

# THE LOWER ARKANSAS VALLEY DRAINAGE SYSTEM STUDY

## DESCRIPTION AND SCOPE OF WORK

### PROJECT SUMMARY

This study concerns the future use of aging subsurface and surface drainage systems in the Lower Arkansas Valley, Colorado. The Lower Arkansas Valley subsurface drainage systems are 90 years old.<sup>1</sup> Tile drains and associated manholes, collectors, and wasteways are in a deteriorated condition. This contributes to saline high water tables and crop production problems.

Recent research conducted by Colorado State University has shown that drainage is of major concern to growers and communities in the Lower Arkansas Valley.<sup>2</sup> Poor drainage will likely be properly addressed only through a combination of modifications to current irrigation practices and improvements in the design and performance of subsurface and surface drainage systems.

This project is generating information that will assist and benefit 25 small drainage districts in the Lower Arkansas Valley. It involves conducting a major inventory and estimation of costs and benefits associated with rehabilitating approximately 200 miles of subsurface tile drains and 107 miles of surface drainage wasteways in the lower valley (i.e., Crowley, Otero, Bent and Prowers counties).

The study is funded by the Colorado Water Conservation Board, the Lower Arkansas Valley Water Conservancy District, the Colorado Department of Transportation, and several communities and drainage districts in the area.

The study will assist the many small drainage districts in the Lower Arkansas Valley in exploring a more consolidated operation and maintenance program to make better use of modern technologies and economies of scale in their annual O&M program.

### BACKGROUND

The exact location of many of the 90 year-old subsurface agricultural drainage networks in the Lower Arkansas Valley has been lost over the years due to misplaced records. In addition, occasional damage continues to occur to these drainage networks as a result of agricultural land preparation and excavation activities associated with the installation of utility pipelines and improperly supervised rural subdivision development.

The proposed research is making it possible for drainage districts to develop a long-term rehabilitation plan for a fully integrated drainage network in the lower valley, including significant reconstruction of existing drains and manholes.

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<sup>1</sup> John H. Griffin, Associate Engineer Appraiser and A. R. Owens, Assistant Engineer Appraiser, The Federal Land Bank of Wichita, 1943.

<sup>2</sup> Gates, Timothy, K., J. Philip Burkhalter, John W. Labadie, James Valliant, and Israel Broner, Monitoring and Modeling Flow and Salt Transport in a Salinity-Threatened Irrigated Valley. Journal of Irrigation and Drainage Engineering (March/April, 2002).

The end product of the study is to identify: (1) cost-effective ways in which older drainage systems for irrigated agriculture can be improved, and (2) how to better design long-term maintenance of drainage systems for irrigated agriculture using up-to-date technology.

### BENEFITS OF STUDY

The output of the study is providing a wide range of stakeholder benefits. These include:

1. For Farmers - better understanding of the importance of drainage systems to their crop production and land.
2. For Agricultural Water Suppliers – better understanding of how canal delivery systems affect drainage issues, and what can be done to improve canal management in a way that minimizes drainage problems on the land they deliver water to.
3. For Municipalities and Rural Domestic Water Suppliers – ensuring cooperation between municipalities, utilities, developers and drainage districts to minimize damage to subsurface and surface drains as residential development occurs around irrigated lands, and to explore possible opportunities for cooperation between municipalities and drainage districts in addressing shared drainage problems or concerns.
4. For Counties - better understanding how drainage affects future residential and commercial development, achieving better equity in the way lands are assessed for drainage, and improving the capability of counties to know the whereabouts of drainage infrastructure in unincorporated areas of the county where county government is responsible for monitoring and planning future growth.

### HISTORY OF DRAINAGE IN THE LOWER ARKANSAS VALLEY

Drainage district acts were passed in 1911 and 1919 by the Colorado legislature authorizing the formation of drainage districts. Between 1911 and 1922, there were 25 known drainage districts organized in Water Districts 67 and 17 in the lower Arkansas Valley.<sup>3</sup> Most of these were organized in Bent and Prowers counties, although several were also organized in Otero, Crowley and Pueblo counties (see Map 1 and Table 1 and 2).

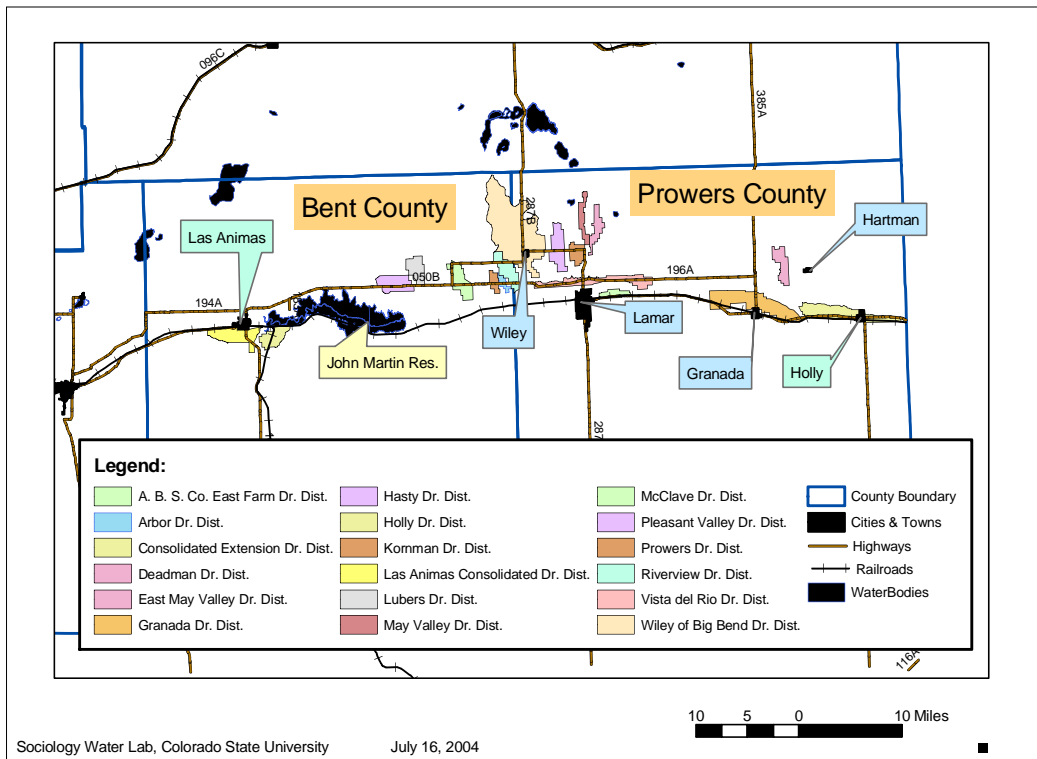
The formation of drainage districts represented a considerable capital investment by growers in the lower valley, attesting to the importance of drainage to agricultural production then and now. Combining the infrastructure of the 25 known drainage districts, approximately 84 miles of tile drains and 107 miles of open drains were constructed at a cost of \$1.4 million dollars between 1911 and 1925. These drainage systems served a minimum of 99,872 acres.

It is known that many of the drainage districts had problems meeting annual assessments during the Depression. This resulted in considerable deferred maintenance on these drainage systems. The Reconstruction Finance Corporation (RFC) under the Roosevelt Administration provided funds to refinance many of the indebted district serial bonds. However, this refinancing was followed by another

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<sup>3</sup> In preparation for this section, the Sociology Water Lab researched archives of the Federal Land Bank at the Farm Credit Services office in Wichita, Kansas. Thanks to Dexter Henderson, Engineer Appraiser and long-time employee of the Federal Land Bank. Engineering Report on Water Districts 17 and 67. John H. Griffin, Associate Engineer Appraiser and A. R. Owens, Assistant Engineer Appraiser, The Federal Land Bank of Wichita, 1943.

Map 1 – Lower Arkansas Valley Drainage Districts



Map 2 – Configuration of Drainage Districts to Canal Systems Negotiating Natural Surface Drainage Coming Off Bench Lands

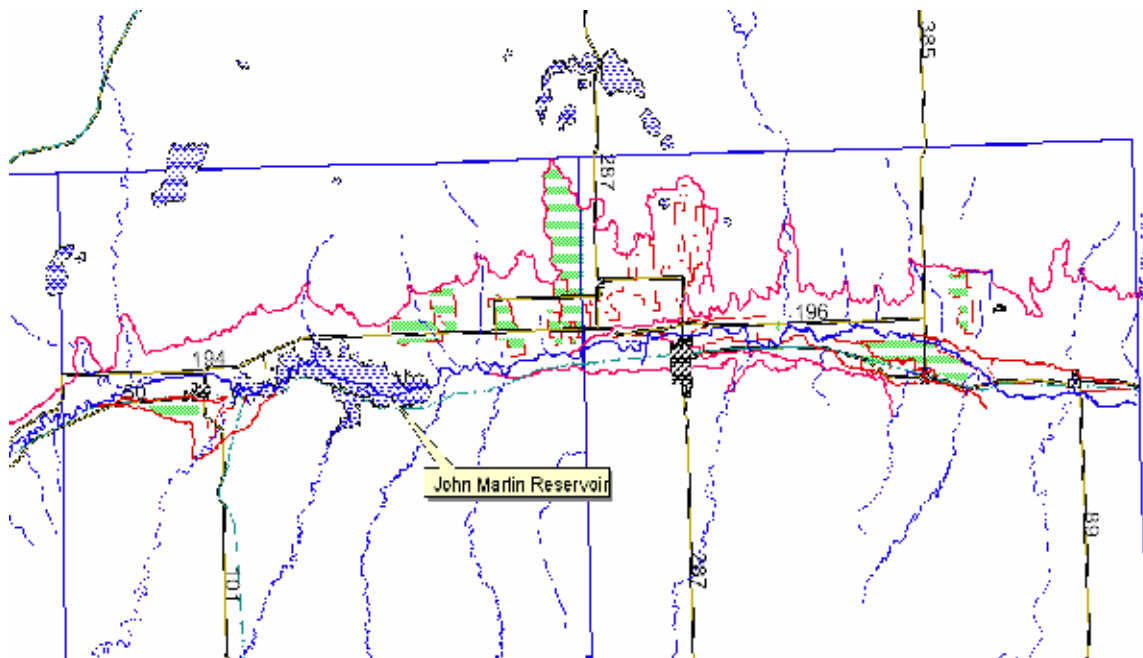


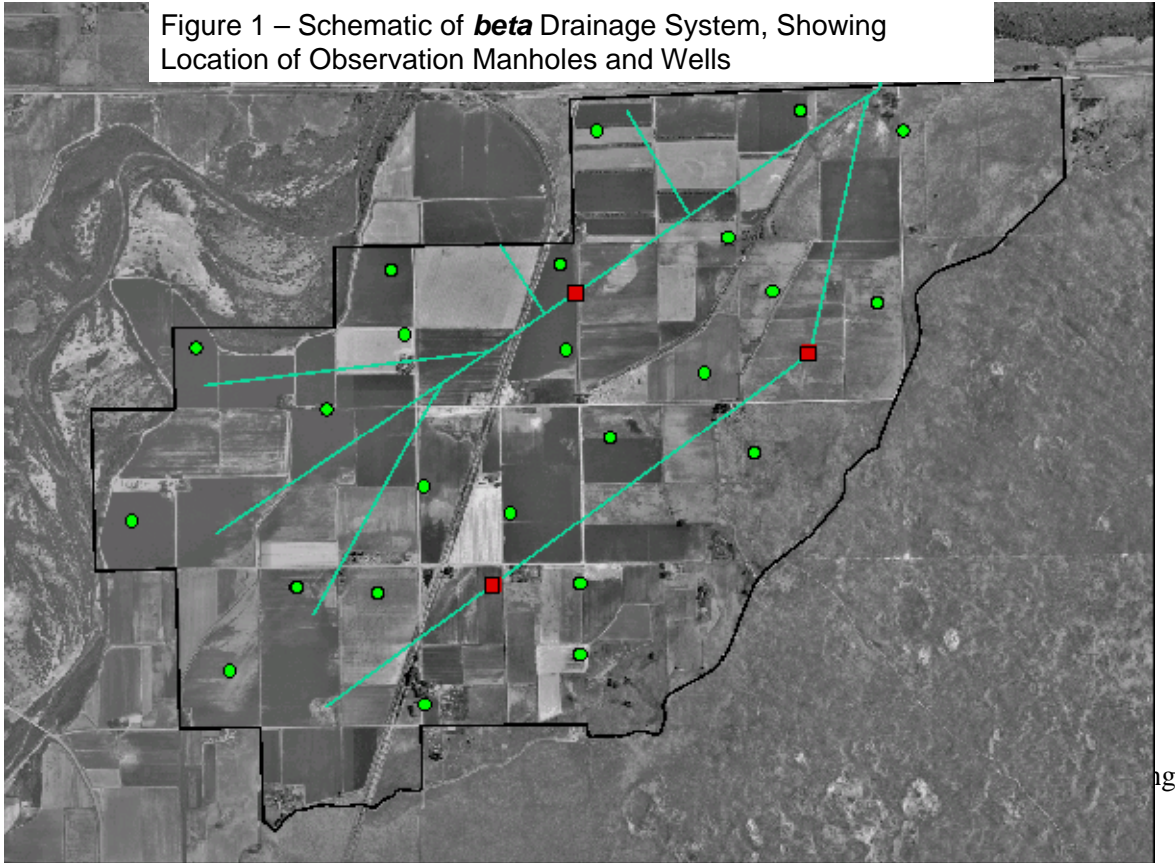
Table 1 - Early Investment in Lower Arkansas Valley Drainage  
(Water District 67) Based on Federal Land Bank Records

Drainage District	Date of Formation	Miles of Tile Drains	Miles of Open Drains	Acreage Assessed	Value of Original Serial Bonds
Granada D.D.	1922	0	11	7812	\$90,000
Arbor D.D.	1923	2	0	572	\$12,000
Kornman D.D.	1921	3	2	1754	\$28,500
Lubers D.D.	1921	0	6.5	2500	\$32,000
May Valley D.D.	1914	0	9	2000	\$25,000
McClave D.D.	1921	2	3.5	3300	\$35,000
Pleasant Valley D.D.	1917	1 (private)	5	3500	\$26,000
Riverview D.D.	1921	3	5.5	2650	\$50,000
Wiley D.D.	1918	40	10	18100	\$140,000
Holly D.D.	1922	0	22	6200	\$105,000
Dry Creek D.D.	1920	0	0	0	0
Prosperity D.D.	?	0	Not known	560	\$11,000
Deadman	?	0	Not known	2406	\$23,000
Vista Del Rio	?	0	Not known	4900	\$75,000
Total for Prowers Co.		51	74.5	56,781	\$652,500

Table 2 - Early Investment in Lower Arkansas Valley Drainage  
(Water District 17) Based on Federal Land Bank Records

Drainage District	Date of Formation	Miles of Tile Drains	Miles of Open Drains	Acreage Assessed	Value of Original Serial Bonds
Grand Valley D.D.	1923	0	3	850	\$22,000
Fairmount D.D.	1918	22	0	1900	\$25,000
Los Animas Consolidated D.D.	1911	6	0	1800	\$20,000
Los Animas Extension D.D.	1919	5	0	2351	\$30,000
Holbrook D.D.	1924	0	30	9469	\$182,000
Crowley D.D.	1923	0	Not known	4243	\$75,000
King Center D.D.	?	0	Not known	2863	41,000
Numa D.D.	1922			9616	\$175,000
Olney Springs D.D.	1921	Not known	0	2023	\$40,000
Ordway D.D.	1922			3929	\$70,000
Valley View D.D.	1922	0	Not known	4047	\$75,000
Total for Bent and Otero Co's		+33	+33	43,091	\$755,000
Total Lower Arkansas Valley		+84	+107.5	99,872	\$1,407,500

Figure 1 – Schematic of *beta* Drainage System, Showing Location of Observation Manholes and Wells



reduction in farm income due to the termination of sugar production in the 1970s. This economic slump led to further deferred maintenance of the drainage systems.

In subsequent years, farm income declined further, leading to reluctance on the part of growers to raise drainage district assessments to meet an emerging problem for crop production in the lower valley. Meanwhile, those growers who were familiar with the whereabouts of tile drain systems were beginning to pass on. Today, there is a core of older growers whose knowledge will be vital to any proposed rehabilitation of the lower valley's drainage systems. Action is being taken immediately to safeguard this important information.

It is known that many of the subsurface drains continue to carry substantial water. This is observable at identifiable outlets along wasteways, and by observing flows through very dilapidated wooden manholes throughout the lower valley. Some engineering designs of the drainage systems are available in the archives of local county assessor's offices. However, they are incomplete and often do not represent the final installation locations, particularly of the tile drain systems. Only the location of principal open collector drains is clearly observable.

Over the years, and often due to the transfer of ownership of land, there has been a loss of knowledge of the whereabouts of the tile drains under farm ground leading to these open surface collectors. This has often led to the tile drains being damaged during land preparation or during the installation of natural gas and other utility pipelines in the valley.

Although cropping and irrigation practices have changed over the years, the drainage network is still used to clear standing water from the land in wet years and to manage a generally high water table in normal years. Growers recently interviewed affirm this fact. Even recent drought years have shown considerable flows in subsurface and surface drainage networks. The predominance of clay loam and loam soils in the Lower Arkansas Valley appears to be an important reason for the continued need of the drainage districts. The natural surface drainage off bench lands and from highline canals negotiating this natural surface drainage also contribute to the need for proper drainage (see Map 2).

More modern drainage systems, such as those found in the U.S. Bureau of Reclamation's Columbia Basin Project in the State of Washington, were built with observation manholes located at every junction of lines in the tile drain system, and at the location of pipe size changes as well.<sup>4</sup> It is believed that the drainage systems in the Lower Arkansas Valley were designed with a limited number of observation manholes, making it difficult to track the performance of the valley's drainage system over time. Manholes are also needed for maintenance, and a lack of adequately constructed manholes of a width and depth sufficient to access drains do not appear to have been part of the early design of drainage systems in the Lower Arkansas Valley.

Today, lack of knowledge of the whereabouts of the drainage structures makes it difficult for the drainage districts to schedule maintenance and plan for long-term rehabilitation. Some of the subsurface drains have "boiled up" in unexpected localities, while surface collector drains have contributed to local flooding of homes.

The proposed study involves developing and/or updating maps of the drainage systems, conducting an assessment of their current condition, determining the approximate cost of rehabilitation where it is needed, and exploring the possibility of consolidating many of the small drainage districts under a new drainage district authority.

## PLAN OF STUDY

The study is being conducted in two phases, to be completed in two years. **Phase I** will involve: (1) mapping the current Lower Arkansas Valley drainage system as it is known and/or can be identified through fieldwork, showing the approximate alignment of known subsurface and surface drains and their interconnection. This will be followed by (2) a thorough cleaning of one of the smaller older subsurface and surface drainage district systems (*beta* system, see Figure 1) in the Lower Arkansas Valley.

**Phase I** mapping and cleaning activities will: (a) provide information and experience needed to estimate the per mile cost of rehabilitating the entire subsurface and surface drainage system in the Lower Arkansas Valley under different economic scenarios, (b) provide information on potential changes in the drainage patterns as a result of drainage system rehabilitation.

**Phase II** will involve completing the mapping of the drainage systems, compiling data on potential changes (benefits) in the drainage of lands resulting from the cleaning of the *beta* system, and generate an action plan for the future rehabilitation and integration of subsurface and surface drainage systems in the Lower Arkansas Valley.

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<sup>4</sup> Personal visit by the P.I. and discussions with Mr. Dan Morasch, Drainage Technician, South Columbia Basin Irrigation District, Pasco, Washington.

## DELIVERABLES

A final report of the drainage system study would include the following:

1. A brief historical review of the drainage systems in the Lower Arkansas Valley and how they arrived at their current condition, including information on the annual assessments and expenditures for the 25 drainage districts over the past ten years.
2. A complete inventory and assessment of the existing drainage system. This will include GPS/GIS mapping of the drainage system, with descriptive information and naming of all known features of the drainage system.
3. The cleaning of one section of the drainage system (i.e., the *beta* system) to obtain cost figures on potential rehabilitation.
4. Economic cost/benefit analysis of three rehabilitation scenarios; cleaning and modest improvements, major rehabilitation of the existing system, and design and construction of a new and redesigned drainage system.