(0-5 pts)	3	3	5	4
Permits, ROW, and easements Notes:	Water treatment plant design and waste stream disposal requires permits and easements	Water treatment plant design and waste stream disposal requires permits and easements	No issues were found	Pipeline requires a railroad and river crossing permits and ROW access
TOTAL	**44**	**42**	**55**	**55**

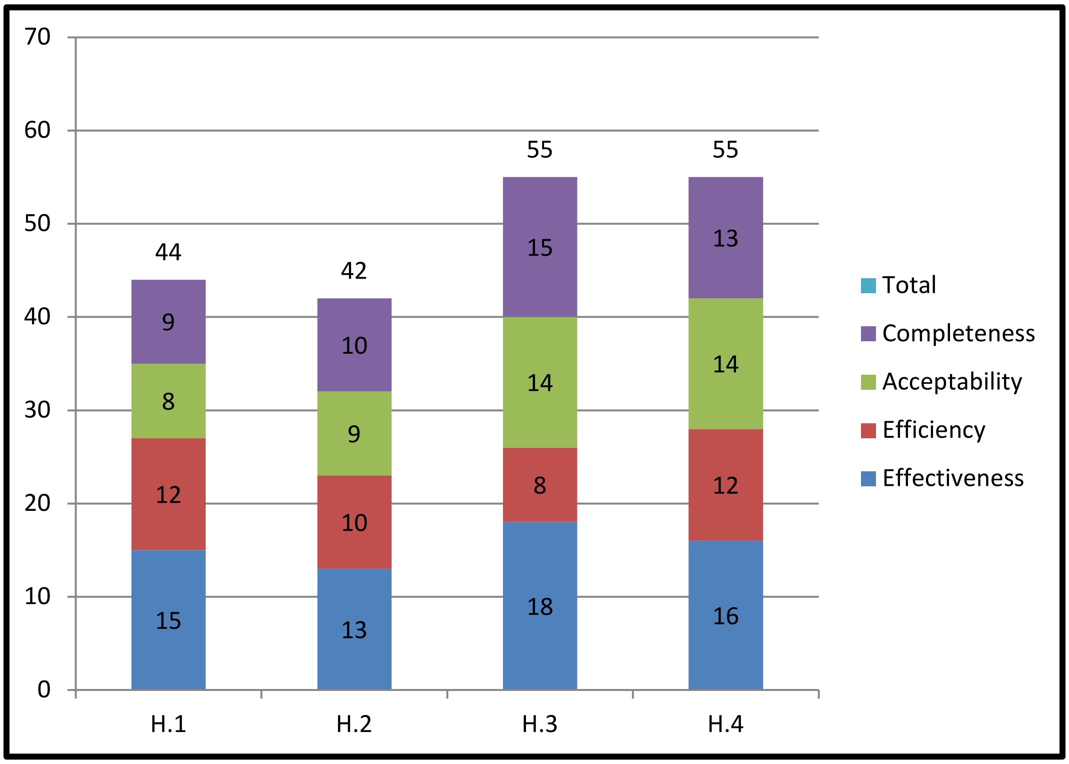


Figure 24. Comparison of Alternatives for Holcomb

Conclusions

A public meeting presenting these alternatives was conducted in Garden City, Kansas on February 25th and was attended by representatives from Wheatland Water, City of Garden City, City of Holcomb, Sunflower Electric, and Finney Co. Rural Water District.

Finney Rural Water District (RWD) described that their Dakota Aquifer Wells had levels of radium and that is why they now purchase treated water from Wheatland. One of the negative effects of purchasing water from other entities is the loss of an asset and continued debt. The asset is the water right that Finney RWD purchased or developed in the Dakota that is no longer utilized and by purchasing water from Wheatland the water rate must be added on top of the existing debt for an asset that is no longer in use.

The alternatives utilizing the purchase of treated water scored very high in comparison to Holcomb constructing and operating its own facilities. T
The advantages of the development of a Regional Authority were not readily apparent in Holcomb Alternatives.

The costs for the purchased water will ultimately determine if these are the most viable of the options. Certain advantages of the purchase of treated water were not captured in this analysis. The construction of water line from Lakin or Wheatland could provide an opportunity to provide treated water to a larger segment of the population in Kearny County.

Alternatives Affordability Analysis

Introduction

The capability of water users to pay for M&I water supplies is defined as the maximum amount water users can pay for water after accounting for household income, business revenues, and household or business expenses. Although there is no universally accepted method for measuring payment capability or affordability for domestic water supplies, two general approaches have been used to estimate capability to pay. One common technique involves the use of an affordability threshold, which is measured as a percentage of median household income. Using this technique, threshold percentages of household income are applied to households in the study area to determine total water payment affordability. A second approach is based on an evaluation of a range of actual water payments made by households and businesses relative to household income after accounting for necessary expenses, and taking the upper end of the relative payment range. These approaches are described in a technical memorandum titled, Evaluating Economic and Financial Feasibility of Municipal and Industrial Water Projects (Piper, 2009).

Payment Capability Thresholds

The U.S. Environmental Protection Agency (EPA) and various rural development agencies have established threshold water payments percentages for determining affordability (payment capability). The EPA (1980) looked at the consumer cost for complying with federal drinking water regulations. Agency economists concluded annual household water service costs ranging from 1.5 percent to 2.5 percent of median annual income raised questions about affordability. Rates over 2.5 percent of median household income were labeled unaffordable. The EPA established affordability criteria for drinking water systems as a result of 1996 Amendments to the Safe Drinking Water Act. These Amendments allowed small public water supply systems to use less extensive water treatment technology if the most effective technology was not considered affordable. Therefore, EPA was required to define affordability in the context of household bills for sewer and drinking water service. As a result, EPA established a 4.0 percent of household income benchmark for affordability (2.0 percent for wastewater treatment and 2.0 percent for drinking water supplies). This was later amended to 4.5 percent to allow 2.5 percent for drinking water expenses. The EPA affordability threshold is not a true measure of affordability, but is instead based on acceptability of fee increases by lending institutions and the cost of other utilities.

For this project investigation, the EPA threshold of 2.5 percent of median household income is used as one measure of payment capability, which is only one of the thresholds used by various government agencies to evaluate affordability. It is a commonly used general measure that is applicable across many regulatory and financial programs. Table 27 contains the Census data and calculated average annual payments using the 2.5 percent threshold and a 40-year period of analysis. As noted in Table 25, the average annual payment capability for Syracuse was determined to be $705,000, but for this analysis, Syracuse's existing revenue was removed from the calculated capability to determine their available payment capability of $355,000 for additional water supply.

Table 27. Economic and demographic data for the communities in the study area and the Average annual payment capability for users of the study area over the 40 year period of analysis.

Entity	Households (2010)	Median Household Income (2010)	Average Annual Payment Capability EPA 2.5%	Average Annual Payment Capability per AF EPA 2.5%
Coolidge	43	$41,250	$46,000	$1,484
Syracuse	715	$34,926	$355,000[2]	$7,889[2]
Hamilton RWD1	39	$35,417	$43,000	$3,308
Deerfield	235	$51,587	$392,000	$2,227
Holcomb	654	$59,792	$1,327,000	$2,332

[1] Zip code 67857 was used to determine the data included for Kendall, Kansas and Hamilton Co. RWD.

[2] Syracuse's total average annual payment capability was calculated as $705,000. Syracuse's existing revenue was removed from the calculated capability to determine their available payment capability of $355,000.

Affordability - Payment Capability Compared to Costs

To evaluate the affordability of the study area, the estimated annual payment capability must be compared to the combined annualized capital costs (includes construction costs and three year of interest during construction) and annual O&M costs of the alternatives. Figure 24 and 25 show this comparison based on each total alternative. Figure 26 and 27 show the comparison based on each alternative in terms of cost per acre-foot; this alternative should provide a more accurate comparison of the alternatives for each public water supply relative to one another.

The results of this preliminary comparison of affordability suggest that Coolidge and Kendall would have difficulty paying for any of the recommended alternatives without significant financial assistance. The results show that Syracuse should consider the three alternatives (S.1, S.3, and S.6), that are with limits of uncertainty for affordability. The results also show that Deerfield, although below the financial capability threshold for each alternative, is within the limits of uncertainty for affordability of all of their alternatives. All four of Holcomb's preliminary alternatives should be considered further, as they are all below the financial capability threshold.

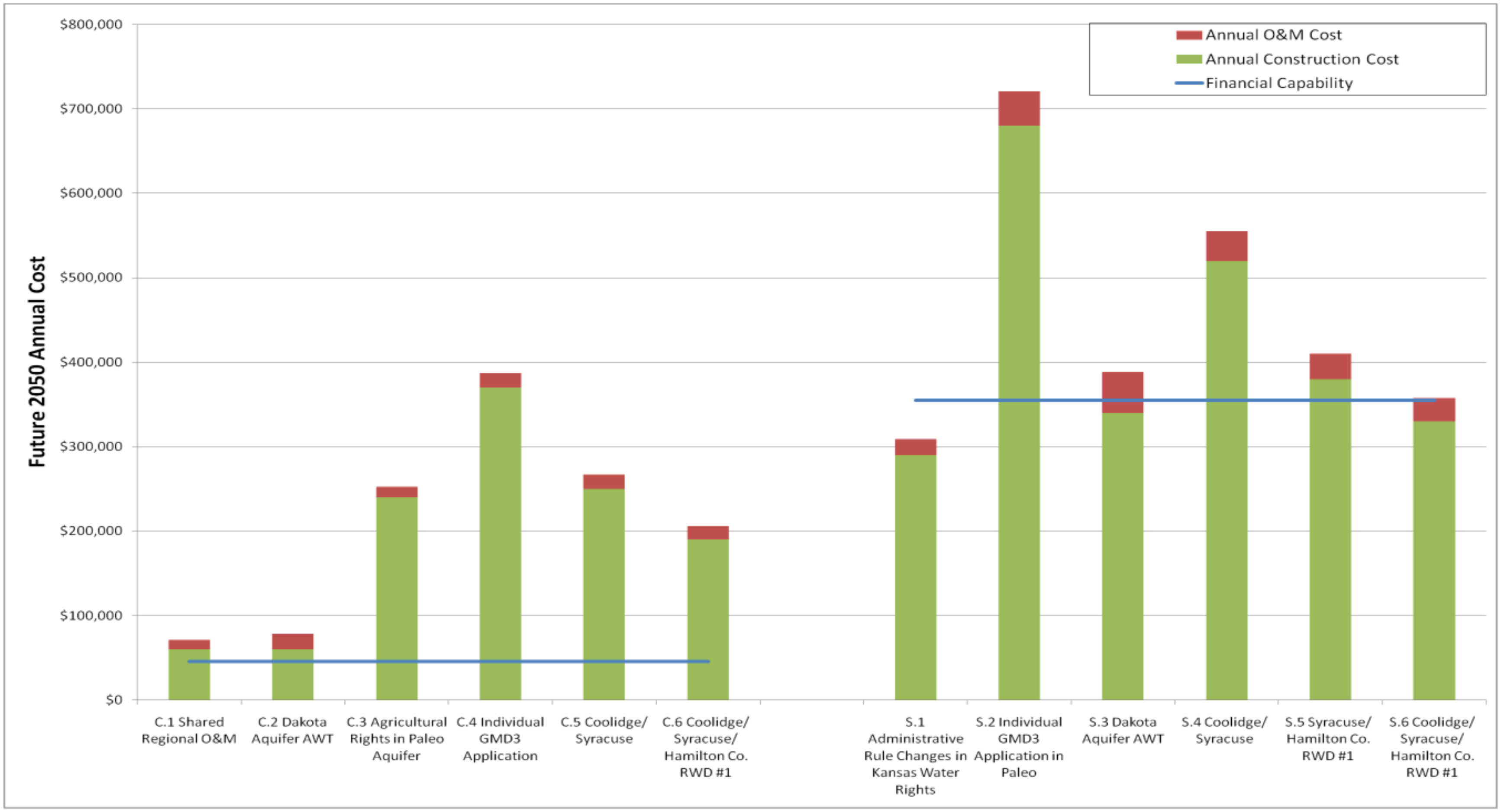


Figure 25. Annualized capital cost (construction cost and three year construction interest) and annual O&M cost versus the average annual payment capability over 40 years for Coolidge and Syracuse.

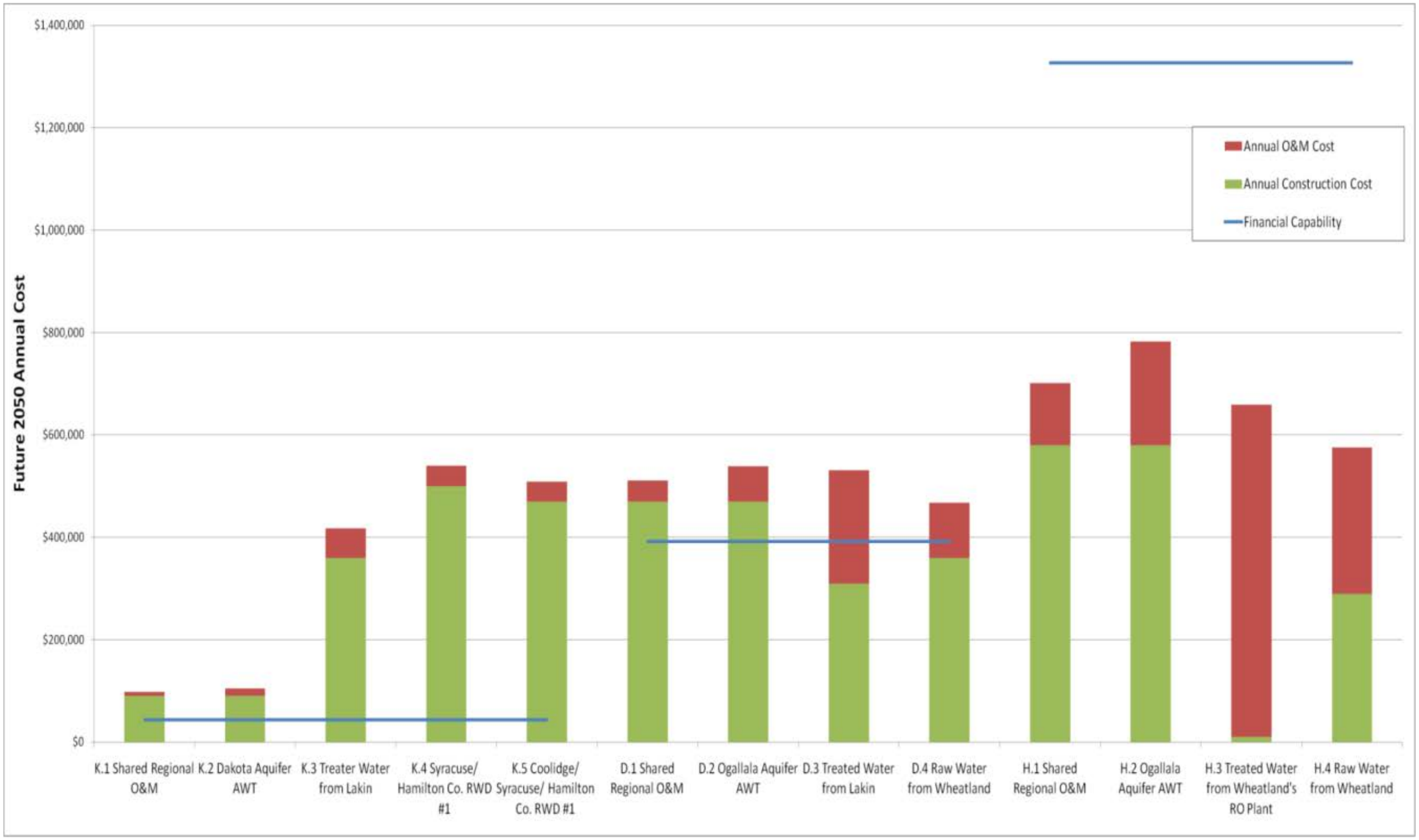


Figure 26. Annualized capital cost (construction cost and three year construction interest) and annual O&M cost versus the average annual payment capability over 40 years for Hamilton RWD1(Kendall), Deerfield, and Holcomb.

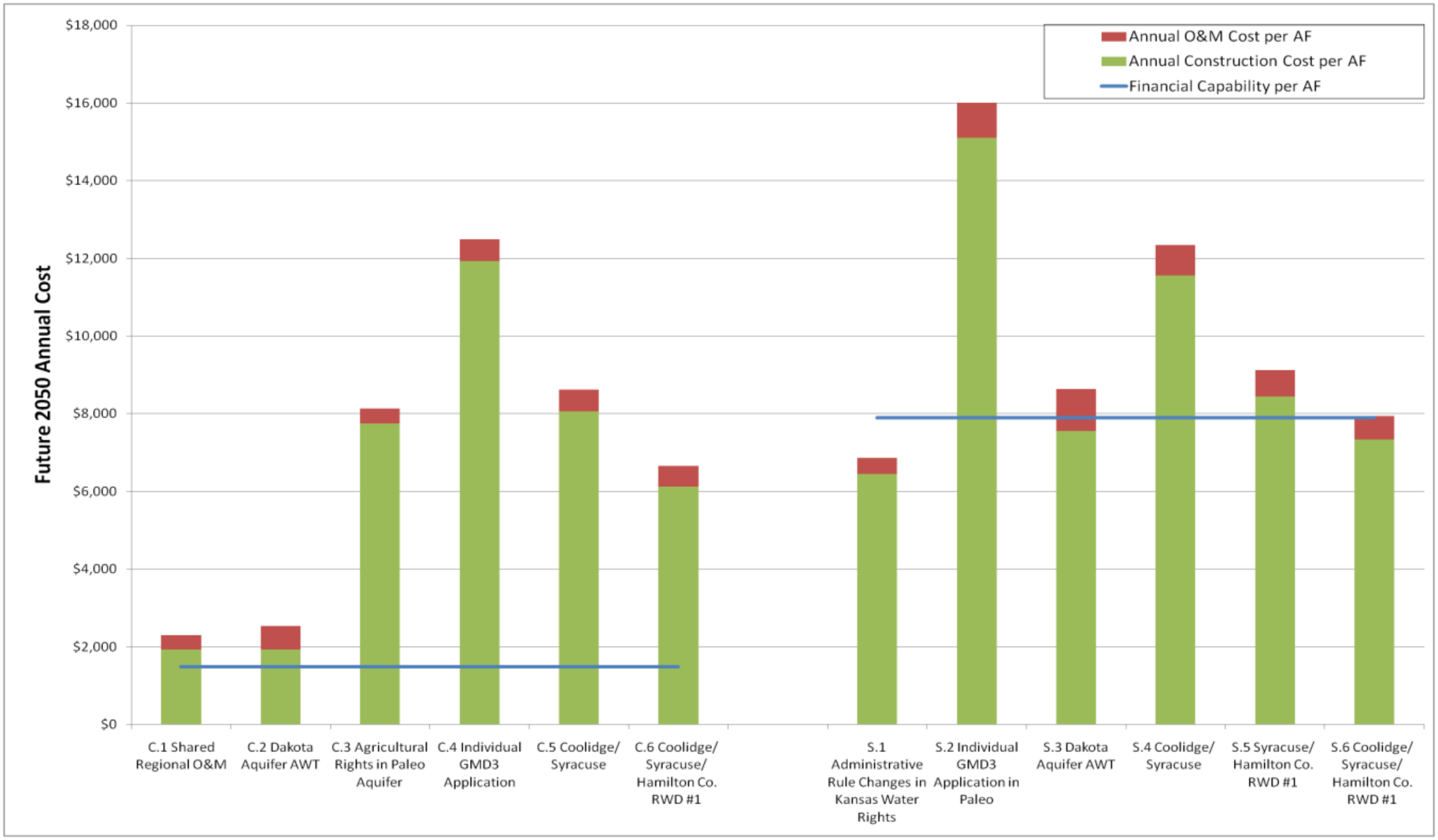


Figure 27. Annualized for capital cost per AF (construction cost and three year construction interest) and annual O&M cost per AF versus the average annual payment capability over 40 years per AF for Coolidge and Syracuse.

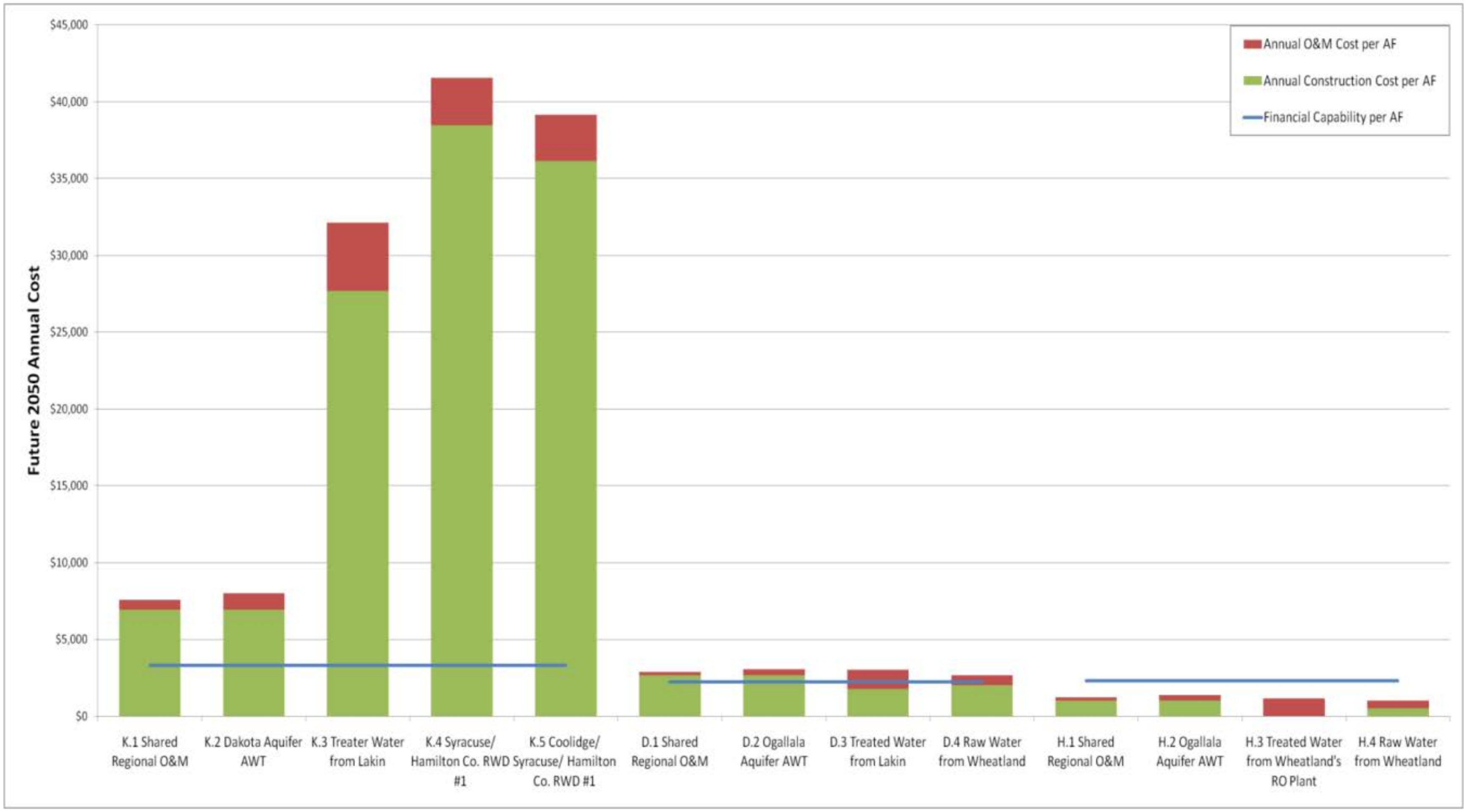


Figure 28. Annualized capital cost per AF (construction cost and three year construction interest) and annual O&M cost per AF versus the average annual payment capability over 40 years per AF for Hamilton RWD1 (Kendall), Deerfield, and Holcomb.

Risk, Uncertainties, and Conclusions

Risks and Uncertainties

Public meeting were held in Garden City, Lakin, and Syracuse, Kansas on February 25th, and 26th 2014. The meetings consisted of an overview of the water quality concerns and a discussion of the alternatives as listed in this report. All alternatives were well received; however, the public input was inconclusive to rank the public acceptability of various alternatives. Further discussions of regionalization and purchase of water should occur and is critical in determining which alternatives are acceptable or should be considered for further study.

Regional Authorities: Several risk and uncertainties exist in the various options discussed within this report. The Regional Authority will require several entities entering into formal agreements. The cost of regional infrastructure is expensive and it may be advantageous for the counties to become involved to provide water to a large segment and eliminate jurisdictional issues. Additional legal or institutional impediments to Regional Authorities should be explored.

Dakota Aquifer: Several unknowns should be resolved before proceeding with the Hamilton county options. Coolidge and Hamilton Rural Water District 1 have experienced “spikes” in poor water quality from their Dakota aquifer wells. Further investigation of these issues should be completed before any revisions to existing treatment processes occur. The Dakota aquifer consists of sandstone units imbedded in shale. The hydraulic properties and water quality of two sandstones units could be quite different. Wells removing water from more than one layer could be susceptible to a potential variation in water quality during pumping. A study to collect samples in conjunction with pumping could possibly lead to an understanding of varying water quality issues. The approach of this study would be to monitor water quality during the pumping scenarios.

Paleo Channel: Additional information on the depth, extent, and character of the Paleo is necessary, in order to effectively model the aquifer before any alternative that utilizes this water source is developed.

Affordability: Ability to pay for new water sources for several entities appears to be outside recommended values. The cities in the study area will need to identify additional sources of funding for any future improvements. The development of Regional Authorities could capture additional needs outside the existing communities. The negotiated cost of the treated water sources at various entities will have a large impact on the efficiency of these alternatives.

Conclusions and Next Steps

The existing water supply in the majority of the area is suffering water quality issues and very few fresh water supplies exist for these communities. All of the alternatives developed in this Analysis consisted of advanced treatment of the existing sources except for the Paleo Aquifer and the importation of the fresh Ogallala Aquifer. Advanced treatment facilities are expensive and require specialized operation and maintenance as well as issues with the disposal of the waste stream.

Advanced water treatment technologies are often costly; however, due to the high cost of moving water from one location to another, traditional water supply approaches may also be costly. For example, a water treatment plant may be capable of treating a local brackish groundwater source for less than the cost of a lengthy pipeline to deliver fresh water from miles away.

A variety of water supply alternatives were developed in the preparation of this report, with several options for each community. The level of detail in this report utilized a cursory look at the various supply options and associated costs. The purpose was to identify the options and perform a cursory evaluation to determine the viability of these various options. The cost estimates were developed as a tool to compare the alternatives. The level of engineering and cost estimating is preliminary in nature and is not adequate for budgeting.

Each community has been experiencing unique issues with their water supply; however, in most cases the proposed solutions could be shared with neighboring communities. It is difficult for smaller communities in the study area (Coolidge and Hamilton RWD1) to construct, operate, and maintain an advanced treatment system. A regional concept of water supply or sharing in the O&M with other entities will be critical for the development of long-term supplies. The larger communities have the resources to develop their own water supplies; however, the regional concept or shared O&M can be a cost effective way of developing a future water supply.

Regionalization of water supply ranked higher among the alternatives, especially in Hamilton County. Regionalization could reduce cost and increase sustainability of available water supply. Additional benefits may be realized from developing regional water supply servicing several communities such as providing water to individual homes and businesses not located within a town. It is estimated that 90% of the population in the counties are located along the Arkansas River Corridor. Providing potable water to the rural population as well as industries located along the river corridor is important to the future growth in Hamilton County. It is likely that these homes and businesses are also struggling with poor quality water.

The next steps in the process would be:

- Conduct additional studies on the Paleo Aquifer to determine the long-term sustainability. The extent of this aquifer in Colorado is currently unknown.
- Conduct pumping studies on the Dakota aquifer sources for Hamilton RWD1 and Coolidge, as well as Holly CO.
- Seek public input from the local communities to determine the viability of the alternatives. This input will need to be factored into the analysis.
- Several alternatives included combining infrastructure and the sale of treated water. It is critical the communities in the study area discuss and work together to ensure a long-term supply for the study area.
- Further exploration of the constraints to the development of a Regional Water Authority.
- Degradation of the Ogallala Aquifer water quality from the influence of the Arkansas River and been identified. The extent of this degradation should be identified before proceeding to identify the area of the aquifer at risk.

Appendices

Appendix 1- Assessment Criteria

Appendix 2 - Alternative Cost Estimate Worksheet

Appendix 3 - Well Logs

Appendix 4 – Public Meeting Notes

Appendix 1 - Assessment Criteria

DRAFT

Appendix 1: Assessment Criteria

Assessment Criteria Guidelines

Methods

Alternatives were formulated based on criteria set forth in the Principles and Guidelines (P&Gs) for Water and Related Land Resources Implementation Studies (Water Resources Council 1983). The P&Gs were developed to ensure proper and consistent planning by Federal agencies in the formulation and evaluation of water-related resources studies, including appraisal and feasibility investigations. The four criteria are as follows:

- **Effectiveness:** extent to which an alternative reliably meets the planning objective by alleviating a specified problem and achieving goals.
- **Efficiency:** extent to which an alternative is cost effective.
- **Acceptability:** workability and viability of an alternative with respect to how compatible it is with authorities, regulations, policies, and environmental law.
- **Completeness:** extent to which an alternative accounts for all necessary investments or other actions to ensure realization of goals.

Although the P&G's list the above criteria as requirements to consider in the evaluation of alternatives, the P&Gs do not specify the manner by which these criteria are analyzed, so discretion is allowed due to the wide variation among project types. For this investigation, criteria were analyzed based on a variety of key factors considered important to each criterion. For instance, the Effectiveness criterion was analyzed based on factors related to the reliability of water deliveries, as well the challenges associated with construction and servicing the project. Next, points were allocated based on whether a criterion and/or factor scored a "high", "moderate", or "low". The point allocation system and a detailed description of each criterion with the associated ranking factors are described later in the report.

Engineering Assumptions and Cost Estimations

The capital, O&M, and life-cycle costs for this viability analysis were preliminary in nature and based on existing data and assumptions. The following discussion provides a brief summary of the methods and assumptions used for each of the major infrastructure components.

Pipeline

For new pipe, Reclamation used the RSMeans Heavy Construction Cost Data (RSMeans 2008), along with market research, to estimate costs based on the following assumptions:

- Pipelines are sized to meet the 2050 peak demand. This represents two times the 2050 average daily flow.
- High Density Poly Ethylene pipe was utilized.
- Excavation for the pipe would have vertical sides and a width equal to the inside diameter of the pipe plus two-feet.
- The total volume of backfill equals the total volume of excavation.

- County road crossings would be made by open cutting, compacting backfill about the pipe, and restoring the road surface.
- Highway road, railroad and river crossings would be made through bore drilling and jacking a casing pipe.

Booster Pumping Plant

Booster pumping plant costs were based on a combination of actual construction costs of existing pumping plants, quoted prices for components, and a pumping plant cost-estimating program developed by Reclamation. Costs were based on the assumption of two horizontal pumps (one primary; one standby) with a service capacity of 2050 peak demand.

Water Treatment

The sizing of water treatment components were based on the 2050 peak demand. Preliminary cost estimates were provided by local and national providers for the specified water treatment plant for pre-treatment, ion exchange, reverse osmosis, and disinfection needed for each alternative.

Contingencies

Cost estimates include a percentage allowance for construction contingencies as a separate item to account for differences in actual and estimated quantities, unforeseeable difficulties at the site, changed site conditions, possible minor changes in plans, and other uncertainties.

- Mobilization included a contingency of +/- 5% of the subtotal.
- Unlisted items included a contingency of +/- 20% of the subtotal with mobilization.
- Contract costs included a contingency of +/- 25% of the contract cost.
- Non-contract costs such as design, environmental/cultural compliance, and construction management included a contingency of +/- 40% of the total field cost.

Operations and Maintenance (O&M) Costs

The O&M costs for this assessment were considered as annual and lifecycle O&M costs. The annual O&M costs were based on five components:

- Pipeline O&M costs per year was calculated using data from existing infrastructure.
- Pumping Plant O&M costs per year were calculated by taking one percent of the estimated capital cost of the pumping plant[27].
- Pumping Power costs per year was calculated assuming a pump efficiency of 80% and energy rate of $0.0511 per kWh. Injection Well Pumping Costs were calculated with the same assumptions.

[27] Desalting Handbook for Planners, 3rd edition, Desalination and Water Purification Research and Development Program Report No. 72, Reclamation, 2003.

Appendix 1: Assessment Criteria

- Advanced Water Treatment Plant O&M costs per year was determined using EPA's 2006 report, Technology and Cost Documentation for the Final Groundwater Rule. This report provides cost estimates of O&M for small communities treating groundwater using advanced treatment.
- Purchase of Water rates per year were assumed as $3.50/1,000 gallons for RO treated water and $1.50 for raw water based on nearby community rates.

The annual O&M cost is the sum of these five components. The life cycle O&M is the annual O&M cost over a 50-year period.

Effectiveness

Effectiveness measures the extent to which a proposed alternative would reliably meet the planning objective by alleviating a specified problem and achieving goals. Effectiveness is measured in terms of:

1. The extent to which proposed alternative will meet the 2050 demand with quality and quantity of water required:
    a. **High Effectiveness –** alternative will provide the expected 2050 demand and meet all quality requirements.
    b. **Low Effectiveness –** alternative may not provide the expected 2050 demand and meet all quality requirements.
2. Challenges associated with the construction of the proposed facilities
    a. **High Effectiveness –** Minimal construction required and ease of construction:
        i. Construction of minimal features. The construction of a simple well; and pipeline; the existing treatment plant requires minor or no modification.
        ii. Physical factors such as terrain and soil type are favorable for pipeline; pumping plant and treatment plant construction.
    b. **Moderate Effectiveness –** Moderate construction required:
        i. Construction of several features including well, pipeline and treatment plant.
        ii. Physical factors such as terrain and soil type may be favorable for pipeline, pumping plant and treatment plant construction.
    c. **Low Effectiveness-** Several difficult features to be constructed
        i. construction of several features, including a disposal well
        ii. physical factors such as terrain and soil type are not favorable for pipeline pumping plant treatment plant construction
3. Challenges associated with operations and serviceability:
    a. **High Effectiveness –** Operational challenges are minimal:
        i. Facilities require low maintenance.

  ii. Pumping plant and/or well(s) are accessible, conveniently located, and located near existing utilities.

  iii. Does not require the operation of a waste stream requiring disposal

b. **Moderate Effectiveness –** Moderate operational challenges:

  i. Facilities require moderate maintenance.

  ii. Pumping plant and/or wells(s) may be accessible, conveniently located, and/or may be located near existing utilities.

  iii. Treatment plant will be constructed near existing facilities.

  iv. Option does not require the operation of a waste stream requiring disposal.

c. **Low Effectiveness –** Operational challenges are significant:

  i. Facilities to require high maintenance.

  ii. facilities to require specialized training to operate

  iii. facilities to require a full time operator

  iv. Facilities are difficult to access, not conveniently located, and are not located near existing utilities.

  v. requires the operation of a waste disposal system

Efficiency

Efficiency measures the extent to which an alternative is cost effective and is based on **preliminary-level** capital costs, and annual operations and maintenance costs:

1. Capital costs of construction:
    a) **High Efficiency –**capital cost is the least expensive of the proposed alternatives.
    b) **Moderate Efficiency –** capital cost fall between the least expensive and the most expensive alternatives.
    c) **Low Efficiency –**capital cost is the most expensive of the alternatives.
2. Annual O&M costs:
    a) **High Efficiency –** annual O&M costs are the least of the alternatives.
    b) **Moderate Efficiency –** annual O&M costs fall between the least expensive and the most expensive alternatives.
    c) **Low Efficiency –** annual O&M costs is the most expensive of the alternatives.

Acceptability

Appendix 1: Assessment Criteria

Acceptability measures the workability and viability of an alternative with respect to how compatible it is with authorities, regulations, policies, and environmental law. Acceptability is measured in terms of:

1. Extent to which proposed option may be in conflict with existing authorities or policies of agencies with statutory jurisdiction:
   a) **High Acceptability –** unlikely that the placement of proposed facilities is in conflict with existing regulations and policies.
   b) **Medium Acceptability –** placement of proposed facilities may be in conflict with existing regulations and/or policies.
   c) **Low Acceptability –** placement of proposed facilities is likely in conflict with existing regulations, and/or policies.
2. Extent to which construction and/or operations is accepted by the public:
   a) **High Acceptability**:
      i. Likely to be well received by the public.
      ii. Facilities would not likely have permanent and significant physical, visual, and/or audible impacts on residents.
   b) **Moderate Acceptability**:
      i. Likely to have be moderately received by the public.
      ii. Facilities would likely have permanent and potentially significant physical, visual, and/or audible impacts on residents.
   c) **Low Acceptability**:
      i. Likely to not be well received by the public.
      ii. Facilities would likely have permanent and significant physical, visual, and/or audible impacts on residents.
3. Extent to which construction and/or operations would impact the natural environment such as fish and wildlife and culturally sensitive areas:
   a) **High Acceptability**
      i. Impacts are primarily in disturbed areas.
      ii. Results in a temporary loss of fish and wildlife habitat.
      iii. Impacts would have no effect on sensitive, state-listed, candidate, or threatened and endangered species.
      iv. No impacts on sensitive or unique habitat such as wetlands, riparian or bottomland hardwood areas, or culturally sensitive area.
   b) **Moderate Acceptability**
      i. impacts located on an equal proportionate share of disturbed and undisturbed areas

ii. results in both temporary and permanent losses of fish and wildlife habitat, but impacts are insignificant

iii. impacts may affect, but are not likely to adversely affect, sensitive, state-listed, candidate, or threatened and endangered species

iv. Minimal impacts on sensitive or unique habitat such as wetlands, riparian or bottomland hardwood areas, or culturally sensitive areas.

c) **Low Acceptability**

i. impacts are primarily in undisturbed areas

ii. Results in both temporary and permanent losses of fish and wildlife habitat, and impacts are likely.

iii. Impacts may affect, and are likely to adversely affect, sensitive, state-listed, candidate, or threatened and endangered species.

iv. Would impact sensitive or unique habitat such as wetlands, riparian or bottomland hardwood areas, or culturally sensitive areas.

4. The extent to which proposed facilities may impact public health or safety:

a) **High Acceptability –** Not likely to permanently increase risk to public health or safety.

b) **Moderate Acceptability –** May significantly and permanently increase risk to public health or safety.

c) **Low Acceptability –** Likely to significantly and permanently increase risk to public health or safety.

Completeness

Completeness measures the extent to which an alternative accounts for all necessary investments or other actions to ensure realization of goals. It is measure in terms of risk factors, which may be present due to uncertainty and variability, as well as the amount of additional coordination and/or investigations needed to affect timely or successful completion of the project. Completeness is measured based on the three subcategories listed below.

1. Extent to which multi-organizational coordination would be required for construction and/or operation of proposed facilities:

a) **High Completeness**

i. Would utilize existing entity water right.

ii. Little to no coordination would be required with other organizations.

iii. Would not require agreements between local entities to complete.

b) **Moderate Completeness**

i. Would require the entity to purchase existing water right.

ii. Some coordination would be required with other organizations.

Appendix 1: Assessment Criteria

iii. Would require agreements between two entities to complete.

c) **Low Completeness**

i. Would require the application for a new water permit.

ii. Substantial coordination would be required with other organizations.

iii. Would require agreements between three or more entities to complete.

2. The degree of engineering uncertainty and associated risk:

a) **High Completeness –** Low risk factors and associated engineering uncertainty; minimal additional investigations are needed to implement the alternative.

b) **Moderate Completeness –** Moderate risk factors and associated engineering uncertainty; a moderate amount of investigations are needed to implement the alternative.

c) **Low Completeness –** High risk factors and associated engineering uncertainty; substantial investigations are needed to implement the alternative.

3. The extent to which proposed facilities would require permits or clearances which entail risk that could affect the timing or successful completion of the project.

a. **High Completeness:**

i. ROW easements would be routine and/or certain to obtain.

ii. Environmental permits and clearances would likely be easy to obtain and mitigation not likely required.

iii. Cultural resources clearance by the State Historic Preservation Office (SHPO) would likely be easy to obtain and mitigation not likely required.

b. **Moderate Completeness:**

i. ROW easements may not be routine and/or certain to obtain.

ii. Environmental permits and clearances may not be easy to obtain and/or mitigation may be required.

iii. Cultural resources clearance by the SHPO may not be easy to obtain and/or mitigation may be required.

c. **Low Completeness:**

i. ROW easements would not be routine and/or certain to obtain.

ii. Environmental permits and clearances would likely be difficult to obtain and mitigation would likely be required.

iii. Cultural resources clearance by the SHPO would likely be difficult to obtain and mitigation would likely be required.

Appendix 1: Assessment Criteria

Point Allocations

Points were allocated based on whether a factor scored a "high," "moderate," or "low." For instance, the Completeness criterion is divided into three factors: coordination, engineering uncertainty and risk, and permitting. If an alternative scored "high" on coordination, then it was allocated 5 points; if it scored "moderate" on coordination, then it was allocated 2 or 3 points; and if it scored "low" on completion, then it was allocated 0 or1 point.

Some factors, such as permitting, were divided into categories in order to capture the full variation that exists among alternatives. With permitting, three categories were assigned [rights-of-way easements (ROW), environmental permitting, and cultural clearances], each of which was distributed an even amount of points within each score. For example, in the case of permitting, the maximum points an alternative that scores "low" can achieve is a 1; therefore, ROW easements, environmental permits, and cultural clearance categories were each allocated 0.33 points, roughly one third of the points. Conversely, if an alternative scored a "high" on permitting, which has a maximum score of a 5, then each of the three categories was allocated 1.66 points. The purpose of making these distinctions was to capture situations in which one alternative may score "low" in one category (i.e., environmental permitting) but score "high" on another (i.e., ROW easements).

Assessment of Coolidge Alternatives

Alternative C.1: Regional/Partnership Shared O&M of Advanced Water Treatment

Effectiveness

- ***Water Quality and Quantity*** *(High)* **–** Utilizes existing water rights and treatment methods. Sharing operators or contracting operators would remove the risk associated with the lack of experienced operator.
- ***Constructability*** *(Moderate to High)* - Requires some upgrades of treatment facilities and construction of a lined lagoon for the waste stream disposal.
- ***Operations and Serviceability*** *(Moderate to High)* - Requires an experienced operator, to operate and maintain the treatment facility and the disposal facilities. A Regional Entity would add cost effectiveness.

Efficiency

- ***Capital Costs*** *(High)* – Requires the construction of a lined evaporative lagoon and upgrades to the existing IX treatment plant.
- ***O&M Costs*** *(Moderate to High)* – A 40% reduction was applied to the shared O&M costs. Shared O&M reduces cost and risk.

Acceptability

Appendix 1: Assessment Criteria

- ***Authorities*** *(Moderate to High)* - A Regional Authority will be required.
- ***Public Acceptance***- Public Acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(Moderate to High)* - No known culturally and environmental sensitive areas affected, but disposal of waste stream requires the construction of a lined evaporative lagoon.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** *(Moderate to High)* - Would require the development of a Regional Authority.
- ***Engineering Uncertainty/Risk*** (*Moderate to High)* – Existing treatment method is utilized and pooled resources will mitigate the risk.
- ***Permitting*** (*Moderate to High)* - Requires permitting the waste stream disposal.

Alternative C.2: Dakota Aquifer - Advanced Treatment (Also considered the No Action Alternative)

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Utilizes existing water rights and existing treatment has proven effective.
- ***Constructability*** *(Moderate to High)* – Will require some upgrades of treatment facilities and the construction of a lined evaporative lagoon for waste disposal.
- ***Operations and Serviceability*** *(Low)* - Current O&M strains resources.

Efficiency

- ***Capital Costs*** *(High)* –Requires little additional infrastructure. A new evaporative lagoon will need to be constructed and upgrades may be necessary to the treatment plant.
- ***O&M Costs*** *(Low)* – Advanced water treatment requires a full time trained personnel.

Acceptability

- ***Authorities*** *(Moderate to High)* - Concern on O&M occurring.
- ***Public Acceptance***- Public Outreach to be developed
- ***Impacts on Natural Environment*** *(Moderate to High)* - No known culturally and environmental sensitive areas affected, but disposal of waste stream required.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** *(High)* – Existing water rights would be utilized.

- ***Engineering Uncertainty/Risk*** *(Moderate to High)* – Proven treatment method, but will require the construction of a lined evaporative lagoon to dispose of the backwash.
- ***Permitting*** *(Moderate to High)* - Would require permitting the waste stream disposal.

Alternative C.3: Obtain Rights in Paleo Aquifer

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo channel requires only chlorination, but concern exists about sustainability.
- ***Constructability*** *(Moderate)* Construction is simple and will consist of a well, pump and chlorination feed. A 4-mile pipeline with an Arkansas River and railroad crossing will be required.
- ***Operations and Serviceability*** *(Moderate)* -The well may be remote, without adequate electricity, construction of a road could be necessary, but would require little in the way of maintenance.

Efficiency

- ***Capital Costs*** *(Moderate)* –Construction will consist of a new well, and a 1-mile pipeline that includes a river crossing and a railroad crossing.
- ***O&M Costs*** *(Moderate to High)* – Water from the Paleo is high quality water and requires only chlorination. Little O&M will be required.

Acceptability

- ***Authorities*** *(High)* - Purchase of agricultural right and no foreseen conflict with regulations and policies.
- ***Public Acceptance***- Public outreach to be developed.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety identified.

Completeness

- ***Agency Coordination*** *(Low to Moderate*) – Purchase of an agricultural or existing water right is required.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - The long-term sustainability of the Paleo channel is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting*** *(Moderate to High)* - Requires the conversion of agricultural to municipal water rights. Easements needed to construct the pipeline.

Alternative C.4: Individual GMD3 Application Paleo Aquifer

Appendix 1: Assessment Criteria

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo channel requires only chlorination, but concern about sustainability.
- ***Constructability*** *(Moderate)* - Construction will be relatively simple and consist of a well, pump and chlorination. An 8.5-mile pipeline with an Arkansas River and railroad crossing will also be required.
- ***Operations and Serviceability*** *(Moderate)* - The well is remote, without electricity, construction of a road may be required, little additional maintenance required.

Efficiency

- ***Capital Costs*** *(Low)* – Construction of an 8.5-mile pipeline and a well without a shared cost is expensive on a per acre-foot basis.
- ***O&M Costs*** *(Low)* – O&M is simple and no advanced treatment is required, but a large amount of infrastructure is required.

Acceptability

- ***Authorities*** *(High)* - No conflict with existing regulations and policies.
- ***Public Acceptance*** - Public was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** (Moderate to High) - GMD3 application for water rights in the Paleo Aquifer will be transferred.
- ***Engineering Uncertainty/Risk***-*(Moderate to High)* – The long-term sustainability of the Paleo channel is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting***--*(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossings are required.

Alternative C.5: GMD3 Application Paleo Aquifer with Syracuse (See Alt. S.4)

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo channel requires only chlorination, but concern about sustainability.
- ***Constructability*** *(Moderate)* - Construction will be relatively simple and consist of a well, pump, chlorination and a 4-mile pipeline with an Arkansas River and railroad crossing.

- ***Operations and Serviceability*** *(Moderate)* - The well is remote, without electricity, construction of a road may be required, little additional maintenance required.

Efficiency

- ***Capital Costs*** *(Moderate)* **–** The construction of the well and a 4 mile pipeline would be shared with Syracuse. Coolidge would be responsible for the construction of the 4.6 mile pipeline from the bifurcation to Coolidge.
- ***O&M Costs*** *(Moderate to High)* **–** The high quality water from the Paleo Aquifer requires only chlorination and shared O&M keep the cost low.

Acceptability

- ***Authorities (****High)* **-** No conflict with existing regulations and policies.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** *(Moderate to High)* - Syracuse and Coolidge will assume GMD3 water right application. A Regional Authority is required.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - The long-term sustainability of the Paleo channel is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting*** *(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Alternative C.6: GMD3 Application Paleo Aquifer with Syracuse and Hamilton RWD1 (See Alt. S.6 and RWD1.5)

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - The current water quality in the Paleo channel requires only chlorination, but there is concern about sustainability.
- ***Constructability*** *(Moderate)* - Construction will be uncomplicated and consist of a well, pump, chlorination and pipelines with an Arkansas River and railroad crossing.
- ***Operations and Serviceability*** *(Moderate)* - The well is remote, without electricity, construction of a road may be required, little maintenance required.

Efficiency

- ***Capital Costs*** *(Moderate)* **–** The overall cost of the project is high, but the cost of construction of the well and pipeline across the Arkansas River and Railroad will be shared.

- ***O&M Costs** (High)* **–** The high quality water in the Paleo Aquifer requires only chlorination. O&M of the infrastructure will be shared.

Acceptability

- ***Authorities** (High)* - No conflict with existing regulations and policies.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment** (High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety** (High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** (Moderate to High) **–** The entities will assume GMD3GMD3 application. The development of a Regional Authority is required.
- ***Engineering Uncertainty/Risk** (Moderate to High)* - The long term sustainability of the Paleo channel is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting** (Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Assessment of Syracuse Alternatives

Alternative S.1: Administrative Rule Change for Paleo Aquifer (Also considered the No Action Alternative)

Effectiveness

- ***Water Quality and Quantity*** (Moderate to High) **-** Assumed that existing wells have capacity
- ***Constructability (High)*** **-** Assumed existing wells and conveyance is adequate
- ***Operations and Serviceability (High)*** - Utilizes existing wells.

Efficiency

- ***Capital Costs** (High)* **–** The administrative rule change will be the least expensive option for Syracuse. It was assumed that additional infrastructure would be required to complete this option.
- ***O&M Costs** (High)* **–** Requires little additional maintenance and advanced treatment is not required. Any pipeline and additional well would be located near existing facilities.

Acceptability

- ***Authorities** (Low)* - Hydrologic study is required to determine if the required yield could be met. Approval by the Chief Engineer would be required.

- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High*) - No impact to public safety noted.

Completeness

- ***Agency Coordination*** *(Moderate to High)* - Approval by the Chief Engineer would be required.
- ***Engineering Uncertainty/Risk*** *(Low)* - The long-term sustainability of the Paleo Aquifer is unknown. A hydrologic study is required to determine if the required yield could be met without affecting other applications of existing water rights. It is also unsure if the State will allow the Rule Change.
- ***Permitting*** *(High)* **-** Existing infrastructure would be utilized.

Alternative S.2: Individual GMD3 Application in Paleo Aquifer

Effectiveness

- ***Water Quality and Quantity (****Moderate to High)* **-** Current water quality in the Paleo requires chlorination only, but some concern about sustainability.
- ***Constructability*** *(Low)* - Construction will uncomplicated and consist of a well, pump, chlorination and a 15 mile pipeline with an Arkansas River and railroad crossing.
- ***Operations and Serviceability*** *(High)* - The well is remote, without electricity, construction of roads may be required; once constructed little maintenance is required.

Efficiency

- ***Capital Costs*** *(Low)* - The construction costs are the highest of the alternatives for Syracuse.
- ***O&M Costs*** *(Low)* - The O&M is straightforward, but the length of the pipeline adds to the cost.

Acceptability

- ***Authorities*** *(High)* - No conflict with existing regulations and policies.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** (Moderate to High) **–** Syracuse will assume GMD3 application

- ***Engineering Uncertainty/Risk*** *(Moderate to High)* -The long term sustainability of the Paleo channel is unknown in both quality and quantity. The pipeline construction will require a river and railroad crossing.
- ***Permitting*** *(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Alternative S.3: Dakota Aquifer Advanced Water Treatment

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Water is available and with proper treatment quality is ensured.
- ***Constructability*** *(Low)* - Construction will consist of 2 wells, pump, and a 3 mile pipeline. Advanced water treatment required.
- ***Operations and Serviceability*** *(Moderate)* - Operation of an IX plant required.

Efficiency

- ***Capital Costs*** *(Moderate)* **–** The construction of 2 wells into the Dakota and an IX treatment facility would be required.
- ***O&M Costs*** *(Low)* **–** O&M of wells and IX treatment plant required.

Acceptability

- ***Authorities*** *(Moderate to High)* - An additional municipal right in the Dakota is required.
- ***Public Acceptance***-Public outreach to be developed.
- ***Impacts on Natural Environment*** *(Moderate to High)* - Disposal of waste stream.
- ***Impacts on Public Safety*** *(Moderate)* - Construction of evaporative lagoon would likely be in the flood plain.

Completeness

- ***Agency Coordination*** *(Low to Moderate)* - Additional water right in Dakota is required.
- ***Engineering Uncertainty/Risk*** *(Moderate)* - Dakota water quality is known and can be adequately treated with IX.
- ***Permitting*** *(Moderate)* - Acquisition of new water rights and disposal of waste stream required.

Alternative S.4: GMD3 Application Paleo Aquifer with Coolidge (See Alternative C.5)

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo requires only chlorination, some concern about sustainability exists.

- ***Constructability*** *(Low)* - Construction will be uncomplicated and consist of a well, pump, chlorination and a 15 mile pipeline with an Arkansas River and railroad crossing.
- ***Operations and Serviceability*** *(High)* - The well is remote, without electricity, construction of a road may be required, little additional maintenance required after construction.

Efficiency

- ***Capital Costs*** *(Moderate)* **–** The construction of the well and a portion of the pipeline will be shared.
- ***O&M Costs*** (*Moderate to High)* **–** The high quality water from the Paleo requires chlorination only and some O&M is shared.

Acceptability

- ***Authorities*** *(High)* - No conflict with existing regulations and policies.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** (Moderate to High) **–** The entities will assume GMD3 application. The development of a Regional Authority is required.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - The long-term sustainability of the Paleo is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting*** *(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Alternative S.5: GMD3 Application Paleo Aquifer with Hamilton RWD1 (See Alt. RWD1.4)

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo channel requires only chlorination, some concern about sustainability.
- ***Constructability*** *(Low)* - Construction will be uncomplicated, and consist of a well, pump, chlorination and several-miles of pipeline with an Arkansas River and railroad crossing.
- ***Operations and Serviceability*** *(High)* - The well is remote, without electricity, construction of a road may be required, little maintenance additional required after construction.

Efficiency

- ***Capital Costs*** *(Moderate to High)* **–** The construction of the well and a portion of the pipeline will be shared.

- ***O&M Costs*** *(Moderate)* **–**The water from the Paleo is of high quality and requires only chlorination and O&M will be shared with Hamilton RWD1.

Acceptability

- ***Authorities*** *(High)* **-** No conflict with existing regulations and policies.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- **Agency Coordination** *(Moderate to High)* - Assume GMD3 application
- **Engineering Uncertainty/Risk** *(Moderate to High)* - The long-term sustainability of the Paleo is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- **Permitting** *(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Alternative S.6: GMD3 Application Paleo Aquifer with Coolidge and Hamilton RWD1 (See Alt. S.6 and RWD1.5)

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo requires only chlorination, but concern about sustainability exists.
- ***Constructability*** *(Low)* - Construction will be uncomplicated and consist of a well, pump, chlorination and several miles of pipeline with an Arkansas River and railroad crossing.
- ***Operations and Serviceability*** *(High)* - The well is remote, without electricity, construction of roads may be required, little additional maintenance required.

Efficiency

- ***Capital Costs*** *(Moderate to High)* **–** The construction of the well and a portion of the pipeline will be shared. A Regional Authority will be required
- ***O&M Costs*** *(Moderate)* **–** The water from the Paleo is of high quality and requires only chlorination and O&M will be shared.

Acceptability

- ***Authorities (****High)* **-** No conflict with existing regulations and policies.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

Appendix 1: Assessment Criteria

- ***Agency Coordination*** *(Moderate to High)* **–** Entities will assume GMD3 application. Regional Authority is required.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - The long-term sustainability of the Paleo is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting*** *(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Assessment of Hamilton RWD1 Alternatives

Alternative RWD1.1: Dakota Aquifer - Advanced Treatment –Shared Regional O&M

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Utilizes existing water rights and sharing operators or contracting operators would remove the risk associated with the lack of experienced operator.
- ***Constructability-(****Low to Moderate)* - Upgrades of treatment facilities and methods for waste stream disposal will be required.
- ***Operations and Serviceability*** *(High)* - Will require an experienced operator to operate and maintain the treatment facility and the disposal facilities.

Efficiency

- ***Capital Costs*** *(High)* - Requires the construction of an IX treatment plant and an evaporative pond for the disposal of the waste stream. Other existing infrastructure would be utilized.
- ***O&M Costs*** *(Moderate to High)* **–**O&M would be shared. A 40% reduction to the costs was applied for this option.

Acceptability

- ***Authorities*** *(Moderate)* - The development of a Regional Authority is required.
- ***Public Acceptance***- Public Outreach to be developed
- ***Impacts on Natural Environment*** *(Moderate to High)* - No known culturally and environmental sensitive areas affected, but disposal of waste stream required.
- ***Impacts on Public Safety*** *(Moderate)* - Disposal lagoon would likely be located in the flood plain.

Completeness

- ***Agency Coordination*** *(Moderate to High)* - Requires the development of a Regional Authority.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - Pooled resources may mitigate the risk.

- ***Permitting*** *(Moderate)* - Would require the permitting waste stream disposal; Lagoon may need to be located in the flood plain.

Alternative RWD1.2: Dakota Aquifer Advanced Water Treatment (Also considered the No Action Alternative)

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Existing water rights are adequate to supply the 2050 demand. IX has been utilized for treatment of the Dakota.
- ***Constructability*** *(Low to Moderate)* - Construction of an IX plant and lined lagoons for waste stream disposal.
- ***Operations and Serviceability*** *(Low)* - An experienced operator is required and upkeep to evaporative lagoons.

Efficiency

- ***Capital Costs*** *(High)* - Requires the construction of an IX treatment plant and an evaporative pond for the disposal of the backwash. All other existing infrastructure, such as wells, would be utilized.
- ***O&M Costs*** *(Moderate)* – O&M of an IX plant will require an experienced operator.

Acceptability

- ***Authorities*** *(High)* - Utilizes existing wells and water rights, disposal lagoons will require permitting.
- ***Public Acceptance***- Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(Moderate to High)* - Evaporative lagoon likely to be located in flood plain.

Completeness

- ***Agency Coordination*** (High) - No new water rights to be acquired, existing water rights are sufficient.
- ***Engineering Uncertainty/Risk*** (High) - Treatment plant design and waste stream disposal consist of standard risks and uncertainties.
- ***Permitting*** (Moderate to High) - Water treatment plant design and waste stream disposal requires permits and easements.

Alternative RWD1.3: Lakin Treated Water

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Lakin will have the capacity to deliver treated water to meet the 2050 demand.

- ***Constructability*** *(Moderate to High)* - Pipeline construction is uncomplicated, but will require pump station and surge tank.
- ***Operations and Serviceability*** *(High)* - O&M will not provide a challenge. Lakin will be responsible for the treatment and disposal facility.

Efficiency

- ***Capital Costs*** *(Moderate)* - Construction of pipeline, pump station and surge tank will likely be required.
- ***O&M Costs*** *(Low)* **–** O&M is simple, but high due to a cost of $3.50/1000 gal ($1/100/ ac-ft) to the cost of treated water included in O&M.

Acceptability

- ***Authorities*** *(High)* - Agreement will be required, but would be beneficial to all.
- ***Public Acceptance***- Public outreach to be developed.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** *(High)* - An agreement between Lakin and Hamilton RWD1 will be required.
- ***Engineering Uncertainty/Risk*** *(Highs)* - Little engineering risk are involved
- ***Permitting*** *(High)* - Simple easements and easy to acquire.

Alternative RWD.4: GMD3 Application Paleo Aquifer with Syracuse (See Alt. S.5)

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo requires chlorination only, but some concern about sustainability.
- ***Constructability*** *(Low)* - Construction will be uncomplicated and consist of a well, pump, chlorination and a pipeline with an Arkansas River and railroad crossing. Pipeline from Syracuse will be 8.5 miles in length.
- ***Operations and Serviceability*** *(High)* - The well is remote, without electricity, construction of roads may be required, but after construction, little additional maintenance required.

Efficiency

- ***Capital Costs*** *(Low)* **–** Construction of the well and a portion of the line shared. Alternative would require construction of an 11.6 mile pipeline.
- ***O&M Costs*** *(High)* **–**O&M conducted by Regional Authority.

Acceptability

- ***Authorities*** *(Moderate to High)* - No conflict with existing regulations and policies. Regional Authority will be required.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** *(Moderate to High)* - Assume GMD3 application. Regional Authority will be required.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - The long-term sustainability of the Paleo is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting*** *(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Alternative RWD1.5: GMD3 Application Paleo Channel with Coolidge and Syracuse (See Alt. C.6 and S.6)

Effectiveness

- ***Water Quality and Quantity*** *(Moderate to High)* - Current water quality in the Paleo channel requires chlorination only, but some concern about sustainability.
- ***Constructability*** *(Low)* - Construction will be uncomplicated and consist of a well, pump, chlorination and a pipeline with an Arkansas River and railroad crossing. Pipeline from Syracuse will be 8.5-miles in length.
- ***Operations and Serviceability*** *(High)* - The well is remote, without electricity, construction of roads may be required, but after construction, little additional maintenance required.

Efficiency

- ***Capital Costs*** *(Low)* **–** The construction of the well and a portion of the pipeline will be shared. Alternative will requires the construction of a pipeline from Syracuse to Hamilton RWD1.
- ***O&M Costs*** *(High)* **–** O&M is not complicated and the major components will be shared.

Acceptability

- ***Authorities*** *(Moderate to High)* - No conflict with existing regulations and policies.
- ***Public Acceptance***-Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Appendix 1: Assessment Criteria

Completeness

- ***Agency Coordination*** *(Moderate to High)* - Assume GMD3 application, Regional Authority will be required.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - The long-term sustainability of the Paleo channel is unknown in both quality and quantity. Construction will require a river and railroad crossing.
- ***Permitting*** *(Moderate to High)* - Easements needed to construct the pipeline and river and railroad crossing required.

Assessment of Deerfield Alternatives

Alternative D.1: Regional/Partnership Shared O&M of Advanced Water Treatment

Effectiveness

- ***Water Quality and Quantity*** *(High)* **-** Utilizes existing water rights and sharing operators or contracting operators would remove the risk associated with the lack of experienced operator.
- ***Constructability*** *(Low to Moderate)* **-** Requires upgrades of treatment facilities and methods for waste stream disposal.
- ***Operations and Serviceability*** *(High)* - Requires an experienced operator to operate and maintain the treatment facility and the disposal facilities.

Efficiency

- ***Capital Costs*** *(Low)* **–** The construction of a NF treatment plant and a disposal well is required.
- ***O&M Costs*** *(High)* **–** The O&M would be conducted by a Regional Authority.

Acceptability

- ***Authorities*** *(Moderate)* - Requires the development of a Regional Authority.
- ***Public Acceptance***- Public acceptance was not used in the ranking.
- ***Impacts on Natural Environment*** *(Moderate to High)* - No known culturally and environmental sensitive areas affected, but disposal of waste stream required.
- ***Impacts on Public Safety*** *(Moderate)* **–** Deep well injection of waste stream will be required.

Completeness

- ***Agency Coordination*** *(Moderate to High)* - The development of a Regional Authority is required.
- ***Engineering Uncertainty/Risk*** *(Moderate to High)* - Pooled resources will mitigate the risk.

- ***Permitting*** *(Moderate)* **–** The presence of uranium in the waste stream would require the permitting of deep well injection for waste stream disposal.

Alternative D.2: Ogallala Aquifer Advanced Water Treatment (Also considered the No Action Alternative)

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Existing water rights are sufficient and NF provides quality water.
- ***Constructability*** *(Low)* **–**Requires an upgrade of the treatment facility to NF and construction a well for deep well injection.
- ***Operations and Serviceability*** *(Low to Moderate)* - Treatment plant and waste stream will require significant O&M.

Efficiency

- ***Capital Costs*** *(Low)* **–** Requires the construction of a NF treatment plant and a disposal of the waste stream by deep well injection.
- ***O&M Costs*** *(Moderate)* **–** Operation of the treatment plant and injection well will require experienced operators.

Acceptability

- ***Authorities*** *(Moderate to High)* **–** Utilizes existing wells and water rights, new treatment facility, and disposal well will require permitting.
- ***Public Acceptance*** - Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(Moderate)* - No known culturally and environmental sensitive areas. Waste stream may have concentrations of uranium.
- ***Impacts on Public Safety*** *(Moderate)* - Treatment plant and waste stream disposal via deep well injections provide minimal health and safety concerns.

Completeness

- ***Agency Coordination*** *(Moderate)* - Little interagency coordination is expected.
- ***Engineering Uncertainty/Risk*** *(Low)* - Deep well injection.
- ***Permitting*** *(Low to moderate)* - Permitting of water treatment and disposal facility required. Disposal of the waste stream in a disposal well may be required due the uranium.

Alternative D.3: Lakin Treated Water

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Lakin will have the capacity to deliver treated water to meet the 2050 demand.
- ***Constructability*** *(High)* - Pipeline construction only

- ***Operations and Serviceability*** *(High)* - O&M will be simple. Lakin will be responsible for the treatment and disposal facility.

Efficiency

- ***Capital Costs*** *(High)* – Requires the construction of a 7.5 mile pipeline. It is assumed that Lakin has adequate pressure for delivery.
- ***O&M Costs*** *(Low)* – O&M is simple, but high due to a cost of $3.50/1000 gal ($1,100/ ac-ft) to the cost of treated water included in O&M.

Acceptability

- ***Authorities*** *(High)* - Agreement will be required, but would be beneficial to all.
- ***Public Acceptance***- Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - Little impact to public safety noted.

Completeness

- ***Agency Coordination*** *(High)* - An agreement with Lakin will be required.
- ***Engineering Uncertainty/Risk*** *(Highs)* - Little engineering risk.
- ***Permitting*** *(High)* – Only simple easements required.

Alternative D.4: Wheatland Treated Water from fresh Ogallala Aquifer

Effectiveness

- ***Water Quality and Quantity*** *(High)* – Wheatland has adequate supply of fresh Ogallala water.
- ***Constructability*** *(Moderate)* – Pipeline will require a river and railroad crossing.
- ***Operations and Serviceability*** *(High)* - O&M will not provide a challenge. Treatment will require chlorination only.

Efficiency

- ***Capital Costs*** *(Moderate to High)* – Requires the construction of a 7.5 mile pipeline. Wheatland has adequate pressure for delivery.
- ***O&M Costs*** *(Moderate)* – O&M is simple, but high due to a cost of treated water included in O&M.

Acceptability

- ***Authorities*** *(High)* - Agreement will be required, but would be beneficial to all.
- ***Public Acceptance***- Public outreach to be developed.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.

- ***Impacts on Public Safety*** *(High)* - Little impact to public safety noted.

Completeness

- ***Agency Coordination*** *(High)* - An agreement with Wheatland will be required.
- ***Engineering Uncertainty/Risk*** *(Highs)* - Little engineering risk.
- ***Permitting*** *(High)* **–** Only simple easements required

Assessment of Holcomb Alternatives

Alternative H.1: Regional/Partnership Shared O&M of Advanced Water Treatment

Effectiveness

- ***Water Quality and Quantity*** *(High)* **-** Utilizes existing water rights and sharing operators or contracting operators would remove the risk associated with the lack of experienced operator.
- ***Constructability*** *(Low to Moderate)* - Requires upgrades of treatment facilities and methods for waste stream disposal.
- ***Operations and Serviceability*** *(High)* - Will require an experienced operator to operate and maintain the treatment facility and the disposal facilities.

Efficiency

- ***Capital Costs*** *(Low)* **–** Construction of a NF treatment plant and a disposal well is required.
- ***O&M Costs*** *(High)* **–**O&M would be conducted by a Regional Authority

Acceptability

- ***Authorities*** *(Moderate)* - Requires the development of a Regional Authority.
- ***Public Acceptance***- Public acceptance was not considered in ranking.
- ***Impacts on Natural Environment*** *(Moderate)* - No known culturally and environmental sensitive areas affected, but disposal of waste stream required.
- ***Impacts on Public Safety*** *(Moderate)* **–** Deep well injection of waste stream likely.

Completeness

- ***Agency Coordination*** *(Moderate to High)* - The development of a Regional Authority is required.
- ***Engineering Uncertainty/Risk*** *(Moderate)* **-** Pooled resources may mitigate the risk.
- ***Permitting*** *(Moderate)* - Requires the permitting of deep well injection for waste stream disposal.

Appendix 1: Assessment Criteria

Alternative H.2: Ogallala Aquifer Advanced Water Treatment (Also considered the No Action Alternative)

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Existing water rights are sufficient and NF provides quality water.
- ***Constructability*** *(Low)* **–**Requires an upgrade of the treatment facility to NF and the construction of a disposal well for waste stream disposal.
- ***Operations and Serviceability*** *(Moderate)* - Water treatment plant and waste stream will require significant O&M.

Efficiency

- ***Capital Costs*** *(Low)* **–** Requires the construction of a NF treatment plant and a disposal of the waste stream by deep well injection.
- ***O&M Costs*** *(Moderate)* **–** Operation of the treatment plant and injection well will require experienced operators.

Acceptability

- ***Authorities*** *(Moderate to High)* **–** Utilizes existing wells and water rights, new treatment facility, and disposal well will require permitting.
- ***Public Acceptance*** - Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(Moderate)* - No know culturally and environmental sensitive areas. Waste stream may have concentrations of uranium.
- ***Impacts on Public Safety*** *(Moderate)* - Treatment plant and waste stream disposal via deep well injections provide minimal health and safety concerns.

Completeness

- ***Agency Coordination*** *(Moderate)* - Little interagency coordination is expected.
- ***Engineering Uncertainty/Risk*** *(Moderate)* - Deep well injection.
- ***Permitting*** *(Moderate)* - Permitting of water treatment and disposal facility required. Disposal of the waste stream in a disposal well will likely be required due the uranium.

Alternative H.3: Wheatland Treated Water (RO) from Ogallala Aquifer

Effectiveness

- ***Water Quality and Quantity*** *(High)* - Wheatland has capacity to deliver treated water to meet the 2050 demand.
- ***Constructability*** *(High)* **–** Minor construction required for connection.
- ***Operations and Serviceability*** *(High)* - O&M will not provide a challenge. Wheatland to provide treated water.

Appendix 1: Assessment Criteria

Efficiency

- ***Capital Costs*** *(High)* – Requires the construction of a 7.5 mile pipeline. It is assumed that Wheatland has adequate pressure for delivery.
- ***O&M Costs*** *(Low)* – O&M is simple, but high cost due to the cost of treated water included in O&M.

Acceptability

- ***Authorities*** *(High)* - Agreement will be required, but would be beneficial to all.
- ***Public Acceptance***- Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

- ***Agency Coordination*** *(High)* - An agreement with Wheatland will be required.
- ***Engineering Uncertainty/Risk*** *(Highs)* - Little engineering risk.
- ***Permitting*** *(High)* – Only simple easements required.

Alternative H.4: Wheatland Raw Water from fresh Ogallala Aquifer Source

Effectiveness

- ***Water Quality and Quantity*** *(High)* – Wheatland has adequate supply of fresh Ogallala Aquifer water.
- ***Constructability*** *(Moderate)* – Pipeline will require a river and railroad crossing.
- ***Operations and Serviceability*** *(High)* - O&M will not provide a challenge. Treatment will require chlorination only.

Efficiency

- ***Capital Costs*** *(Moderate to High)* – Requires the construction of a 7.5-mile pipeline. It is assumed that Lakin has adequate pressure for delivery.
- ***O&M Costs*** *(Moderate)* – O&M is simple, but high cost due to the cost of treated water included in O&M.

Acceptability

- ***Authorities*** *(High)* - Agreement will be required, but would be beneficial to all.
- ***Public Acceptance***- Public acceptance was not considered in the ranking.
- ***Impacts on Natural Environment*** *(High)* - No known culturally and environmental sensitive areas.
- ***Impacts on Public Safety*** *(High)* - No impact to public safety noted.

Completeness

Appendix 1: Assessment Criteria

- ***Agency Coordination*** *(High)* - An agreement with Wheatland will be required.
- ***Engineering Uncertainty/Risk*** *(High)* - Little engineering risk.
- ***Permitting*** *(Moderate to High)* **–** Only simple easements required.

Appendix 2- Alternative Estimate Worksheets

Appendix 2: Alternative Estimate Worksheet

Alternative C.1 and C.2

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet 1 of 1

FEATURE:	PROJECT:
Alternative C.2 Coolidge will operate their existing Dakota Well and treat with Ion Exchange. Additions to current system includes modification of disposal lagoons	Construction Cost Estimate
	WOID:
	ESTIMATE LEVEL: Appraisal
	REGION: GP
	UNIT PRICE LEVEL:
	FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Evap Lagoon					
		Excavation		13,713	CY	$14.00	$192,000
		Membrane Lining		74,052	SF	$1.40	$103,700
		Misc Const.		1	LS	$20,000	$20,000
	2	Land Cost		3.4	acre	$1,550	$5,300
		Subtotal					$321,000
		Mobilization	+/-	5%			$14,000
		SUBTOTAL					$335,000
		Design Contingency	+/-	15%			$50,000
		Allowance for Procurement	+/-	5%			$15,000
		CONTRACT COST					$400,000
		Construction Contingency	+/-	25%			$100,000
		TOTAL FIELD COST					$500,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$200,000
		NON CONTRACT COSTS					$200,000
		CONSTRUCTION COST					$700,000
		Water Rights Acquisition					$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative C.3

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet 1 of 1

FEATURE: **Alternative C.3** Coolidge to Purchase an existing Agricultural Water Right and construct a well south of the river and a pipeline to convey the source to Coolidge	PROJECT: **Construction Cost Estimate** WOID: — ESTIMATE LEVEL: **Appraisal** REGION: GP — UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well 10" dia		110	L.F.	$445.00	$49,000
		Casing and gravel pack		70	LF	$46.50	$3,300
		Well screen		40	LF	$355.00	$14,200
		Pump and misc piping		1	Ea	$98,000.00	$98,000
	2	Pipeline 6 "HDPE		21,648	L.F.	$18.35	$397,000
		Excavation		10,022	Cy	$14.00	$140,000
		Backfill		8,018	CY	$2.15	$17,000
	3	Railroad Crossing Bore and case 24"		110	LF	$520.00	$57,000
		Jacking Pit		2	LS	$5,000.00	$10,000
	4	Arkansas River Crossing Bore & Case 24"		650	LF	$550.00	$360,000
		Jacking Pit		2	LS	$10,000.00	$20,000
	5	Standard Dual-Pump Chemical Feed Skids		1	ea	$8,700	$8,700
		Water Rights Acquisition		31	ac-ft	$2,000.00	$62,000
	6	Land Cost			acre	$1,531	$0
		Easement Cost		12	Acre	$383	$4,800
		Subtotal					$1,240,000
		Mobilization	+/-	5%			$61,000
		SUBTOTAL					$1,300,000
		Design Contingency	+/-	15%			$200,000
		Allowance for Procurement	+/-	5%			$60,000
		CONTRACT COST					$1,560,000
		Construction Contingency	+/-	25%			$360,000
		TOTAL FIELD COST					$1,920,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$760,000
		NON CONTRACT COSTS					$760,000
		Water Rights Acquisition		31	ac-ft	$2,000.00	$60,000
		CONSTRUCTION COST					$2,740,000

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative C.4

BUREAU OF RECLAMATION — **ESTIMATE WORKSHEET** — Sheet __1__ of __1___

FEATURE:	PROJECT:
Alternative C.4 Coolidge to utilize the existing GMD3 application south of the Arkansas River and convey this to Coolidge	Construction Cost Estimate WOID: — ESTIMATE LEVEL: Appraisal REGION: GP — UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well		110	L.F.	$510.00	$56,100
		Casing and gravel pack		70	LF	$86.00	$6,000
		Well screen		40	LF	$390.00	$15,600
		Pump and misc pipe		1	LS	$120,000.00	$120,000
	2	Pipeline 6 "HDPE		44,880	L.F.	$18.35	$820,000
		Excavation		20,778	CY	$14.00	$290,900
		Backfill		16,622	CY	$2.15	$35,700
	3	Standard Dual-Pump Chemical Feed Skids		1	ea	$8,600	$8,600
	4	Railroad Crossing Bore&case 24"		110	LF	$520.00	$57,200
		Jacking pits		2	LS	$5,000.00	$10,000
	5	Arkansas River Crossing Bore & case 24"		850	LF	$550.00	$470,000
		Jacking pits		2	LS	$10,000.00	$20,000
	6	Land Cost			acre	$1,531.00	$0
		Easement Cost		26	Acre	382.75	$9,900
		Subtotal					$1,920,000
		Mobilization	+/-	5%			$80,000
		SUBTOTAL					$2,000,000
		Design Contingency	+/-	15%			$300,000
		Allowance for Procurement	+/-	5%			$100,000
		CONTRACT COST					$2,400,000
		Construction Contingency	+/-	25%			$600,000
		TOTAL FIELD COST					$3,000,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$1,200,000
		NON CONTRACT COSTS					$1,200,000
		CONSTRUCTION COST					$4,200,000
		Water Rights Acquisition		0			$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative C.5 and S.4

BUREAU OF RECLAMATION **ESTIMATE WORKSHEET** Sheet 1 of 1

FEATURE: **Alternative C.5 and S.4** Paleo Channel utilizing GMD3 application for Coolidge and Syracuse	PROJECT: Construction Cost Estimate
	WOID: / ESTIMATE LEVEL: Appraisal
	REGION: GP / UNIT PRICE LEVEL:
	FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well		110	L.F.	$510.00	$56,000
		Casing and gravel pack		70	LF	$86.00	$6,000
		Well screen		40	LF	$390.00	$15,600
		Pump and misc piping		1	EA	$150,000	$150,000
	2	Pipeline 10 "HDPE		21,120	L.F.	32.00	$676,000
		Excavation		11,081	CY	$14.00	$155,100
		Backfill		8,865	CY	$2.15	$19,100
		6 "HDPE		24,288	L.F.	18.35	$446,000
		Excavation		11,244	CY	$14.00	$157,000
		Backfill		8,996	CY	$2.15	$19,300
		8 "HDPE		55,440	L.F.	23.50	$1,300,000
		Excavation		27,378	CY	$14.00	$383,000
		Backfill		21,902	CY	$2.15	$47,100
	3	Standard Dual-Pump Chemical Feed Skids		1	ea	$8,600	$8,600
	4	Railroad Crossing Bore & case 24"		111	LF	$520	$58,000
		Jacking pits		2		$5,000	$10,000
	5	Arkansas River Crossing bore & case 36"		850	LF	$620	$527,000
		Jacking pits		2	LS	$10,000	$20,000
	6	Land Cost			acre	$1,531	$0
		Easment Cost		58	acre	$383	$22,200
		Subtotal					$4,076,000
		Mobilization	+/-	5%			$204,000
		SUBTOTAL					$4,280,000
		Design Contingency	+/-	15%			$640,000
		Allowance for Procurement	+/-	5%			$210,000
		CONTRACT COST					$5,130,000
		Construction Contingency	+/-	25%			$1,270,000
		TOTAL FIELD COST					$6,400,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$2,500,000
		NON CONTRACT COSTS					$2,500,000
		CONSTRUCTION COST					$8,900,000
		Water Rights Acquisition		0			$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative C.6, S.6, and K.5

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet 1 of 1

FEATURE: **Alternative C.6, S.6, K.5** Paleo Channel Alternativenative for Syracuse. Coolidge and Hamilton Co. RWD #1	PROJECT: **Construction Cost Estimate**
	WOID: — ESTIMATE LEVEL: **Appraisal**
	REGION: GP — UNIT PRICE LEVEL:
	FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well		110	L.F.	$510.00	$56,000
		Casing and gravel pack		70	LF	$86.00	$6,000
		Well screen		40	LF	$390.00	$15,600
		Pump and misc piping		1	LS	$150,000.00	$150,000
	2	Pipeline 10 "HDPE		21,120	L.F.	$32.00	$675,800
		Excavation		7,822	CY	$14.00	$109,500
		Backfill		6,258	CY	$2.15	$13,500
	3	Pipeline 8 "HDPE		55,440	L.F.	$23.50	$1,300,000
		Excavation		20,533	CY	$14.00	$287,500
		Backfill		16,427	CY	$2.15	$35,300
	4	Pipeline 6 "HDPE		24,288	L.F.	$18.35	$445,700
		Excavation		8,996	CY	$14.00	$125,900
		Backfill		7,196	CY	$2.15	$15,500
	5	Pipeline 4 "HDPE		61,248	L.F.	$12.35	$756,400
		Excavation		22,684	CY	$14.00	$317,600
		Backfill		18,148	CY	$2.15	$39,000
	6	Standard Dual-Pump Chemical Feed Skids		1	ea	$8,700	$8,700
	7	Railroad Crossing Bore & case 24"		110	LF	$250	$27,500
		Jacking pits		2	LS	$5,000	$10,000
	8	Arkansas River Crossing Bore &case36"		850	LF	$620	$527,000
		Jacking pits		2	LS	$10,000	$20,000
	9	Land Cost			acre	$1,531.00	$0
		Easements		93	Acres	1,531.25	$142,500
		Subtotal					$5,085,000
		Mobilization	+/-	5%			$255,000
		SUBTOTAL					$5,340,000
		Design Contingency	+/-	15%			$790,000
		Allowance for Procurement	+/-	5%			$270,000
		CONTRACT COST					$6,400,000
		Construction Contingency	+/-	25%			$1,600,000
		TOTAL FIELD COST					$8,000,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$3,200,000
		NON CONTRACT COSTS					$3,200,000
		CONSTRUCTION COST					$11,200,000
		Water Rights Acquisition		0			$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative S.1

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet _1_ of _1_

FEATURE:	PROJECT:
Alternative S.1 Administrative Rule Change for the Paleo Aquifer (Assume the construction of a new well and pipeline required)	**Construction Cost Estimate** WOID: — ESTIMATE LEVEL: **Appraisal** REGION: GP — UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well		110	L.F.	$510.00	$56,000
		Casing and gravel pack		70	LF	$86.00	$6,000
		Well screen		40	LF	$390.00	$15,600
		Pump costs		1	EA	$150,000	$150,000
	2	Pipeline 10 "HDPE		0	L.F.	32.00	$0
		Excavation		0	CY	$14.00	$0
		Backfill		0	CY	$2.15	$0
		6 "HDPE		0	L.F.	18.35	$0
		Excavation		0	CY	$14.00	$0
		Backfill		0	CY	$2.15	$0
		8 "HDPE		20,000	L.F.	23.50	$470,000
		Excavation		9,877	CY	$14.00	$138,300
		Backfill		7,901	CY	$2.15	$17,000
	3	Standard Dual-Pump Chemical Feed Skids		1	ea	$8,600	$8,600
	4	Railroad Crossing Bore & case 24"		111	LF	$520	$57,700
		Jacking pits		2		$5,000	$10,000
	5	Arkansas River Crossing bore & case 36"		850	LF	$620	$527,000
		Jacking pits		2	LS	$10,000	$20,000
	6	Land Cost			acre	$1,531	$0
		Easment Cost		11	acre	$383	$4,400
		Subtotal					$1,480,600
		Mobilization	+/-	5%			$74,000
		SUBTOTAL					$1,555,000
		Design Contingency	+/-	15%			$230,000
		Allowance for Procurement	+/-	5%			$100,000
		CONTRACT COST					$1,885,000
		Construction Contingency	+/-	25%			$475,000
		TOTAL FIELD COST					$2,360,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$940,000
		NON CONTRACT COSTS					$940,000
		CONSTRUCTION COST					$3,300,000
		Water Rights Acquisition		0			$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative S.2

BUREAU OF RECLAMATION — **ESTIMATE WORKSHEET** — Sheet _1_ of _1_

FEATURE: **Alternative S.2** Paleo Channel utilizing GMD3 application Syracuse	**PROJECT:** **Construction Cost Estimate**
	WOID: — **ESTIMATE LEVEL:** Appraisal
	REGION: GP — **UNIT PRICE LEVEL:**
	FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well		110	L.F.	$510.00	$56,000
		Casing and gravel pack		70	LF	$86.00	$6,000
		Well screen		40	LF	$390.00	$15,600
				1	EA	$180,000	$180,000
	2	Pipeline 10 "HDPE		21,120	L.F.	32.00	$676,000
		Excavation		11,081	CY	$14.00	$155,000
		Backfill		8,865	CY	$2.15	$19,100
		6 "HDPE		0	L.F.	18.35	$0
		Excavation		0	CY	$14.00	$0
		Backfill		0	CY	$2.15	$0
		8 "HDPE		55,440	L.F.	23.50	$1,300,000
		Excavation		27,378	CY	$14.00	$383,300
		Backfill		21,902	CY	$2.15	$47,000
	3	Standard Dual-Pump Chemical Feed Skids		1	ea	$8,600	$8,600
	4	Railroad Crossing Bore & case 24"		111	LF	$520	$57,700
		Jacking pits		2		$5,000	$10,000
	5	Arkansas River Crossing bore & case 36"		850	LF	$620	$527,000
		Jacking pits		2	LS	$10,000	$20,000
	6	Land Cost			acre	$1,531	$0
		Easment Cost		44	acre	$383	$16,800
		Subtotal					$3,478,100
		Mobilization	+/-	5%			$173,900
		SUBTOTAL					$3,652,000
		Design Contingency	+/-	15%			$548,000
		Allowance for Procurement	+/-	5%			$200,000
		CONTRACT COST					$4,400,000
		Construction Contingency	+/-	25%			$1,100,000
		TOTAL FIELD COST					$5,500,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$2,200,000
		NON CONTRACT COSTS					$2,200,000
		CONSTRUCTION COST					$7,700,000
		Water Rights Acquisition		0			$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative S.3

BUREAU OF RECLAMATION **ESTIMATE WORKSHEET** Sheet __1__ of __1___

FEATURE:

Alternative S.3

Sryacuse will construct additional wells in the Dakota Aquifer, treat with Chlorination and blend with the existing water supply. Additions to current system include acquistion of additional water rights, constructing two wells, constructing a pipeline, and installing a chlorination system at well site.

PROJECT:

Construction Cost Estimate

WOID:		ESTIMATE LEVEL:	Appraisal
REGION:	GP	UNIT PRICE LEVEL:	

FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well Drilling		350	L.F.	$510.00	$178,500
		Casing and gravel pack		280	LF	$86.00	$24,100
		Well screen		70	LF	$390.00	$27,000
		Pump and misc pipe		1	LS	$310,000.00	$310,000
		2nd well					$515,300
	2	Pipeline 8 "HDPE		26,400	L.F.	23.50	$620,000
		Excavation		13,037	CY	$14.00	$183,000
		Backfill		10,430	CY	$2.15	$22,000
	3	Water Treatment Ion Exchange Unit		2	L.S.	$153,500	$307,000
	4	Standard Dual-Pump Chemical Feed Skids		1	ea	$8,600	$8,600
	5	Facility for mixing		1	LS	$25,000	$25,000
	6	Land Cost			acre	$1,531	$0
		Easement cost		15	acre	$383	$5,800
		Subtotal					$2,226,300
		Mobilization	+/-	5%			$114,000
		SUBTOTAL					$2,340,000
		Design Contingency	+/-	15%			$351,000
		Allowance for Procurement	+/-	5%			$117,000
		CONTRACT COST					$2,808,000
		Construction Contingency	+/-	25%			$702,000
		TOTAL FIELD COST					$3,510,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$1,400,000
		NON CONTRACT COSTS					$4,910,000
		Acquistion of Water Right					
		CONSTRUCTION COST					$4,910,000

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative S.5 and K.4

BUREAU OF RECLAMATION ESTIMATE WORKSHEET Sheet _1_ of _1_

FEATURE: Alternative S.5 and K.4 Paleo Channel Alternativenaive for Syracuse and Hamilton Co. RWD #1	PROJECT: Construction Cost Estimate
	WOID: / ESTIMATE LEVEL: Appraisal
	REGION: GP / UNIT PRICE LEVEL:
	FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Well		110	L.F.	$510.00	$56,000
		Casing and gravel pack		70	LF	$86.00	$6,000
		Well screen		40	LF	$390.00	$15,600
		Pump and misc piping		1	LS	$150,000	$150,000
	2	Pipeline 10 "HDPE		21,120	L.F.	$32.00	$675,800
		Excavation		7,822	CY	$14.00	$109,500
		Backfill		6,258	CY	$2.15	$13,500
	3	Pipeline 8 "HDPE		55,440	L.F.	$23.50	$1,300,000
		Excavation		20,533	CY	$14.00	$287,500
		Backfill		16,427	CY	$2.15	$35,300
		6 "HDPE		0	L.F.	$18.35	$0
				0	CY	$14.00	$0
				0	CY	$2.15	$0
	4	Pipeline 4 "HDPE		61,248	L.F.	$12.35	$756,400
		Excavation		22,684	CY	$14.00	$318,000
		Backfill		18,148	CY	$2.15	$39,000
	5	Standard Dual-Pump Chemical Feed Skids		3	ea	$8,600	$25,800
	6	Railroad Crossing Bore & case 24"		110	LF	$250	$27,500
		Jacking pits		2	LS	$5,000	$10,000
	7	Arkansas River Crossing Bore &case36"		850	LF	$620	$527,000
		Jacking pits		2	LS	$10,000	$20,000
	8	Land Cost			acre	$1,531.00	$0
		Easements		79	Acres	1,531.25	$121,100
		Subtotal					$4,490,000
		Mobilization	+/-	5%			$226,000
		SUBTOTAL					$4,716,000
		Design Contingency	+/-	15%			$710,000
		Allowance for Procurement	+/-	5%			$240,000
		CONTRACT COST					$5,670,000
		Construction Contingency	+/-	25%			$1,410,000
		TOTAL FIELD COST					$7,080,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$2,820,000
		NON CONTRACT COSTS					$2,820,000
		CONSTRUCTION COST					$9,900,000
		Water Rights Acquisition		0			$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative K.1 and K.2

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet 1 of 1

FEATURE: **Alternative K.2** Hamilton Co. RWD #1 will operate their existing Dakota Well. Additions to current system includes constructing a new water treatment plant.	PROJECT: **Construction Cost Estimate** WOID: — ESTIMATE LEVEL: Appraisal REGION: GP — UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Water Treatment					
		Duplex filtration system followed by RO skid		2	LS	$83,000	$166,000
		Standard Dual-Pump Chemical Feed Skids		1	ea	$8,600	$8,600
		Storage Building		2,500	SF	$60.50	$151,000
	2	Lagoon Earthwork		5,529	CY	$14.00	$77,400
		Membrane Lining		29,855	SY	$1.37	$40,900
		Piping		1	LS	$15,000.00	$15,000
	3	Land Cost		1.4	acre	$1,531.00	$2,100
		Subtotal					$461,000
		Mobilization	+/-	5%			$24,000
		SUBTOTAL					$485,000
		Design Contingency	+/-	15%			$72,000
		Allowance for Procurement	+/-	5%			$23,000
		CONTRACT COST					$580,000
		Construction Contingency	+/-	25%			$145,000
		TOTAL FIELD COST					$725,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$275,000
		NON CONTRACT COSTS					$1,000,000
		CONSTRUCTION COST					$1,000,000
		Water Rights Acquisition					$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative K.3

BUREAU OF RECLAMATION — **ESTIMATE WORKSHEET** — Sheet _1_ of _1_

FEATURE: **Alternative K.3** Lakin to supply treated water to Hamilton Co. RWD #1	PROJECT: **Construction Cost Estimate**
	WOID: — ESTIMATE LEVEL: **Appraisal**
	REGION: GP — UNIT PRICE LEVEL:
	FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Pipeline 4 "HDPE		81,840	L.F.	$12.35	$1,011,000
		Excavation		35,363	CY	$14.00	$495,000
		Backfill		28,290	CY	$2.15	$61,000
	2	Booster Pumping Plant		1	EA	$270,000	$270,000
							$0
	3	Chlorination for Residual		1	LS	$5,000	$5,000
	4	Land Cost			acre	$1,531	$0
		Easement Cost		47	Acre	$383	$18,000
		Subtotal					$1,860,000
		Mobilization	+/-	5%			$90,000
		SUBTOTAL					$1,950,000
		Design Contingency	+/-	15%			$290,000
		Allowance for Procurement	+/-	5%			$100,000
		CONTRACT COST					$2,340,000
		Construction Contingency	+/-	25%			$580,000
		TOTAL FIELD COST					$2,920,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$1,180,000
		NON CONTRACT COSTS					$1,180,000
		CONSTRUCTION COST					$4,100,000
		Purchase Treated Water		13	Ac-ft/year	$1,100.00	$14,300

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative D.1 and D.2

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet __1__ of __1___

FEATURE:	PROJECT:
Alternative D.2 Deerfield will operate their existing Ogallala Well. Additions to current system includes constructing a new water treatment plant.	**Construction Cost Estimate**
	WOID: — ESTIMATE LEVEL: **Appraisal**
	REGION: GP — UNIT PRICE LEVEL:
	FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Water Treatment Plant					
		Duplex filtration system followed by 3 RO skids		1	LS	$700,000	$700,000
		Standard Dual-Pump Chemical Feed Skids		1	ea	$8,600	$8,600
		Storage Building		3,000	SF	$60.50	$182,000
	2	Deep Well Injection		1	LS	$1,500,000	$1,500,000
	3	Land Cost		0	acre	$1,531.00	$0
		Subtotal					$2,390,600
		Mobilization	+/-	5%			$119,400
		SUBTOTAL					$2,510,000
		Design Contingency	+/-	15%			$375,000
		Allowance for Procurement	+/-	5%			$125,000
		CONTRACT COST					$3,010,000
		Construction Contingency	+/-	25%			$750,000
		TOTAL FIELD COST					$3,760,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$1,500,000
		NON CONTRACT COSTS					$5,250,000
		CONSTRUCTION COST					$5,250,000
		Water Rights Acquisition					$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative D.3

BUREAU OF RECLAMATION **ESTIMATE WORKSHEET** Sheet 1 of 1

FEATURE: **Alternative D.3** Lakin to supply Deerfield with Treated Water	PROJECT: **Construction Cost Estimate** WOID: ESTIMATE LEVEL: Appraisal REGION: GP UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Pipeline 10 "HDPE		39,600	L.F.	$32.00	$1,267,000
		Excavation		20,778	CY	$14.00	$291,000
		Backfill		16,622	CY	$2.15	$35,700
	2	Land Cost			acre	$1,531	$0
		Easment Cost		23	acre	$383	$8,700
	3	Chlorination for Residual		1	LS	$8,600	$8,600
		Subtotal					$1,611,000
		Mobilization	+/-	5%			$79,000
		SUBTOTAL					$1,690,000
		Design Contingency	+/-	15%			$240,000
		Allowance for Procurement	+/-	5%			$70,000
		CONTRACT COST					$2,000,000
		Construction Contingency	+/-	25%			$500,000
		TOTAL FIELD COST					$2,500,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$1,000,000
		NON CONTRACT COSTS					$1,000,000
		CONSTRUCTION COST					$3,500,000
		Purchase Treated Water		176	ac-ft/year	$1,000.00	$180,000

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative D.4

BUREAU OF RECLAMATION | **ESTIMATE WORKSHEET** | Sheet __1__ of __1__

FEATURE:

Alternative D.4
Wheatland to supply Deerfield with Ogallala Aquifer water from a fresh source south of the river. Wheatland will chlorinate

PROJECT:

Construction Cost Estimate

WOID: | **ESTIMATE LEVEL:** Appraisal
REGION: GP | **UNIT PRICE LEVEL:**

FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Pipeline 10 "HDPE		36,960	L.F.	$32.00	$1,183,000
		Excavation		13,689	CY	$14.00	$191,600
		Backfill		10,951	CY	$2.15	$23,500
		Pump and misc piping		1	LS	$200,000	
	2	Standard Dual-Pump Chemical Feed Skids		0	ea	$8,600	$0
	3	Railroad Crossing Bore & case 24"		110	LF	$520	$57,200
		Jacking Pits		2	LS	$5,000	$10,000
	4	Arkansas River Crossing Bore &case36"		600	EA	$620	$372,000
		Jacking Pits		2	LS	$10,000	$20,000
	5	Land Cost			acre	$1,531	$0
		Easment Cost		21	acre	$383	$8,100
		Subtotal					$1,865,400
		Mobilization	+/-	5%			$91,000
		SUBTOTAL					$1,960,000
		Design Contingency	+/-	15%			$294,000
		Allowance for Procurement	+/-	5%			$100,000
		CONTRACT COST					$2,350,000
		Construction Contingency	+/-	25%			$580,000
		TOTAL FIELD COST					$2,900,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$1,130,000
		NON CONTRACT COSTS					$1,130,000
		CONSTRUCTION COST					$4,000,000
		Purchase raw water		176	ac-ft/year	$490.00	$86,000

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative H.1 and H.2

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet __1__ of __1___

FEATURE: **Alternative H.2** Holcomb will operate their existing Ogallala Well. Additions to current system includes constructing a new water treatment plant. Will require a deep well disposal.	PROJECT: **Construction Cost Estimate** WOID: — ESTIMATE LEVEL: **Appraisal** REGION: GP — UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Water Treatment Plant					
		Duplex filtration system and 3 RO skids		1	LS	$1,000,000	$1,000,000
		Standard Dual-Pump Chemical Feed		1	ea	$8,600	$8,600
	2	Land Cost		5	acre	$1,531	$7,700
	3	Deep Well Injection		1	EA	$2,000,000	$2,000,000
		Subtotal					$3,016,000
		Mobilization	+/-	5%			$154,000
		SUBTOTAL					$3,170,000
		Design Contingency	+/-	15%			$470,000
		Allowance for Procurement	+/-	5%			$160,000
		CONTRACT COST					$3,800,000
		Construction Contingency	+/-	25%			$900,000
		TOTAL FIELD COST					$4,700,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$1,800,000
		NON CONTRACT COSTS					$1,800,000
		CONSTRUCTION COST					$6,500,000
		Water Rights Acquisition					$0

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative H.3

BUREAU OF RECLAMATION — ESTIMATE WORKSHEET — Sheet __1__ of __1___

FEATURE: **Alternative H.3** Wheatland Water to supply Holcomb with Treated Ogallala Aquifer Water(Reverse Osmosis.	PROJECT: Construction Cost Estimate WOID: — ESTIMATE LEVEL: Appraisal REGION: GP — UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Miscellaneous Connection costs		1	L.S.	$50,000.00	$50,000
		Subtotal					$50,000
		Mobilization	+/-				$0
		SUBTOTAL					$50,000
		Design Contingency	+/-				$0
		Allowance for Procurement	+/-				$0
		CONTRACT COST					$50,000
		Construction Contingency	+/-				$0
		TOTAL FIELD COST					$50,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-				$0
		NON CONTRACT COSTS					$0
		CONSTRUCTION COST					$150,000
		Treated (RO) Water		569	ac-ft/year	$1,100.00	$626,000

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 2: Alternative Estimate Worksheet

Alternative H.4

BUREAU OF RECLAMATION **ESTIMATE WORKSHEET** Sheet __1__ of __1___

FEATURE:	PROJECT:
Alternative H.4 Wheatland Water to supply Holcomb with Ogallala Aquifer fresh water source. Wheatland will chlorinate.	**Construction Cost Estimate** WOID: / ESTIMATE LEVEL: Appraisal REGION: GP / UNIT PRICE LEVEL: FILE:

PLANT ACCOUNT	PAY ITEM	DESCRIPTION	CODE	QUANTITY	UNIT	UNIT PRICE	AMOUNT
	1	Pipeline 12 "HDPE		14,790	L.F.	$46.00	$680,000
		Excavation		8,217	CY	$14.00	$115,000
		Backfill		6,573	CY	$2.15	$14,100
	3	Standard Dual-Pump Chemical Feed		0	ea	$8,600	$0
	4	Railroad Crossing		110	LF	$625	$68,800
		Jacking pits		2	LS	$5,000	$10,000
	5	Arkansas River Crossing		850	LF	$625	$531,300
		Jacking pits		2	LS	$10,000	$20,000
	6	Land Cost Fee Title			acre	$1,531	$0
		Easment Cost		8	Acre	$383	$3,200
		Subtotal					$1,442,400
		Mobilization	+/-	5%			$73,000
		SUBTOTAL					$1,515,000
		Design Contingency	+/-	15%			$230,000
		Allowance for Procurement	+/-	5%			$75,000
		CONTRACT COST					$1,820,000
		Construction Contingency	+/-	25%			$450,000
		TOTAL FIELD COST					$2,270,000
		Design, Environmental/Cultural Compliance, Construction Mgmt, etc	+/-	40%			$910,000
		NON CONTRACT COSTS					$910,000
		CONSTRUCTION COST					$3,200,000
		Purchase Raw Water		569	ac-ft/year	$487.50	$277,000

QUANTITIES		PRICES		
BY	CHECKED	BY	CHECKED	REVIEWED
DATE PREPARED	REVIEWED	DATE	PRICE LEVEL	

Appendix 3 - Well Logs in Area of Paleo Channel

Appendix 3: Well Logs in area of Paleo Channel

Well Logs in area of Paleo Channel													
Township Range	WELL_ID	Sec. #	Owner	Longitude	Latitude	Well Use	Well Depth (ft)	Static Depth (ft)	Est. Yield	Surface Elevation	Assumed Formation	Lithographic Log	
T 23 S, R 42 W													
	320686	31	Helfrich	-101.9639	38.0072	Domestic	275	76			Dakota	From: 1 ft. to 13 ft.	fine sand - loose
											Aquifer	From: 13 ft. to 16 ft.	brown clay
												From: 16 ft. to 20 ft.	fine sand - clay strip
												From: 20 ft. to 23 ft.	coarse gravel
												From: 23 ft. to 40 ft.	shale - hard pull down 30C
												From: 40 ft. to 50 ft.	shale - hard pull down 500 - Dakota sandstone strip
												From: 50 ft. to 70 ft.	shale - hard pull down 40C
												From: 70 ft. to 104 ft.	Dakota sandstone - hard pull down 60C
												From: 104 ft. to 110 ft.	shale - 50% Dakota sandstone - hard pull down 30C
												From: 110 ft. to 144 ft.	gray shale - 50% Dakota sand stone - hard pull down 700
												From: 144 ft. to 158 ft.	gray shale - hard pull down 70C
												From: 158 ft. to 166 ft.	Dakota sandstone
												From: 166 ft. to 223 ft.	gray shale - hard pull down 70C
												From: 223 ft. to 260 ft.	Dakota sandstone - hard pull down 40C
												From: 260 ft. to 290 ft.	shale - 20% Dakota sandstone - hard pull down 40C
	348982	34	Fallwell	-101.91815	38.0072533	Domestic	56	12	40		?	From: 0 ft. to 20 ft.	top soil, clay, and fine-coarse sanc
	25402	35	Millsap	-101.89068	38.0073845		75	22	1500		Paleo	From: 0 ft. to 22 ft.	overburden
											Channel	From: 22 ft. to 74 ft.	gravel
												From: 74 ft. to 75 ft.	blue shale
T 23 S, R 43 W													
	25407	24	Hines	-101.9845	38.0326	Irrigation	65	24			Paleo	From: 0 ft. to 10 ft.	Type: CLAY
											Channel	From: 10 ft. to 63 ft.	Type: SAND & GRAVEL
												From: 63 ft. to 65 ft.	Type: SHALE
	427531	25	tal Land and	-101.99596	38.0199308	Irrigation	80	9			Paleo	From: 0 ft. to 2 ft.	Topsoil, brown sandy clay
											Channel	From: 2 ft. to 7 ft.	Hard black dirt
												From: 7 ft. to 20 ft.	Fine to medium sand and gravel, some coarse, very loose, streaks of clya
												From: 20 ft. to 78 ft.	Fine to medium sand and gravel, 50% coarse with strips of brown clay
												From: 78 ft. to 80 ft.	Yellow clay, hard, 300 pull down
												From: 80 ft. to 95 ft.	Hard dry gray shale, 400 pull down
	25408	25	Lowe	-101.9983	38.0290	Irrigation	91	7		3330	Paleo	From: 0 ft. to 7 ft.	top soil & clay
											Channel	From: 7 ft. to 88 ft.	sand & gravel
												From: 88 ft. to 91 ft.	shale (blue)
	329834	26	Oxy USA	-102.00283	38.0199466	Oil Field W	100	7	100		Paleo	From: 0 ft. to 4 ft.	topsoil
											Channel	From: 4 ft. to 15 ft.	sand and gravel
												From: 15 ft. to 24 ft.	clay, blue
												From: 24 ft. to 38 ft.	sandstone, blue
												From: 38 ft. to 83 ft.	sandstone, white
												From: 83 ft. to 92 ft.	sandstone, brown
												From: 92 ft. to 100 ft.	clay and sandstone layers, blue
	444414	27	Low Farms	-102.02566	38.019956	domestic	193	36	30		Dakota	From: 0 ft. to 20 ft. Topsoil,	fine to coarse sand, small to medium gravel
											Aquifer	From: 20 ft. to 40 ft.	Fine to coarse sand, small to medium gravel
												From: 40 ft. to 60 ft.	Blue clay, thin rock layer
												From: 60 ft. to 80 ft.	Blue clay sandstone
												From: 80 ft. to 100 ft.	Sandstone
												From: 100 ft. to 120 ft.	Sandstone, gray clay layers
												From: 120 ft. to 195 ft.	Sandstone
	25409	28	Palmer	-102.0394	38.0181	Irrigation	80	12	1800	3358	Paleo	From: 0 ft. to 12 ft.	top soil and clay
											Channel	From: 12 ft. to 78 ft.	sand and gravel
												From: 78 ft. to 80 ft.	shale
	25410	33	Palmer	-102.0374	38.0127	Irrigation	120	34	2000	3378	Paleo	From: 0 ft. to 45 ft.	overburden
											Channel	From: 45 ft. to 118 ft.	sand and gravel
												From: 118 ft. to 120 ft.	shale
	25411	33	Palmer	-102.0374	38.0018	Irrigation	120	34	2000	3380	Paleo	From: 0 ft. to 45 ft.	overburden
											Channel	From: 45 ft. to 118 ft.	sand & gravel
												From: 118 ft. to 120 ft.	shale
	25412	36		-101.9822	38.0144	Domestic	52	6	20		Paleo	From: 0 ft. to 5 ft.	topsoil & fine sand
											Channel	From: 5 ft. to 60 ft.	sand & gravel
	428958	36	TLW	-101.99825	38.0145001		240				Paleo	From: 0 ft. to 12 ft.	Topsoil and brown clay
											Channel	From: 12 ft. to 16 ft.	Sand and gravel
												From: 16 ft. to 40 ft.	Shale and rock
												From: 40 ft. to 180 ft.	Sandstone and shale, hard
												From: 180 ft. to 240 ft.	White sandstone and shale streaks
												From: 20 ft. to 46 ft.	fine-coarse sand, small gravel, gravel
												From: 46 ft. to 60 ft.	blue clay

Appendix 3: Well Logs in area of Paleo Channel

Well Logs in area of Paleo Channel													
Township Range	WELL_ID	Sec. #	Owner	Longitude	Latitude	Well Use	Well Depth (ft)	Static Depth (ft)	Est. Yield	Surface Elevation	Assumed Formation	Lithographic Log	
T 24 S, R 40 W													
	25486	18	Sharp	-101.7580	37.9603	Irrigation	50	14	1050		Paleo	**From:** 0 ft. **to** 8 ft.	top soil & clay
											Channel	**From:** 8 ft. **to** 48 ft.	sand & gravel
												From: 48 ft. **to** 50 ft.	shale
	25488	19	ity of Syracus	-101.7604	37.9567	Public Wat	19	1000			Paleo	**From:** 0 ft. **to** 15 ft.	**Type:** SAND
											Channel	**From:** 15 ft. **to** 64 ft.	**Type:** SAND & GRAVEL
												From: 64 ft. **to** 66 ft.	**Type:** SHALE
	25489	23	Brownlee	-101.67731	37.9568084	Irrigation	88	23	1451		Paleo	**From:** 0 ft. **to** 3 ft.	top soil
											Channel	**From:** 3 ft. **to** 9 ft.	brown and gray color clay
												From: 9 ft. **to** 15 ft.	brown clay and gravel, mixed
												From: 15 ft. **to** 56 ft.	sand fine med. Coarse, small gravel to large and cobblestones, used water, mud heavy. Mixed 2 more sacks of mud at 40 feet. Loose in places
												From: 56 ft. **to** 86 ft.	white sand st., hard in places. Used pull down a lot. Few soapstone st.
												From: 86 ft. **to** 90 ft.	shale, very hard
	330642	28	Miguel Dairy	-101.71181	37.9421727	Domestic	45	8	100		Paleo	**From:** 0 ft. **to** 1 ft.	top soil
											Channel	**From:** 1 ft. **to** 8 ft.	brown sandy clay
												From: 8 ft. **to** 21 ft.	coarse sand & gravel
												From: 21 ft. **to** 45 ft.	coarse gravel
	25491	30	il Field Suppl	-101.7569	37.9340	Oil Field W	93	60			Paleo	**From:** 2 ft. **to** 28 ft.	sandy clay & fine sand mix
											Channel	**From:** 28 ft. **to** 52 ft.	sand & gravel
												From: 52 ft. **to** 55 ft.	sand
												From: 55 ft. **to** 70 ft.	sandy gravel & rocks
												From: 70 ft. **to** 73 ft.	clay
												From: 73 ft. **to** 87 ft.	sand, gravel & rock w/fine clay lenses
												From: 87 ft. **to** 93 ft.	shale
T 24 S, R 41 W													
	25497	5	Hatcher	-101.85194	37.9909941	Irrigation	65	13.5	1600		Paleo		
											Channel	**From:** 15 ft. **to** 63 ft.	**Type:** GRAVEL
												From: 63 ft. **to** 65 ft.	**Type:** SAND & GRAVEL
												From: 65 ft. **to** 66 ft.	**Type:** CLAY
												From: 66 ft. **to** 80 ft.	**Type:** SHALE
	331709	8	ying T girl Sco	-101.83597	37.9801531	Domestic	30	8			Paleo	**From:** 0 ft. **to** 9 ft.	sandy clay
											Channel	**From:** 9 ft. **to** 20 ft.	sand crs gravel
												From: 20 ft. **to** 35 ft.	shale caliche
	331708	8	ying T Girl Sco	-101.83597	37.9801531	Domestic	140	40			Dakota	**From:** 0 ft. **to** 9 ft.	sandy clay
											Aquifer	**From:** 9 ft. **to** 20 ft.	sand crs gravel
												From: 20 ft. **to** 35 ft.	shale caliche
												From: 35 ft. **to** 83 ft.	shale
												From: 83 ft. **to** 89 ft.	sandstone shale
												From: 89 ft. **to** 116 ft.	shale
												From: 116 ft. **to** 130 ft.	sandstone shale
												From: 130 ft. **to** 135 ft.	shale sandstone
												From: 135 ft. **to** 140 ft.	sandstone
												From: 140 ft. **to** 170 ft.	shale sandstone
												From: 170 ft. **to** 198 ft.	shale sandstone
	447214	8	TWL	-101.84512	37.9855816	Domestic	300				Dakota	**From:** 0 ft. **to** 17 ft.	Sand and gravel
											Aquifer	**From:** 17 ft. **to** 80 ft.	Shale little sandstone
												From: 80 ft. **to** 120 ft.	Sandstone and shale
												From: 120 ft. **to** 140 ft.	Sandstone little clay
												From: 140 ft. **to** 160 ft.	Clay little sandstone
												From: 160 ft. **to** 180 ft.	Lime stone little shale
												From: 180 ft. **to** 190 ft.	Sandstone little shale
												From: 190 ft. **to** 200 ft.	Black shale little limestone
												From: 200 ft. **to** 260 ft.	Sandstone little shale
												From: 260 ft. **to** 300 ft.	Sandstone little shale and clay
												From: 300 ft. **to** 320 ft.	Sandstone and shale
	25502	10	K&L Hogs	-101.7993	37.9730	Feedlot/LI	325	96			Paleo	**Type:** CLAY	
											Channel	**From:** 8 ft. **to** 36 ft.	**Type:** MEDIUM GRAVEL
												From: 36 ft. **to** 350 ft.	**Type:** SHALE
	25507	17	tate	-101.8405	37.9621	Irrigation	85	14	800		Paleo	**From:** 0 ft. **to** 6 ft.	top soil fine sand
											Channel	**From:** 6 ft. **to** 40 ft.	coarse gravel
												From: 40 ft. **to** 45 ft.	brown sandy clay
												From: 45 ft. **to** 61 ft.	medium coarse gravel, loose
												From: 61 ft. **to** 66 ft.	brown sandy clay
												From: 66 ft. **to** 75 ft.	medium sand to coarse gravel, loose
												From: 75 ft. **to** 82 ft.	medium coarse gravel with white rock, loose
												From: 82 ft. **to** 83 ft.	yellow clay
												From: 83 ft. **to** 86 ft.	shale
	25510	22	heyenne Drilli	-101.8119	37.9539	Oil Field W	60	20	200		Paleo	**From:** 0 ft. **to** 20 ft.	sand
											Channel	**From:** 20 ft. **to** 60 ft.	gravel
												From: 60 ft. **to** ft.	blue shale

Appendix 3: Well Logs in area of Paleo Channel

Well Logs in area of Paleo Channel

Township Range	WELL_ID	Sec. #	Owner	Longitude	Latitude	Well Use	Well Depth (ft)	Static Depth (ft)	Est. Yield	Surface Elevation	Assumed Formation	Lithographic Log	
T 24 S, R 41 W													
	100034	22	ity of Syracus	-101.8061	37.9512	Domestic	85	32	45		Paleo	**From:** 0 ft. **to** 20 ft.	topsoil fine - med sand
											Channel	**From:** 20 ft. **to** 40 ft.	coarse sand clay layers
												From: 40 ft. **to** 60 ft.	coarse sand clay layers
												From: 60 ft. **to** 80 ft.	coarse sand clay
												From: 80 ft. **to** 83 ft.	coarse sand clay layers
												From: 83 ft. **to** 110 ft.	clay blue shale
	100038	22	ity of Syracus	-101.8016	37.9512	Domestic	80	33	40	N/A	Paleo	**From:** 0 ft. **to** 20 ft.	topsoil coarse sand
											Channel	**From:** 20 ft. **to** 40 ft.	fine - med sand
												From: 40 ft. **to** 60 ft.	coarse sand
												From: 60 ft. **to** 80 ft.	coarse sand
												From: 80 ft. **to** 95 ft.	coarse sand
												From: 95 ft. **to** 100 ft.	blue shale
	314068	22	ity of Syracus	-101.7993	37.9530	Public Wat	94.5	32	1500	3271	Paleo	**From:** 0 ft. **to** 20 ft.	medium sand
											Channel	**From:** 25 ft. **to** 30 ft.	medium sand, small rock
												From: 30 ft. **to** 35 ft.	large sand
												From: 35 ft. **to** 45 ft.	large sand, small rock
												From: 45 ft. **to** 50 ft.	medium to large sand
												From: 50 ft. **to** 75 ft.	large sand to medium rock
												From: 75 ft. **to** 95 ft.	large sand to 1 1/2-inch and greater rock
	25511	31	Reed	-101.8701	37.9239	Domestic	380	160	30		Paleo/	**From:** 2 ft. **to 42** ft.	fine sand - tan
											Dakota	**From:** 42 ft. **to** 67 ft.	fine gravel
												From: 67 ft. **to** 74 ft.	clay & gravel
												From: 74 ft. **to** 148 ft.	shale w/sandstone layers
												From: 148 ft. **to** 152 ft.	sandstone hard - fine, silty
												From: 152 ft. **to** 185 ft.	shale
												From: 185 ft. **to** 318 ft.	sandstone v fine, silty
												From: 318 ft. **to** 332 ft.	sandstone - med, soft
												From: 332 ft. **to** 380 ft.	sandstone - hard
	322798	36	Laster	-101.7627	37.9277	Domestic	230	105			Dakota	**From:** 0 ft. **to** 15 ft.	topsoil & sandy clay
											Aquifer	**From:** 15 ft. **to** 35 ft.	sand & a little clay
												From: 35 ft. **to** 52 ft.	sand & gravel
												From: 52 ft. **to** 56 ft.	brown clay
												From: 56 ft. **to** 105 ft.	blue clay
												From: 105 ft. **to** 115 ft.	blue clay & 30% sandstone
												From: 115 ft. **to** 132 ft.	blue clay
												From: 132 ft. **to** 230 ft.	sandstone, hard; strks of clay
	409642	36	Spiker	-101.7719	37.9186	Domestic	370	135			Dakota	**From:** 0 ft. **to** 2 ft.	silt
											Aquifer	**From:** 2 ft. **to** 9 ft.	sandy clay
												From: 9 ft. **to** 45 ft.	sand fine gravel med gravel
												From: 45 ft. **to** 48 ft.	caliche
												From: 48 ft. **to** 149 ft.	shale
												From: 149 ft. **to** 187 ft.	caliche sandstone
												From: 187 ft. **to** 203 ft.	sandstone caliche
												From: 203 ft. **to** 224 ft.	caliche sandstone
												From: 224 ft. **to** 252 ft.	sandstone caliche
												From: 252 ft. **to** 293 ft.	caliche sandstone
												From: 293 ft. **to** 307 ft.	sandstone
												From: 307 ft. **to** 316 ft.	caliche
												From: 316 ft. **to** 367 ft.	sandstone caliche

Appendix 3: Well Logs in area of Paleo Channel

Well Logs in area of Paleo Channel

Township Range	WELL_ID	Sec. #	Owner	Longitude	Latitude	Well Use	Well Depth (ft)	Static Depth (ft)	Est. Yield	Surface Elevation	Assumed Formation	Lithographic Log	
T 24 S, R 42 W													
	316228	2	Triple T	-101.8918	37.9919	Domestic	300	15			Dakota	From: 0 ft. to 13 ft.	tan and brown sandy clay
											Aquifer	From: 13 ft. to 24 ft.	large gravel
												From: 24 ft. to 36 ft.	black clay
												From: 36 ft. to 68 ft.	black clay streaks in black shale
												From: 68 ft. to 88 ft.	shale with small sandstone streaks
												From: 88 ft. to 112 ft.	sandstone with cemented fine sand
												From: 112 ft. to 119 ft.	black shale
												From: 119 ft. to 138 ft.	sandstone with sand streaks (soft)
												From: 138 ft. to 166 ft.	sandstone (hard)
												From: 166 ft. to 168 ft.	sandstone (soft)
												From: 168 ft. to 179 ft.	shale (hard)
												From: 179 ft. to 202 ft.	shale (soft)
												From: 202 ft. to 215 ft.	black shale
												From: 215 ft. to 234 ft.	gray and white sandy clay
												From: 234 ft. to 265 ft.	soft sandstone with shale and sandy clay streaks
												From: 265 ft. to 269 ft.	hard shale
												From: 269 ft. to 273 ft.	soft sandstone
												From: 273 ft. to 278 ft.	gray and white sandy clay with sandstone
												From: 278 ft. to 295 ft.	soft sandstone with gray sandy clay
												From: 295 ft. to 300 ft.	hard
	25512	5	Triple T	-101.9502	37.9963	Domestic	260	41	60		Dakota	From: 0 ft. to 20 ft.	topsoil fine - med sand
											Aquifer	From: 20 ft. to 39 ft.	med-coarse sand large gravel
												From: 39 ft. to 75 ft.	blue shale rock layers
												From: 75 ft. to 80 ft.	blue shale sandstone in layers
												From: 80 ft. to 160 ft.	sandstone clay layers
												From: 160 ft. to 180 ft.	sandstone clay in layers
												From: 180 ft. to 200 ft.	sandstone clay in layers
												From: 200 ft. to 220 ft.	sandstone clay layers
												From: 220 ft. to 260 ft.	sandstone
	25513	7	Triple T	-101.9663	37.9818	Feedlot/Li	75	40	10		Paleo	From: 0 ft. to 20 ft.	sand clay sandy gravel & rock
											Channel	From: 20 ft. to 40 ft.	gravel & rock
												From: 40 ft. to 60 ft.	gravel & rock
												From: 60 ft. to 73 ft.	rock
												From: 73 ft. to 75 ft.	shale
	25514	8	Scott	-101.9616	37.9727	Irrigation	130	46	1350		Paleo	From: 0 ft. to 3 ft.	top soil fine
											Channel	From: 3 ft. to 12 ft.	brown clay
												From: 12 ft. to 31 ft.	fine to medium sand and gravel
												From: 31 ft. to 60 ft.	coarse gravel
												From: 60 ft. to 74 ft.	yellow clay
												From: 74 ft. to 80 ft.	medium coarse gravel
												From: 80 ft. to 127 ft.	coarse gravel
												From: 127 ft. to 140 ft.	shale
	25515	8	Scott	-101.9570	37.9764	Irrigation	130	41	1350		Paleo	From: 0 ft. to 9 ft.	top soil fine
											Channel	From: 9 ft. to 13 ft.	brown clay
												From: 13 ft. to 23 ft.	fine to medium sand and gravel
												From: 23 ft. to 130 ft.	coarse gravel
												From: 130 ft. to 140 ft.	shale
	25516	11	Triple T	-101.8907	37.9730	Domestic	285	40	71		Dakota	From: 0 ft. to 20 ft.	topsoil fine - med sand
											Aquifer	From: 20 ft. to 80 ft.	med-coarse sand gravel very loose
												From: 80 ft. to 100 ft.	clay rock layers sand rock layer
												From: 100 ft. to 120 ft.	sandstone rock layers
												From: 120 ft. to 160 ft.	rock layers sandstone
												From: 160 ft. to 180 ft.	sandstone thin rock layer
												From: 180 ft. to 200 ft.	sandstone in layers gray clay
												From: 200 ft. to 210 ft.	gray clay sandstone
												From: 210 ft. to 240 ft.	sandstone
												From: 240 ft. to 250 ft.	sandstone
												From: 250 ft. to 280 ft.	sandstone very loose
	93591	17	Triple T	-101.9547	37.9655	Domestic	285	70	30		Dakota	From: 0 ft. to 30 ft.	topsoil fine sand
											Aquifer	From: 30 ft. to 40 ft.	sandy clay
												From: 40 ft. to 80 ft.	coarse sand gravel
												From: 80 ft. to 100 ft.	blue shale rock
												From: 100 ft. to 120 ft.	sand rock shale
												From: 120 ft. to 210 ft.	gray shale rock layers
												From: 210 ft. to 212 ft.	rock
												From: 212 ft. to 220 ft.	sandstone rock
												From: 220 ft. to 285 ft.	sandstone shale
												From: 285 ft. to ft.	shale
	428959	18	TLW	-101.9730	37.9583	Domestic	240				Paleo	From: 0 ft to 2 ft	Topsoil
											Channel	From: 2 ft. to 56 ft.	Sand and gravel
												From: 56 ft. to 105 ft.	Shale
												From: 105 ft. to 220 ft.	Sandstone and a little shale
												From: 220 ft. to 240 ft.	Shale, little sandstone and iron pyrite
	428960	18	TLW	-101.9731	37.9637	Domestic	200				Dakota	From: 0 ft. to 8 ft.	Topsoil and brown sandy clay
											Aquifer	From: 8 ft. to 16 ft.	Fine sand
												From: 16 ft. to 20 ft.	Brown sandy clay
												From: 20 ft. to 30 ft.	Fine sand
												From: 30 ft. to 43 ft.	Sand and gravel
												From: 43 ft. to 60 ft.	Shale
												From: 60 ft. to 190 ft.	Sandstone and shale
												From: 190 ft. to 195 ft.	Sandstone with charcoal
												From: 195 ft. to 200 ft.	Gray clay

Appendix 3: Well Logs in area of Paleo Channel

Well Logs in area of Paleo Channel

Township Range	WELL_ID	Sec. #	Owner	Longitude	Latitude	Well Use	Well Depth (ft)	Static Depth (ft)	Est. Yield	Surface Elevation	Assumed Formation	Lithographic Log	
T 24 S, R 42 W													
	320686	31	Helfrich	-101.96391	38.0071992	Domestic	275	76			Dakota	**From:** 0 ft. **to** 1 ft.	top soil
											Aquifer	**From:** 1 ft. **to** 13 ft.	fine sand - loose
												From: 13 ft. **to** 16 ft.	brown clay
												From: 16 ft. **to** 20 ft.	fine sand - clay strip
												From: 20 ft. **to** 23 ft.	coarse gravel
												From: 23 ft. **to** 40 ft.	shale - hard pull down 300
												From: 40 ft. **to** 50 ft.	shale - hard pull down 500 - Dakota sandstone strip
												From: 50 ft. **to** 70 ft.	shale - hard pull down 400
												From: 70 ft. **to** 104 ft.	Dakota sandstone - hard pull down 600
												From: 104 ft. **to** 110 ft.	shale - 50% Dakota sandstone - hard pull down 300
												From: 110 ft. **to** 144 ft.	gray shale - 50% Dakota sand stone - hard pull down 700
												From: 144 ft. **to** 158 ft.	gray shale - hard pull down 700
												From: 158 ft. **to** 166 ft.	Dakota sandstone
												From: 166 ft. **to** 223 ft.	gray shale - hard pull down 700
												From: 223 ft. **to** 260 ft.	Dakota sandstone - hard pull down 400
												From: 260 ft. **to** 290 ft.	shale - 20% Dakota sandstone - hard pull down 400
	348731	35	heyenne Drilli	-101.893	37.9257897	Oil field	280	170	15		Dakota		
											Aquifer	**From:** 3 ft. **to** 62 ft.	clay and white rock
												From: 62 ft. **to** 245 ft.	shale, black
												From: 245 ft. **to** 255 ft.	sandstone, white
												From: 255 ft. **to** 280 ft.	shale, black and blue
	25517	36	Guldner	-101.8747	37.9149	Feedlot/LIV	313	168	25		Dakota	**From:** 0 ft. **to** 62 ft.	overburden & clay
											Aquifer	**From:** 62 ft. **to** 192 ft.	blue shale
												From: 192 ft. **to** 310 ft.	Dakota sand
												From: 310 ft. **to** 313 ft.	gray shale
T 24 S, R 43 W													
	427812	1	TLW	-101.9823	37.9999336	N/A	305				Dakota	**From:** 0 ft. **to** 80 ft.	Sand and gravel
											Aquifer	**From:** 80 ft. **to** 90 ft.	Yellow clay
												From: 90 ft. **to** 189 ft.	Blue clay and a few sandstone streaks
												From: 189 ft. **to** 191 ft.	Rock, hard
												From: 191 ft. **to** 200 ft.	Shale and a little sandstone
												From: 200 ft. **to** 206 ft.	Sandstone
												From: 206 ft. **to** 267 ft.	Shale, sandstone streaks
												From: 267 ft. **to** 273 ft.	White rock
												From: 273 ft. **to** 280 ft.	Shale
												From: 280 ft. **to** 290 ft.	Shale, sandstone streaks
												From: 290 ft. **to** 306 ft.	Rock
	444415	2	Low Farms	-102.00747	37.9944784	Domestic	165	52	30		Dakota	**From:** 0 ft. **to** 20 ft.	Topsoil, fine sanc
											Aquifer	**From:** 20 ft. **to** 40 ft.	Fine to coarse sand, fine to medium sanc
												From: 40 ft. **to** 75 ft.	Fine to coarse sand, small to medium gravel
												From: 75 ft. **to** 80 ft.	Clay
												From: 80 ft. **to** 100 ft.	Clay, blue shale, sandstone
												From: 100 ft. **to** 120 ft.	Sandstone
												From: 120 ft. **to** 140 ft.	Sandstone, gray clay, layers
												From: 140 ft. **to** 160 ft.	Sandstone
												From: 160 ft. **to** 180 ft.	Sandstone, gray clay
	25518	2	Low	-102.0121	37.9909	Irrigation	116	38	1450		Paleo	**From:** 0 ft. **to** 8 ft.	top soil, fine sand
											Channel	**From:** 8 ft. **to** 10 ft.	brown sandy clay
												From: 10 ft. **to** 23 ft.	medium coarse gravel
												From: 23 ft. **to** 85 ft.	coarse gravel
												From: 85 ft. **to** 112 ft.	coarse gravel, hard pull dowr
												From: 112 ft. **to** 115 ft.	shale, hard pull dowr
	25519	3	Olsen	-102.0212	37.9892	Irrigation	132	40	2500		Paleo	From: 0 ft to 2 ft	surface
											Channel	**From:** 2 ft. **to** 20 ft.	clay and fine sand
												From: 20 ft. **to** 35 ft.	coarse sand
												From: 35 ft. **to** 125 ft.	coarse sand and gravel w/big rocks
												From: 125 ft. **to** 132 ft.	coarse sand and gray shale
	25520	3	Palmer	-102.0325	38.0000	Irrigation	76	34	2000		Paleo	**From:** 0 ft. **to** 32 ft.	overburden
											Channel	**From:** 32 ft. **to** 74 ft.	sand & gravel
												From: 74 ft. **to** 76 ft.	shale
	25521	3	Low	-102.0303	37.9910	Irrigation	136	36	1350		Paleo	**From:** 0 ft to 1 ft	top soil
											Channel	**From:** 1 ft. **to** 6 ft.	fine sand
												From: 6 ft. **to** 15 ft.	brown sandy clay
												From: 15 ft. **to** 22 ft.	medium coarse gravel
												From: 22 ft. **to** 132 ft.	coarse gravel
												From: 132 ft. **to** 134 ft.	yellow shale hard pull dowr
	341957	3	Brown	-102.0280	37.9946	Irrigation	83	53.8	750		Paleo	From: 0 ft. to 12 ft.	top & fine sand & clay
											Channel	**From:** 12 ft. **to** 80 ft.	sand & gravel
												From: 80 ft. **to** 83 ft.	shale
	25522	3	Palmer	-102.0257	37.9964	Irrigation	68	34	2000		Paleo	From: 0 ft. to 32 ft.	overburden
											Channel	**From:** 32 ft. **to** 66 ft.	sand & gravel
												From: 66 ft. **to** 68 ft.	shale
	373360	4	Olsen	-102.0380	37.9973	Irrigation	72	36	1700		Paleo	**From:** 0 ft. **to** 7 ft.	sand
											Channel	**From:** 7 ft. **to** 67 ft.	sand, fine to med coarse; small to large gravel; few cobble stones, very few clay streaks
												From: 67 ft. **to** 71 ft.	soapstone - limestone, shale
	373361	4	Olsen	-102.0366	37.9928	Irrigation	82	41	1000		Paleo	**From:** 0 ft. **to** 7 ft.	sandy clay and fine sand
											Channel	**From:** 7 ft. **to** 77 ft.	sand, fine to medium coarse, small to large gravel, few cobble stones, very few clay streaks
												From: 77 ft. **to** 81 ft.	weathered shale

Appendix 3: Well Logs in area of Paleo Channel

	Well Logs in area of Paleo Channel												
Township Range	WELL_ID	Sec. #	Owner	Longitude	Latitude	Well Use	Well Depth (ft)	Static Depth (ft)	Est. Yield	Surface Elevation	Assumed Formation	Lithographic Log	
T 24 S, R 43 W													
	25523	9	Finkbinder	-102.0387	37.9856	Feedlot/LIV	108	54	20		Paleo	From: 0 ft. to 10 ft.	top soil, lime, & clay
											Channel	From: 10 ft. to 30 ft.	sand & gravel
												From: 30 ft. to 32 ft.	clay
												From: 32 ft. to 43 ft.	shale
												From: 43 ft. to 60 ft.	shale (hard)
												From: 60 ft. to 103 ft.	sand stone
												From: 103 ft. to 108 ft.	shale
	25524	9	Low	-102.0387	37.9819	Feedlot/LIV	70	50			Paleo	From: 0 ft. to 10 ft.	top soil
											Channel	From: 10 ft. to 29 ft.	brown sandy clay
												From: 29 ft. to 36 ft.	fine to medium sand and gravel
												From: 36 ft. to 41 ft.	brown sandy clay
												From: 41 ft. to 51 ft.	fine to medium sand and gravel
												From: 51 ft. to 56 ft.	fine to medium sand and hard pull dowr
												From: 56 ft. to 78 ft.	cemented sand stone hard pull down harc
												From: 78 ft. to 83 ft.	yellow clay
												From: 83 ft. to 86 ft.	shale
	25525	10	Seay	-102.0281	37.9856	Irrigation	120	40	3000		Paleo	0-2 ft.	surface
											Channel	From: 2 ft. to 105 ft.	brown clay & sand
												From: 105 ft. to 120 ft.	blue & brown clay and sand
	25526	10	Tabscott	-102.0212	37.9838	Irrigation	90	47	1325		Paleo		top soil
											Channel	From: 1 ft. to 6 ft.	fine sand
												From: 6 ft. to 22 ft.	brown clay
												From: 22 ft. to 33 ft.	medium coarse gravel, clay trace, loose
												From: 33 ft. to 39 ft.	coarse gravel, tight
												From: 39 ft. to 43 ft.	coarse gravel, clay trace
												From: 43 ft. to 55 ft.	coarse gravel, loose
												From: 55 ft. to 85 ft.	coarse gravel
												From: 85 ft. to 90 ft.	yellow clay
												From: 90 ft. to 95 ft.	shale
	466689	10	Tabcscott	-102.01892	37.9837799	Irrigation	90	62	800		Paleo	From: 0-30	Top Clay
											Channel	From: 30-87	Sand and gravel
												From: 87-90	Shale
	25527	11	Low	-102.0076	37.9837	Irrigation	116	42	1500		Paleo	From: 0 ft. to 16 ft.	top soil fine
											Channel	From: 16 ft. to 24 ft.	brown clay
												From: 24 ft. to 32 ft.	medium coarse gravel
												From: 32 ft. to 95 ft.	coarse gravel
												From: 95 ft. to 112 ft.	medium sand to medium coarse gravel, yellow trace
												From: 112 ft. to 120 ft.	yellow clay
												From: 120 ft. to 124 ft.	shale
	25528	11	Low	-102.0053	37.9818	Irrigation	125	35	1325		Paleo	From: 0 ft. to 5 ft.	top soil, fine sand
											Channel	From: 5 ft. to 16 ft.	fine sand, clay streaks
												From: 16 ft. to 21 ft.	brown sandy clay
												From: 21 ft. to 33 ft.	medium coarse gravel
												From: 33 ft. to 88 ft.	coarse gravel
												From: 88 ft. to 89 ft.	yellow clay
												From: 89 ft. to 95 ft.	shale
	444416	11	Low Farms	-102.0006	37.9728	Domestic	165	42	35		Paleo	From: 0 ft. to 20 ft.	Topsoil, fine sanc
											Channel	From: 20 ft. to 35 ft.	Fine to coarse sand, small gravel
												From: 35 ft. to 40 ft.	Gray clay, thin rock layers
												From: 40 ft. to 80 ft.	Sandstone
												From: 80 ft. to 100 ft.	Sandstone, gray clay
												From: 100 ft. to 120 ft.	Sandstone, blue clay
												From: 120 ft. to 160 ft.	Sandstone
												From: 160 ft. to 180 ft.	Gray clay
	104004	13	ter-Wilson Dr	-101.9972	37.9700299	Domestic	200	80	10		Dakota	From: 0 ft. to 20 ft.	sand
											Aquifer	From: 20 ft. to 26 ft.	clay
												From: 26 ft. to 29 ft.	brown & yellow clay
												From: 29 ft. to 42 ft.	shale
												From: 42 ft. to 74 ft.	sand stone & shale
												From: 74 ft. to 81 ft.	gray shale
												From: 81 ft. to 91 ft.	sand stone
												From: 91 ft. to 122 ft.	sand stone
												From: 122 ft. to 132 ft.	shale
												From: 132 ft. to 141 ft.	sand stone
												From: 141 ft. to 160 ft.	gray clay
												From: 160 ft. to 166 ft.	sand stone
												From: 166 ft. to 172 ft.	shale
												From: 172 ft. to 200 ft.	shale & sand stone
	111238	14	Helfrich	-102.01658	37.9692864	Irrigation	297	80	450		Dakota	From: 0 ft. to 30 ft.	top soil, fine sand, and clay
											Aquifer	From: 30 ft. to 40 ft.	yellow clay (shale)
												From: 40 ft. to 90 ft.	shale
												From: 90 ft. to 108 ft.	sand stone
												From: 108 ft. to 196 ft.	shale
												From: 196 ft. to 293 ft.	sandstone
												From: 293 ft. to 297 ft.	shale
	310086	24	Triple T	-101.98216	37.9474302	Feedlot	65	43	20		Paleo	From: 0 ft. to 20 ft.	sand to med gravel
											Channel	From: 20 ft. to 40 ft.	med gravel to rock
												From: 40 ft. to 60 ft.	1-inch rock
												From: 60 ft. to 62 ft.	rock
												From: 62 ft. to 65 ft.	shale

Appendix 4 -Public Meeting Notes

Garden City Meeting — *February 25, 2014*

The Garden City meeting was attended by representatives from Wheatland Water, City of Garden City, City of Holcomb, Sunflower Electric, and Finney Co. Rural Water District. Meeting team members for the first part consisted of representatives from Reclamation, Southwest Kansas Groundwater Management District No. 3 (GMD3), Kansas Water Office (KWO), Kansas Geological Survey (KGS) and Wichita State University (WSU). The meeting consisted of an overview of the water quality concerns in the area from Don Whittemore with KGS. Don described that the uranium in the Arkansas River are from natural sources that are concentrated due to human activity. Thomas Michalewicz with Reclamation and Mark Rude with GMD3 then presented the alternatives developed for Holcomb and Deerfield in the Upper Arkansas River Water Supply Alternatives for Hamilton, Kearny, and Finney Counties, Kansas.

Finney Rural Water District (RWD) described that their Dakota Aquifer Wells had levels of radium and that is why they now purchase treated water from Wheatland. One of the negative effects of purchasing water from other entities is the loss of an asset and continued debt. The asset is the water right that Finney RWD purchased or developed in the Dakota that is no longer utilized and by purchasing water from Wheatland the water rate must be added on top of the existing debt for an asset that is no longer in use.

The Basin Study, Plan of Study session was also led by Thomas and Mark. This facilitated a discussion of further aquifer studies, aquifer recharge, and water reuse. Holcomb currently treats and distributes their wastewater to Sunflower Electric for free as part of a 20-year contract. When asked of the communication with all the entities upstream along the Arkansas River, it was discussed that minimal contact has been reciprocated thus far, but that the meeting in Holly was scheduled February 27th.

Lakin Meeting — *February 25, 2014*

The Lakin meeting was attended by representatives from Deerfield, Lakin and Irrigation Ditch areas. Meeting team members for the first part consisted of representatives from Reclamation, Southwest Kansas Groundwater Management District No. 3 (GMD3), Kansas Water Office (KWO), Kansas Geological Survey (KGS) and Wichita State University (WSU). The meeting consisted of an overview of the water quality concerns in the area from Don Whittemore with KGS. Don described that the uranium in the Arkansas River are from natural sources that are concentrated due to human activity. Thomas Michalewicz with Reclamation and Mark Rude with GMD3 then presented the alternatives developed for Deerfield and Kendall in the Upper Arkansas River Water Supply Alternatives for Hamilton, Kearny, and Finney Counties, Kansas.

When asked what problems the cities faced, Lakin stated that operations and maintenance, treatment, and well water quantity has all been a problem for the city to startup their new nanofiltration treatment plant. When asked whether selling water to other entities was acceptable for Lakin, they responded that originally they anticipated selling water to other entities but their well production has been so low that they have not even finished their treatment plant's startup. Lakin's nanofiltration plant must have a continual stream of flow to operate correctly, but with the low well production, they have had to purchase an initial storage tank that has still not been approved by Kansas Department of Health and Environment. The new treatment facility itself, if water is available to treat, could be expanded along the 1.5-million gallon per day as a regional system.

There is local desire to aid neighboring communities if municipal quality and quantity remain adequate to provide water. A discussion was had if the LEMA (regionalization) designation could apply for Lakin and Deerfield well supply areas. Diane Knowles with KWO spoke and provided a handout to describe all of the regional partnership designations in the state that could be beneficial for the area. Deerfield indicated they have already had discussions with Wheatland Water for future supply and distribution alternatives

The Basin Study, Plan of Study session was also led by Thomas and Mark. This facilitated a discussion of further aquifer studies, aquifer recharge, water reuse, KDHE regulations, tamarisk removal, and economic challenges for the region. It was speculated that irrigators and the dry Amazon ditch may contribute to the low well production for Lakin. There may be need for future local discussions regarding water quantity specific to their municipal wells. There is concern regarding water quality in the Arkansas River/Amazon Ditch and its impacts on municipal water quality. An aquifer study could benefit Lakin directly by developing a pumping management strategy with all of the local well users to optimize the production value. Aquifer recharge would require additional treatment capabilities, but water reuse would be a straightforward solution for nonpotable uses. Tamarisk removal has been very effective as short-term solutions in the past, but removal would have to be a priority throughout all of the northern portions of the Arkansas River to have long-term impacts. The economic impact of the area on the state and county markets has not been identified in the past and could be an addition to the Plan of Study.

Syracuse Meeting February 26, 2014

The Syracuse meeting was attended by representatives from Hamilton County, the city of Syracuse, and town of Kendall (Hamilton RWD1). Meeting team members for the first part consisted of representatives from Reclamation, Southwest Kansas Groundwater Management District No. 3 (GMD3), Kansas Water Office (KWO), Kansas Geological Survey (KGS) and Wichita State University (WSU). The first part of the meeting was facilitated by Katie Miller of Environmental Finance Center, WSU. The meeting consisted of an overview of the water quality concerns in the area from Don Whittemore with Kansas Geological Survey (KGS). Don described that the uranium in the Arkansas River are from natural sources that are concentrated due to human activity. Don also discussed the uncertainties associated with the new development four-miles south of the river along the Kansas Stateline and its impacts on the Paleo Channel

Aquifer. Thomas Michalewicz and Katie Miller then presented the alternatives developed for Coolidge, Syracuse, and Deerfield in the Upper Arkansas River Water Supply Alternatives for Hamilton, Kearny, and Finney Counties, Kansas.

The status of Syracuse's wells were discussed and their relation to the Paleo Channel Aquifer. Whether accessing this source near Syracuse or Coolidge could benefit all of Hamilton County was discussed. There was also a discussion of whether GMD3 borders should extend to encompass the river aquifer areas of Hamilton County since at this time GMD3 has been acting as a concerned third party in those areas. A water rights application for Syracuse to address study need before further state issued appropriations occur and to provide water to the entire county from the fresh water Paleo channel aquifer was also discussed. Mark Rude with GMD3 described the benefit of protecting and securing that source as soon as possible.

The Basin Study, Plan of Study session was also led by Thomas and with Mark Rude. There is local concern regarding quality and quantity of municipal supplies for the county. The unknown geohydrology of the Paleo Channel was also expressed as a concern and how activities on either side of the Stateline might affect sustainability. There was local support for investigating alternatives for Coolidge and Hamilton Rural Water District No. 1, but future planning or alternatives cannot be considered without knowing sustainability of the Paleo. The City and County Commissions were interested in more information related to a comprehensive study of the Paleo by KGS. It was also announced that the meeting in Holly was scheduled February 27th and everyone was welcomed to attend.

Upper Arkansas River Basin Study – Plan of Study

An option for the plan of study would include groundwater modeling of the Paleo Channel and Dakota Aquifer with historic average pumping, monitoring water quality, and identifying recharge parameters and opportunities for sustainable use.

Identified Unknowns in no particular order

1. What are overall social and economic risks to present water use as water quality declines in the Ark valley areas?
2. What is the influence of seepage from the Amazon ditch into Lakin municipal wells?
3. What is the influence of nearby wells effect on Lakin wells?
4. Can managed recharge of treated wastewater be used to address quality issues?
5. How could infiltration though the Playa Lakes be increased?
6. Paleo Channel sustainable yield. This includes the determination of recharge areas, supply from across State line, requirements to protect the high water quality and extent of the aquifer.

7. What could be the economic impact and usability of the declining river and recharged aquifer water quality on the areas, especially on agricultural production? There are probably minor and major impacts and scenarios that could be investigated such as decreases in crop yield to conversions to dry land farming.
8. Institutional impediments for communities to share resources, including across Stateline.
9. Dakota well operation to understand the pumping scenarios impact on the water quality.
10. Modifying the timing of releases from John Martin Reservoir as part of a best management approach to improve water quality?
11. Could conjunctive use of irrigation releases from storage for managed recharge be used to mitigate the water quality issues and or reduce water loss
12. An Appraisal Level (preliminary design) alternatives based on the ongoing Kansas System Optimization Review recommendations to improve the delivery in the canal systems could be completed as part of the study.
13. Are there any additional regulatory constraints for the public water supplies in the area?