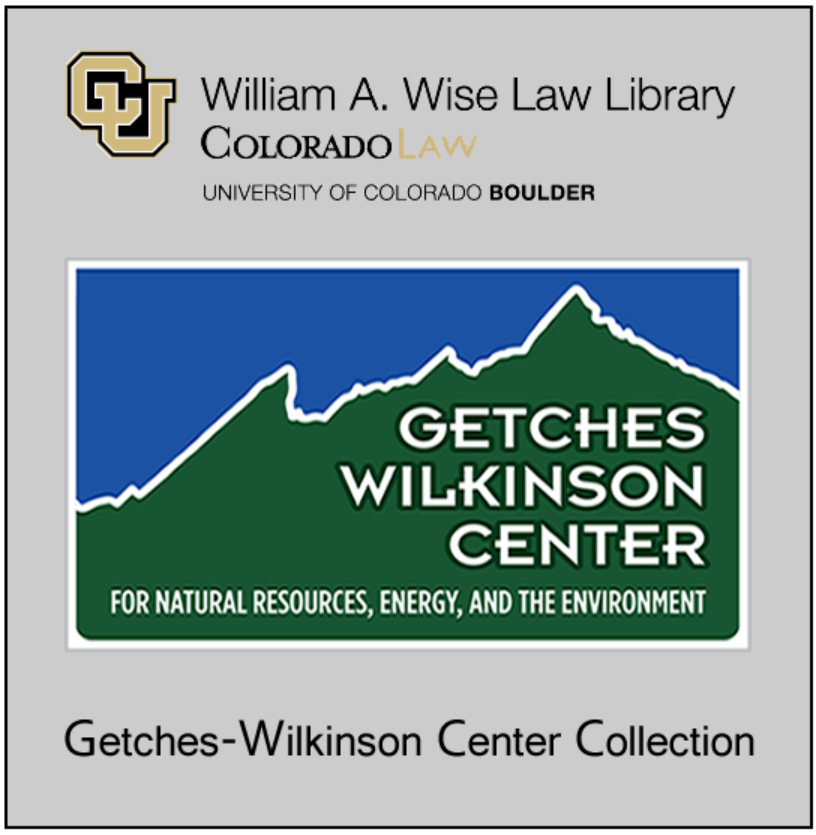
6-2-1986

Augmenting Municipal Water Supplies Through Agricultural Water Conservation

David Engels



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AUGMENTING MUNICIPAL WATER SUPPLIES

THROUGH AGRICULTURAL WATER CONSERVATION

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Western Water: Expanding Uses/Finite Supplies

Sponsored by Natural Resources Law Center
University of Colorado School of Law
June 2-4, 1986

I. INTRODUCTION

A. Municipal use of water within the State of Wyoming constitutes less than one percent (1%) of the total demand. Despite this fact, cities and towns are searching for firm, reliable water supplies to provide for their existing and future citizenry during times of drought.

The City of Casper - largest municipality within the State of Wyoming - is the holder of several junior water rights from the North Platte River. Just upstream of the City lies the various facilities contained in the Kendrick Project, one of the U.S. Bureau of Reclamation's large projects on the Platte River system. These facilities provide a firm water supply to the Project's user, the Casper-Alcova Irrigation District.

Typical of many irrigation districts throughout Wyoming, a notable lack of funds exists for the District for debt retirement and replacement. Through an innovative agreement executed in 1982, the City, District, and Bureau have taken important steps to address the problems of each entity.

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II. HISTORY OF THE KENDRICK PROJECT

A. Wyoming Senator John Kendrick, as a result of recent victory in the 1928 election, attempted to show his gratitude to the citizens of Natrona County by sponsoring a federal reclamation project for lands south and west of Casper. At that time neither President Herbert Hoover nor U.S. Bureau of Reclamation Commissioner Elwood Mead were enthralled with the project due to questionable feasibility. Senator Kendrick argued that Natrona County had contributed

$30 million in Federal Mineral Royalties from the extraction of oil, gas, and other minerals within central Wyoming. This, coupled with the high rate of unemployment in the oil and gas business because of the depression, gave Senator Kendrick additional incentive.

B. Both the States of Colorado and Nebraska objected strongly to development of the Kendrick Project, citing limited supplies within the North Platte Basin. The Wyoming Water Users Association also objected to the project because of the proposal by the Wyoming State Engineer that this project be granted a 1904 water right, based upon the supposition that this project was merely an extension of the earlier-constructed North Platte Project (irrigators in eastern Wyoming and western Nebraska had 1915 water rights).

C. In 1935, President Franklin Roosevelt approved the Kendrick Project construction with a 1934 water right. That same year both the States of Nebraska and Colorado filed suit to block the project. A Supreme Court decision was finally rendered ten years later - to be known as the North Platte Decree -

which limited the amounts of water available to the three states from the North Platte River and its tributaries. The original Kendrick Project scope proposed that 66,000 acres of land be irrigated from the project water. Today there are only 24,000 acres of land being irrigated.

D. The Kendrick Project consists of the following components (see Figure 1): Seminoe Dam Reservoir and Power Plant (1,026,360 acre-feet storage); the Alcova Dam, Reservoir, and Power Plant (165,765 acre-feet storage); and, an irrigation delivery system. The irrigation system consists of the 59-mile long Casper Canal - the backbone of the system, 190 miles of laterals, and 42 miles of drains.

Current water rights for the Kendrick Project are as follows:

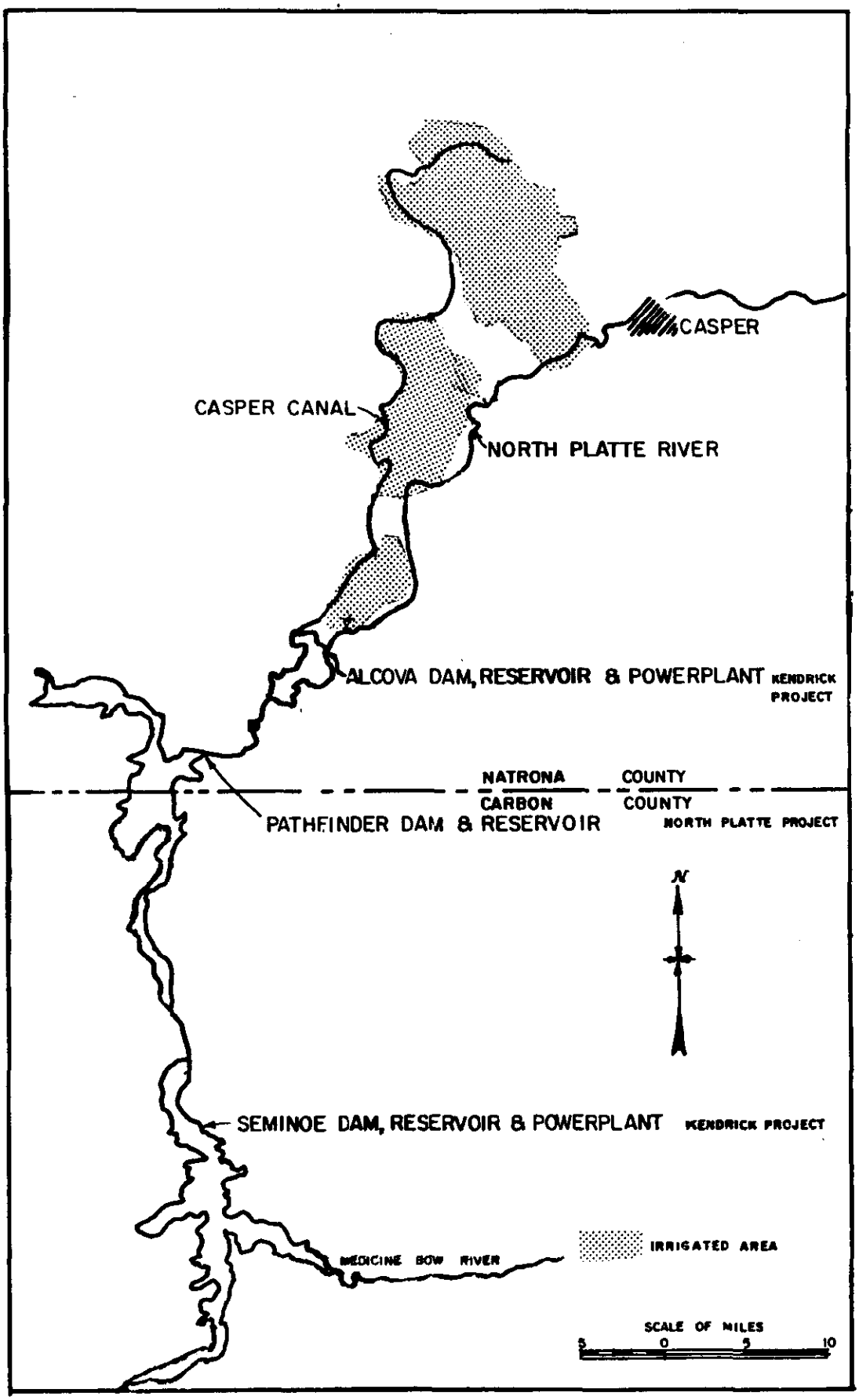
Permit	Facility	Priority Date	Use	Capacity Acre-Feet
4552R	Seminoe Res.	12/1/31	Irrigation, Power, Flood Control	1,026,360
4630R	Alcova Res.	04/25/36	Irrigation, Power	165,765

The storage water in Seminoe and Alcova Reservoirs is attached to the lands under the Casper-Alcova Irrigation District by the following secondary permits:

Permit	Ditch	Date	Acres	cfs	Source
18683	Casper Canal	12/1/31	23,300.3	Sec. Sup.	Seminoe Res.
18488	Casper Canal	7/27/34	23,134.1	330.49	O.S. Poison Spider Cr Permit 7469
				Sec. Sup.	North Platte River
18682	Casper Canal	4/25/36	23,300.3	Sec. Sup.	Alcova Reservoir

In addition, there are 964.3 unadjudicated acres - same permits.

E. The District has operated the irrigation system for the Bureau of Reclamation since 1958. The Bureau continues to operate and maintain the dams, reservoirs, and power plants. These facilities operate in conjunction with the various water storage facilities along the North Platte River in Wyoming. (See Figure 2.) The operating plan for the North Platte River provides for fall and winter release from upstream reservoirs through the power plants, to be recaptured in



KENDRICK PROJECT
FIGURE 1

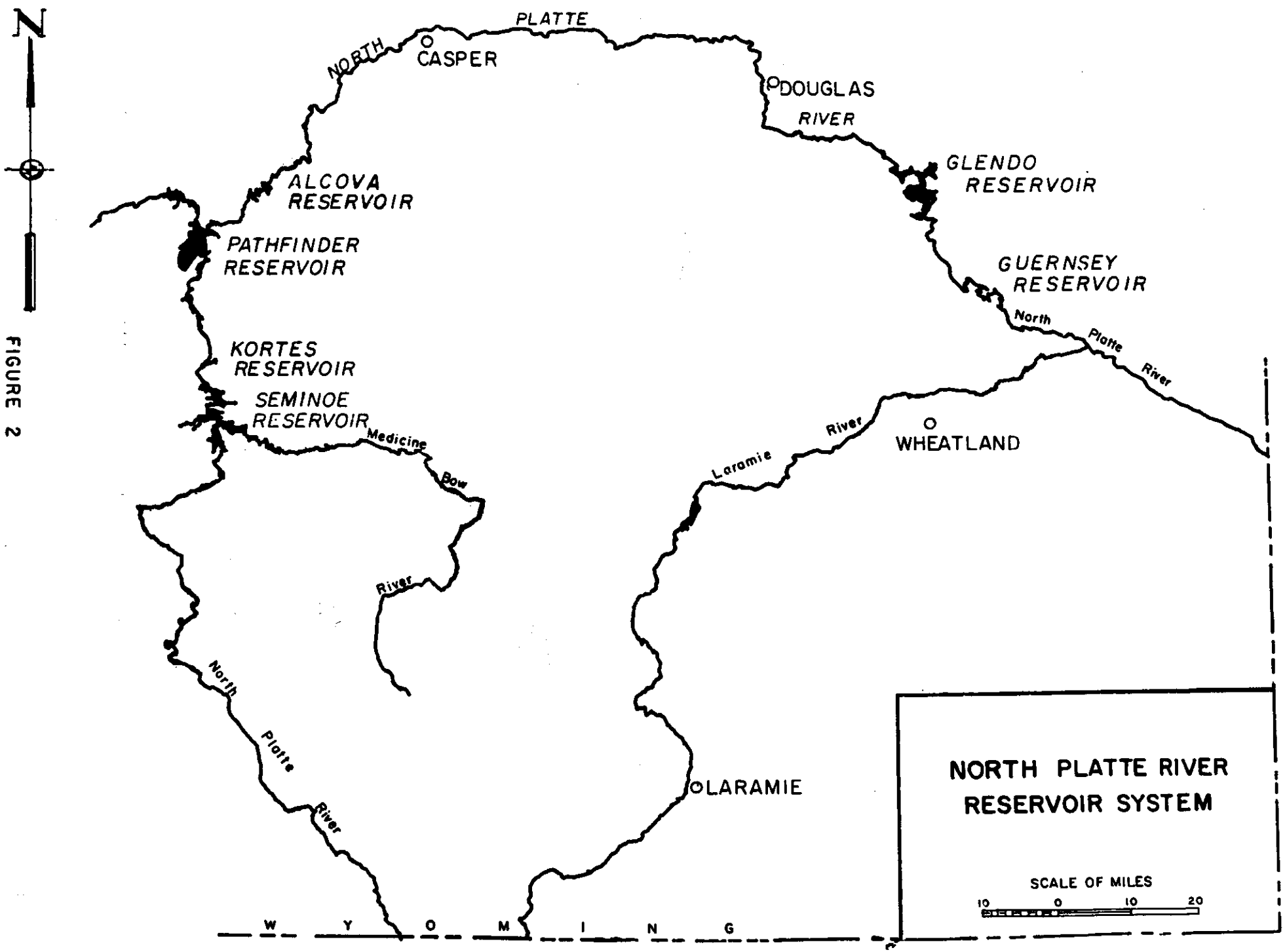

N
NORTH PLATTE RIVER
CASPER
DOUGLAS
GLENDO RESERVOIR
ALCOVA RESERVOIR
PATHFINDER RESERVOIR
GUERNSEY RESERVOIR
North Platte River
KORTES RESERVOIR
SEMINOE RESERVOIR
Medicine Bow River
WHEATLAND
Laramie River
North Platte River
LARAMIE
WYOMING
NORTH PLATTE RIVER RESERVOIR SYSTEM
SCALE OF MILES
10 0 10 20

FIGURE 2

Glendo Reservoir. This operation allows for maximum hydroelectric power generation, as well as instream flows for certain important fisheries. Seminoe Reservoir then fills in the spring without regard to its junior priority.

F. Lands under the District now produce predominantly alfalfa hay and small grains, with limited amounts of corn being grown. Some lands are used for irrigation pasture.

III. DEVELOPMENT OF THE CAID - USBR - CITY OF CASPER SYSTEM IMPROVEMENT PROJECT

A. Need for the Project.

1. Casper-Alcova Irrigation District. The original contract between the District and the Bureau of Reclamation was signed in 1935 and was based upon a service area of 35,000 acres. Currently, approximately 24,000 acres are being irrigated. The District's original obligation to repay $2.8 million of the project's construction cost has been reduced to $600,000. The remainder of the Kendrick Project costs are allocated to hydroelectric power and other purposes.

Later amendments to the contract have provided an additional debt obligation to the District, which has now made their total indebtedness to the Bureau of Reclamation $750,000.

Certain lands within the system have proven to be unsuitable for irrigation. Extensive seepage from the distribution system has complicated this problem. Because of the relatively short growing season and marginal soil conditions, most of the crops grown are of low value. The limited lands and crop values inhibit the ability of the District to pay for its operation and maintenance cost, let alone the cost to rehabilitate the leaking distribution system and service the debt to the Bureau of Reclamation. Many landowners are "recreational" farmers who do not rely upon the land as their main source of income, due to the close proximity of Casper and its more lucrative oil-related jobs.

2. The City of Casper. Casper has historically relied upon shallow alluvial wells

for its water supplies. After 1970, the growing population necessitated that a surface water treatment facility be constructed. This treatment facility thus has water rights junior to almost every irrigation and industrial user along the North Platte in this region. The State Engineer has also stated that the shallow groundwater wells are subject to regulation in the same manner as surface water due to the direct relationship between the river and the alluvium aquifer. Thus, the City does not have firm, reliable water supplies for its citizenry during times of drought.

The City has identified both its current and projected water needs, based upon continued growth of the region because of the vast energy resources present. (See Figure 3.)

The City considered several alternatives to meeting its existing and future water demands:

a. The purchasing and transferring of senior irrigation water rights to

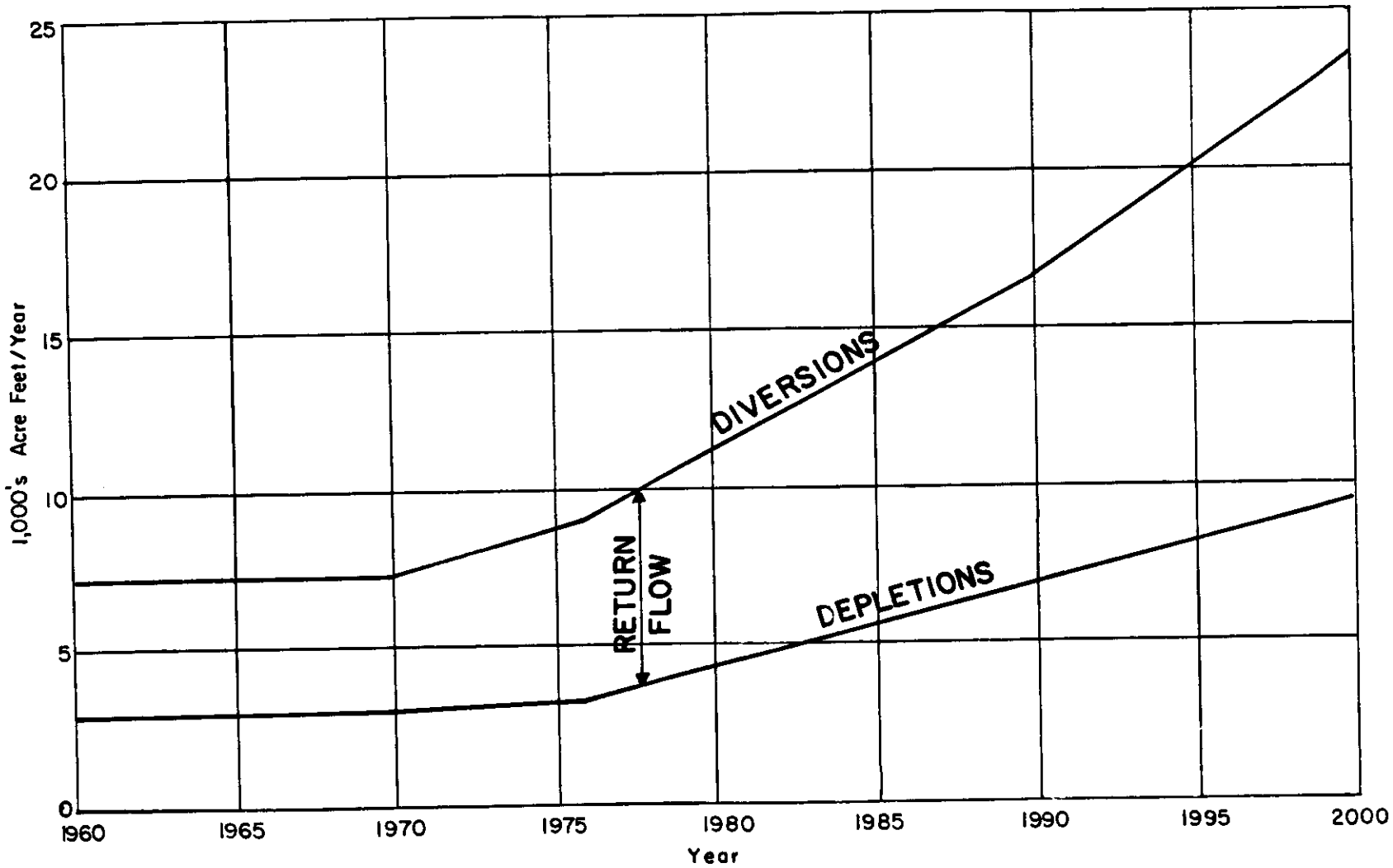
the City for municipal purposes. This is a politically unpopular means of supplying municipal water in this agricultural-oriented state, although conceivably cost-effective. Denials of two proposed transfers from irrigation to municipal and/or industrial use in the period of 1980-85 have proven this to be a disfavorable method of water supply procurement.

b. The development of unallocated water within the North Platte Basin. Because of the limits of the North Platte Supreme Court Decree, the amounts of water actually available within the system, and the high local cost, this was not looked upon as a viable means of obtaining additional water. Recent plans to construct the Deer Creek Dam Project near Casper anticipate high state subsidy to make it attractive to local users.

c. Develop trans-basin diversion projects into the North Platte Basin

FIGURE 3

CASPER'S PROJECTED WATER USE



(Little Snake River Water Management Project). Because of the large costs involved (± $225 million) and its political unpopularity, this alternative has not been vigorously pursued.

d. Construct groundwater supply facilities which are not tributary to the North Platte River. This alternative was seen and has proven to be a hit-or-miss alternative. In 1982, Casper used state funds to drill to the Madison formation, only to encounter groundwater of poor quality and quantity.

e. Negotiate with the Casper-Alcova Irrigation District to obtain some of the Kendrick Project water supply.

Because of the Kendrick Project's location immediately upstream of Casper, the City employed a consulting engineer to investigate possible ways to obtain water via alternative e. The consulting engineer, Wright Water Engineers (WWE),

concluded that water savings improvements could in fact be made which would provide both a cost-effective and politically popular method of obtain water for the City.

3. U.S. Bureau of Reclamation. The District's lack of available funds for rehabilitation and debt service meant:

   a. That much of the Bureau's water supply being made available to the District was being lost; and,

   b. The prospect of receiving funds from the District for debt retirement grew more and more distant.

B. Contract Negotiations and Development.

1. The original development plan for the Kendrick Project and its Wyoming water right did not allow for the use of Kendrick Project water as a municipal use. The Bureau of Reclamation thus looked at two alternatives in order to provide for this municipal purpose.

a. Request Congress to specifically authorize a new project purpose.

b. Using the general authority provided by the Reclamation Project Act of 1939, which allows the authorization to furnish a municipal water supply from the existing Kendrick Project in such manner as to not in any way impair the District's use of the facilities. This would include provisions such that Casper would pay for its appropriate share of the operation, maintenance, and fixed costs of the Kendrick Project.

The Bureau of Reclamation chose to implement alternative b. This required implementation of the following tasks.

i. Identify more specifically areas where the existing system could be improved and water could be conserved such that a water supply could be made available to the City without impacting the District's use of the water for irrigation.

ii. Determine the effect of the City's use of these "additional" waters upon downstream North Platte River water rights.

iii. Conduct an environmental assessment of the proposed system improvement and conservation plan.

iv. Coordinate the use of these "additional" waters with the State Engineer in such manner as to receive the necessary permits and water rights.

Tasks i, ii, and iv were addressed via a contract between the City and Wright Water Engineers. The City also contract with Environmental Research and Technology Inc. (ERT), in order to conduct an environmental assessment of the proposed project to determine potential environmental impact.

Via the contract with the City, WWE looked closely at the distribution system being operated by the District. Significant water

losses were identified from seepage through the various canals and ditches, this seepage water being used non-beneficially by evaporation and phreatophytic plants. WWE recommended various improvements to alleviate this seepage, including the installation of ditch and canal liners, pipeline construction, and rehabilitation of structures such as headgates, siphons, checks, and drops. It also identified approximately 8,000 acre-feet of water being lost via this non-beneficial use. It further recommended that a rehabilitation and betterment program could be implemented which could save approximately 7,000 acre-feet of water, which could be made available to the City. Because of the fact that much of this water was being used non-beneficially, the impact upon downstream appropriators via historical return flows from the District would prove to be negligible. WWE also coordinated with the State Engineer's Office to identify legally acceptable means of identifying this potential water supply for the City. This later resulted in permits being issued to the City of Casper identifying the source of water as the Kendrick Project via the system improvement program.

ERT addressed the wetlands which could potentially be impacted by the proposed conservation project. As a result of the assessment, a Finding Of No Significant Impact was eventually issued for the proposed project.

2. The above studies and recommendations finally led the City, Bureau, and District to sign an agreement in April, 1982, calling for the following:

   a. The City was to pay off the District's existing $750,000 indebtedness to the Bureau in three equal installments of $250,000 annually.

   b. The City was to pay the District not less than $150,000 annually, said funds to be used by the District to implement a system improvement program which would yield up to 7,000 acre-feet per year, said water savings being made available to the City as the improvements are performed.

c. The water made available to the City was specifically not a water right, merely a water supply. The contract was for a term of 40 years, to be renewed upon terms and conditions agreeable among the Bureau, the City, and the District.

d. The City was to pay the Bureau an annual water service charge of $24 per acre-foot of water delivered to the City. Additionally, the City was to pay a prorata share of the estimated annual operation and maintenance cost of the project allocated to irrigation.

e. The Bureau would "after consultation with the District and the City" determine the amount of water savings made available by the system improvements. In the event that the City requires water prior to the time that the 7,000 acre-feet of water was made available, the City could "borrow" water from the District in amounts of 7,000 acre-feet per year.

f. All water delivered to the City was to be released and measured through Alcova Reservoir for diversion by the City at its raw water intake. The City was to be responsible for all conveyance losses and transportation of the water from Alcova to Casper.

III. PROJECT IMPLEMENTATION

A. Financial.

The City has lived up to the letter of the agreement by providing three annual installment payments of $250,000 each for the repayment of the District's loan from the Bureau, and has also provided $150,000 for the past four-year period. These monies have been used to pay for the salaries of hydrologists necessary in the measurement of potential water savings and for the construction of the system improvement program to date. The City received a Farm Loan Board loan in the amount of $750,000 to pay for the District's debt retirement. The terms of this loan are six and one-half percent (6 1/2%) for 20 years, thus the City is paying the State $68,067 annually to retire the District's debt.

In 1985, Wyoming State Legislature recognized potential benefits of this project and allocated funds up to $1,263,000 to be applied as matching funds for all future construction work undertaken as part of this project.

B. Preliminary Investigations.

Upon execution of the 1982 contract, the District employed the services of the Soil Conservation Service (SCS) to implement both a long-range conservation plan and an annual system improvement program. The SCS, using the WWE's report on the potential water savings areas, as well as cumulative information on the District, attempted to identify the most cost-effective areas for rehabilitation. Soils data was then used in conjunction with the Moritz equation to identify specific improvement sections and associated costs.

Moritz Equation - $S = 0.2\ C\sqrt{Q/V}$

Where: S = loss in cubic feet per second per mile of canal

Q = discharge in cubic feet per second

V = mean velocity in feet per second

C = cubic feet of water lost in 24 hours through each square foot of wet land area of canal prism.

C values range from 0.31 for clay to 1.68 for loamy sand.

The SCS report identified capital construction costs ranging from $55 per acre-foot to over $4,000 per acre-foot, with lateral systems deemed to be the most cost-effective means of generating water savings.

C. Water Loss Measurements.

The District has employed a full-time hydrologist and part-time technician/inspector for the purpose of attempting to quantify the amount of water lost in the District's system. The technician/inspector also performs instruction and inspection services. Salaries are paid out of the money provided by the City. The measurement team uses two techniques to quantify water losses - the

inflow/outflow method and infiltration testing.

1. Inflow/Outflow.

Measurements are taken at the point of turnout from the main canal. Water is then measured at each turnout from this lateral, as well as at the end of the lateral. The difference between the amount of water measured entering and leaving the lateral section is the loss for that section, less all farm turnouts. Parshall flumes, cipoletti weirs, and control sections with rated curves are used in conjunction with water stage recorders to determine flows.

2. Infiltration tests are made by filling sections of pipe (that are driven into the bottom section of the canal at 1,500 foot intervals) with water in such manner as to approximate the normal operating level for that canal section. Water is added and measured in order to keep the water level constant. Measurements are not accurate enough to use this as reliable field data for water

savings, but rather to identify potential areas for future inflow/outflow study.

Rainfall and evaporation are also quantified, although they have not significantly effected water loss measurements.

D. Although the first section of rehabilitation improvements used only one year's worth of field data, the State Engineer and Bureau have recommended more lengthy studies of two to three years minimum in order to substantiate water savings.

E. The first phase of rehabilitation improvements was constructed on Lateral 41 in 1984. The canal section was replaced with 13,600 feet of PVC underground pipe at a cost of $183,000, for a savings of 382 acre-feet of water made available to the City ($479 per acre-foot). In 1985, 13,600 feet of lateral 210 was concrete-lined at a cost of $268,000, with a savings of 333 acre-feet of water ($805 per acre-foot). The lower two sections of Lateral 210 are proposed to be lined in the fall of 1986 at a cost of approximately $300,000 for a savings of 894 acre-feet of

savings ($335 per acre-foot). Total construction cost for all rehabilitation improvements constructed as of January 1, 1987, will be approximately $751,000 for a savings of 1,609 acre-feet, giving a capital construction cost average amount of $467 per acre-foot.

F. Annual project costs to the City of Casper are identified below:

$750,000 Farm Loan Board (6 1/2% @ 20 years)	$ 68,067
Rehabilitation Improvements 700,000 acre-feet x $467/acre-foot x .1057[1]	345,533[2]
Less State Share of Rehabilitation Improvements $1,263,000 x .1057[1]	(133,499)
U.S. Bureau of Reclamation Service Charge 7,000 acre-feet x $24/acre-foot	168,000
City of Casper Share of Project $\frac{7,000 \text{ acre-feet}}{60,000 \text{ acre-feet}} \times \$70,000$	8,166
	$733,733

$733,733/7,000 acre-feet = $105/acre-feet/year, or $.32/1,000 gallons

1 .1057 = capital recovery factor - 8 1/2% @ 20 years

2 Upon completion of improvements, City to pay to the District a charge of not less than $25/acre-foot after completion of improvements, decreasing this annual amount to 7,000 acre-feet x $25 = $175,000.

IV. PROJECT CONSTRAINTS/PROBLEMS

A. Determination of the actual water to be conserved has been proven more extensive than originally envisioned. Field measurements have oftentimes proven inaccurate or inconclusive. Three years worth of data has sometimes been "wasted" because the amount of water savings possible was shown to not be cost-effective.

B. Construction costs are higher than originally thought. Original cost estimates for the water to the City were to total $60-70 per acre-foot annually. Actual costs are proving to be approximately $105 per acre-foot per year annually, which includes a State subsidy.

C. The most cost-effective savings are in sandy soils. These are not the problem areas, however. Problem areas are in clay soils which do not drain effectively. Thus farmers with problems concerning wasted wetlands are not being aided.

D. The project has directed itself to cost-effective rehabilitation improvements and has not extensively considered possible return

flow impact. This has become a concern to the Bureau because of possible downstream appropriator complaints.

E. The most cost-effective savings have been determined to be on the laterals as opposed to the main canals. This is not in strict compliance with the original 1979 report prepared by the WWE.

F. Because of the relatively small amounts of water to be released through the Alcova Dam outlet works (5-30 cfs), the State Engineer has requested an actual measurement of the water diverted for the City's purposes. This would involve construction of separate outlet works at Alcova Dam for the smaller amounts, or measured diversion through the Casper Canal and conveyance via a drainageway back to the North Platte River.

G. The contract does not allow Casper to carry-over storage water from one year to the next. Thus, Casper cannot store water during wet years when it does not need the Kendrick Project water.

H. There is some concern that a total of 7,000 acre-feet of water cannot economically be

saved. This fear is based upon the more intensive water measurement studies conducted by the District over the past few years.

V. CONCLUSION

In 1982, a water savings agreement among the City of Casper, Bureau of Reclamation, and Casper-Alcova Irrigation District was a very desirable project to be implemented. The project serves to benefit all parties and does not appear to detrimentally affect anyone. By invoking rehabilitation practices to create additional water supplies has proven to be a very popular alternative to the development of additional municipal water supplies by more conventional methods (dam and reservoir construction) and transfer of irrigation water to municipal use. Initial cost projection showed the project to be very costeffective; however, history of the rehabilitation improvements has shown it to be not as cost-effective as originally envisioned, although still an efficient means of providing a water supply.

Several constraints and problems that were unforeseen at the time of the project signing have increased the cost of the water and provided barriers to the project's full implementation. Nonetheless, it appears that these constraints and

problems can be overcome, and that the project can be implemented essentially in the manner as it was conceived.